Fundamental Movement Skills of Childhood

Fundamental locomotor skills are the building blocks of more specific skills developed later in childhood.

Prewalking Movements
- Crawling
- Creeping
- Locomoting with hands held

- Major limitation
  - The hands are required to move
  - Child cannot explore the environment
Walking

- Characterized by a progressive alteration of leading legs and continuous contact with the support surface
- **Gait cycle** or walking cycle –

Phases of the Gait Cycle

- **Swing phase**
  - Begins when foot of one leg leaves support surface
  - Ends when foot touches surface
- **Support phase**
  - Time when balance is maintained on one foot
  - Right foot in swing phase while left foot is in support phase
- **Double support phase**
  - When both feet are in contact with the ground

Walking

- Independent walking requires
  - Leg strength
  - Equilibrium
  - Initial walking patterns in the infant are designed to foster equilibrium
Balance Facts
• Also called postural control
• Two types of balance
  – Static
  – Dynamic
• Task specific
• Affected by growth and developmental changes
  – Foot length, base of support (BOS) width, height of the center of mass (COM) over the BOS

Balance Facts
• Static balance requires the processing of visual information
• Negative correlation between balance and body fat

An Infant’s First Steps
• Short, quick, rigid steps
• Toes point outward
• Use of wide base of support
• Flat-footed contact with floor
• Arms in high-guard position
• Arms are rigid
  – Arms are not swung freely in opposition to legs
Walking

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Appearance*</th>
<th>Range *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heel strike</td>
<td>22.6</td>
<td>3-50</td>
</tr>
<tr>
<td>Base within lateral dimensions of the trunk</td>
<td>17.5</td>
<td>5-43</td>
</tr>
<tr>
<td>Synchronous movement of upper extremities</td>
<td>21.6</td>
<td>6-43</td>
</tr>
<tr>
<td>Double knee lock</td>
<td>27.2</td>
<td>8-55</td>
</tr>
</tbody>
</table>

* Weeks after the onset of independent walking

Walking

- Immature walker ~ Note the high guard-arm position, wide base of support, flat-footed contact, and toeing-out

Walking ~ Dynamic Base

- A change in the width of the base of support from wide (immature walking) to narrow (mature walking)
- Average step width is
- Average step width is
- Average step width is
Walking ~ Dynamic Base

• With improved balance, the base of support narrows, the arms are lowered and work in opposition to the legs, and the toes point more in a forward direction

Walking ~ Dynamic Base

• In mature walking, a heel strike is exhibited

Walking ~ Foot Angle

• Amount of toeing in or out
• Toeing out decreases during first 4 years
• Toeing in is considered abnormal
Walking ~ Walking Speed

- Determined by the length of the stride and the speed of the stepping movements
- Until infant gains sufficient neuromuscular control, he/she must take more steps per unit of time to increase walking speed
- Step frequency decreases with advancing age during childhood years

walking speed table:

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Step Length (cm)</th>
<th>Stride Length (cm)</th>
<th>Steps/min</th>
<th>Walking Speed (cm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21.6</td>
<td>43.0</td>
<td>175.7</td>
<td>63.7</td>
</tr>
<tr>
<td>2</td>
<td>27.5</td>
<td>54.9</td>
<td>155.8</td>
<td>71.8</td>
</tr>
<tr>
<td>3</td>
<td>32.9</td>
<td>67.7</td>
<td>153.5</td>
<td>85.5</td>
</tr>
<tr>
<td>7</td>
<td>47.9</td>
<td>96.5</td>
<td>143.5</td>
<td>114.3</td>
</tr>
<tr>
<td>Adult</td>
<td>65.5</td>
<td>129.4</td>
<td>114.0</td>
<td>121.6</td>
</tr>
</tbody>
</table>

Walking ~ Walking Speed

- Gait changes occur by 3 years of age
- Little difference in walking patterns between 3 and 7 year old children
  – Stride length and high step frequency in younger children
- Recent research indicates that stride dynamics may not be mature completely in some children even by age 7 yr.
## Walking ~ External Loads

- An example of how environmental conditions influence movement patterns
  - Complaints of back & shoulder pain from carrying book bags
    - Forces children to walk with improper mechanics and movement patterns
  - Book bag or backpack weight should not exceed 10% of body weight in young children

## Walking with and without Shoes

- Wearing shoes allows the child to walk with a more mature walking gait
- Longer steps can be taken
- Better dynamic balance

## Running

- Natural extension of walking
- Characterized by an alternate flight phase
Running ~ Requirements

- Adequate lower limb strength to propel body through air
- Adequate lower limb strength to handle the additional force encountered when the airborne foot strikes the supporting surface
- Improved motor coordination to control the moving legs

Running

- Immature running is similar to immature walking
  - Wide base of support
  - Arms held in high guard position
  - Flat-footed contact with floor
- Reverting to an immature walking pattern allows the child to improve balance and confidence for the new movement

Running ~ Pattern

- Phases
  - Support
  - Flight
  - Recovery
- Arm action is important
Running ~ Support Phase

• The leg
  – Absorbs the impact of the striking foot
  – Supports the body
  – Maintains forward motion while accelerating the body's COG
  – Provides thrust to propel the body forward
• Inexperienced runners run flatfooted

Running ~ Flight Phase

• Body is thrust into the air by a vigorous extension of the support leg
• Immature runner unable to project body through space
  – Does not use thrust leg
• Hip, knee, and ankle are required for full extension and to generate maximum thrust

Running ~ Recovery Phase

• Back leg is brought forward quickly
• Experienced runners flex the knee so the recovery foot comes close to hitting the buttocks
• Inexperienced runners have very little knee and hip flexion
  – May cause child to stumble
  – Inadequate clearance between foot and ground
Running ~ Arm Action

• Beginning
  – Arms are flexed and held in high guard position
• More adult-like
  – Arms are lowered and hang free, but do not help with running speed (by working in opposition to the legs); arms swing across midline of body
• Experienced
  – Arms are in opposition to legs, elbows flexed at 90°, vigorous pumping action toward (not across) midline

Running

• Two ways to analyze developmental sequences in running
  – Component approach
    • See Table 12.4 for example
  – Whole body approach
    • See Figure 12.3 in text for example

Running

• Arms are extended sideward at shoulder height
• Stride is short and of shoulder width
• Surface contact is made with the entire foot, striking simultaneously
• Little knee flexion
• Feet remain near surface
Running

- Arms are carried waist high
- Stride is long
- Surface contact is made with entire foot, striking simultaneously
- Greater knee flexion
- Swing leg is flexed
- Movement of legs becomes anterior-posterior

Stage 2

Running

- Arms are no longer used for balance
- Arms are carried below waist level and may flex
- Foot contact is heel-toe
- Stride length increases
- Both feet move along a midsagittal line
- Swing-leg flexion may be as great as 90°

Stage 3

Running

- Foot contact is heel-toe (except in sprinting)
- Arm action is in opposition to leg action
- Knee flexion is used to maintain momentum during support phase
- Swing leg may contact buttocks during recovery

Stage 4
Running ~ Inappropriate Movements

- **Inversion** during support phase
  - Results in medial rotation of the leg and thigh
  - Oblique, rather than anterior-posterior pattern as the leg comes forward in swing phase

- **Eversion** during support phase
  - Results in lateral rotation of the leg and thigh
  - Accompanied by exaggerated counter-rotary action of the arms in an attempt to maintain balance

Running ~ Speed

- Girls’ running speed peaks at about 14 to 15 years of age
- Boys’ running speed improves beyond 17 yr
- Between 9 and 17 years of age
  - Girls improve running speed by 8%
  - Boys improve running speed by 20%
- The more immature runner takes much longer to perform a specified run distance (30 yard dash)

Jumping

- Body is projected into the air by force generated in one or both legs
- Body lands on one or both feet
- Forms of jumping
  - Hopping
  - Leaping
- The downward leap may be the first jumping experience when going down a step
Jumping

• **Horizontal** and **vertical** jumping are most often studied in children

• Phases
  – Preparatory phase
  – Takeoff phase
  – Flight phase
  – Landing phase

Jumping ~ Horizontal

• Preparatory phase
  – Crouch (flexion at hips, knees, ankles)
  – Backward swing of the arms
  – Missing in inexperienced jumpers

Jumping ~ Horizontal

• The advanced jumper fully extends the body during the **takeoff phase**
Jumping ~ Horizontal

• **Takeoff and flight phases**
  – Rapid and vigorous extension of the hips, knees and ankles
  – Vigorous swing of the arms in the direction of desired travel
  – Provides the impetus for the body to become airborne

Jumping ~ Horizontal

• Takeoff and flight phases in the inexperienced jumper
  – Little or no crouch
    • Little if any extension of body segments
  – Arms are not integrated with the lower extremities to increase the momentum (mass x velocity)

• For maximum distance, takeoff angle should be 45°

Jumping ~ Horizontal

• **Landing phase**: The advanced jumper absorbs the landing forces by flexing the knees, hips, and ankles at impact

• Stiff-legged landings can result in serious injury
Jumping ~ Standing Long Jump

- Vertical component of force may be greater than horizontal
- Jump is upward rather than forward
- Arms move backward, acting as brakes to stop the momentum of the trunk.
- Legs extend in front of the center of mass.

**Stage 1**

**Total Body Approach**

Jumping ~ Horizontal

- Arms move in an anterior-posterior direction during the preparatory phase
- Arms move sideward during the in-flight phase
- Knees and hips flex and extend more fully
- Angle of takeoff is above 45°
- The landing is made with the center of gravity above base of support
- Thighs are perpendicular to the surface rather than parallel

**Stage 2**

Jumping ~ Horizontal

- Arms swing backward and then forward during preparatory phase
- Knees and hips flex prior to takeoff
- Arms extend and move forward during takeoff
- Knee extension may be complete
- Takeoff angle is > 45°
- Upon landing, thigh is less than parallel to the surface
- Center of gravity is near the base of support

**Stage 3**
Jumping ~ Horizontal

- Arms extend forward and upward upon takeoff, reaching full extension above the head
- Hips and knees are extended fully
- Takeoff is <45°
- Upon landing, thighs are parallel to the surface
- Center of gravity is behind base of support
- Knees flex and arms thrust forward at contact in order to carry center of gravity beyond the feet

Stage 4

Age at which 60% of boys and girls are able to perform at a specific level

Jumping ~ Vertical

- 248 boys and 232 girls aged 7-11 (grades 1-5) performed four vertical jumps with a countermovement and four jumps without one
- Countermovement = crouch with immediate jump
- No countermovement = crouch and hold for 3 seconds

Jumping ~ Vertical

- Contrary to adult populations
  – Children performed better without the countermovement
- Children had not yet acquired neural coordination
- No difference between boys and girls until age 11 yr
### Jumping ~ Vertical

#### Initial Stage
- Inconsistent preparatory crouch
- Difficulty in taking off with both feet
- Poor body extension on takeoff
- Little or no head lift
- Arms not coordinated with the trunk and leg action
- Little height achieved

#### Elementary Stage
- Knee flexion exceeding 90° on preparatory crouch
- Exaggerated forward lean during crouch
- Two-footed takeoff
- Entire body not fully extended during flight phase
- Noticeable horizontal displacement on landing

#### Mature Stage
- Preparatory crouch with knee flexion from 60° to 90°
- Forceful extension at hips, knees, and ankles
- Simultaneous coordinated upward arm lift
- Upward head tilt with eyes focused on target
- Full body extension
- Elevation of reaching arm by shoulder girdle tilt combined with downward thrust of nonreaching arm at peak of flight
- Controlled landing very close to point of takeoff
Hopping
• A form of jumping
• One foot is used to project the body into space with landing on the same foot
• More difficult than the two-footed jump
• Performed better on preferred foot

Hopping
• Requires additional strength and better balance
• Girls are approximately 6 months advanced compared to boys
• Very few children are able to exhibit a mature hopping pattern by age 5 yr
• See Table 12-10 for the developmental sequence approach

Hopping
• Nonsupport knee is flexed at 90°
• Nonsupport thigh is parallel to surface
• Body is in upright position with arms flexed at elbows
• Hands are near shoulder
• Force production is limited

Stage 1
Hopping

- Nonsupport knee is fully flexed – foot near buttocks
- Thigh of the nonsupport leg is nearly parallel to the surface
- Trunk is flexed
- Arms participate vigorously in force production
- Balance is precarious
- Number of hops equals 2 to 4.

Stage 2

Hopping

- Thigh of nonsupport leg is vertical with knee flexed at 90° or less
- Greater forward body lean
- Greater distance in relation to the height of hop achieved
- Knee of nonsupport leg is vertical, but knee flexion varies
- Arms are used in force production

Stage 3

Hopping

- Knee of the nonsupport leg is at 90° or less
- Entire leg swings back and forth like a pendulum to aid in force production
- The arms are carried close to the body, elbow at 90°
- Nonsupport leg increases force production, so arm use decreases

Stage 4
Gallop, Slide, and Skip

- Fundamental motor patterns can be combined to elicit new movement patterns
- Gallop is exhibited first
  - A forward step followed by a leap onto the trailing foot
  - Same leg always leads
  - Performed in a front-facing direction
  - Emerges around age 2 years

Gallop

- Pattern resembles an uneven run
- Tempo is fast and rhythm inconsistent
- Trail leg crosses in front of the lead leg during the airborne phase
- Both feet generally contact the floor in a heel-toe pattern

Stage 1

- Slow to moderate tempo with rhythm appearing choppy
- Trail leg moves in front of, adjacent to, or behind lead leg during airborne phase, but is adjacent to or behind lead leg at contact
- Trail leg is extended during airborne phase
- Transfer of weight is stiff
- Vertical component is exaggerated
**Gallop**

- Pattern is smooth, rhythmical, and at a moderate tempo
- Trail leg may cross in front of or move adjacent to lead leg during airborne phase
- Trail leg placed adjacent to or behind lead leg at contact
- Both trail and lead legs ≤ 45° with feet carried close to surface during airborne phase

**Slide**

- The slide is the same as a gallop, except instead of moving forward, the slide is performed in a sideward direction
- Difficult because the child must face ahead while moving in a sideways direction

**Sliding**

- Sliding is a very important motor skill as it is used in many sports
- Examples
  - Sliding the baseline in tennis
  - Leading off on a base
  - Guarding a basketball opponent
Skipping

• Most difficult motor pattern of the three
  – Forward step followed by a hop on the same foot
    • Requires a duel task of one leg
  – There is alternation of the leading leg
  – Balance may be difficult
  – See Table 12-11 for developmental sequence

Skipping

• Girls are generally more advanced than boys
• Girls at stage 3, 6-7 months before boys
• All children start to skip between 6th and 7th birthday

Skipping

• Step-hop pattern
• Little effective use of arms
• An exaggerated step or leap is present during the transfer of weight from one supporting limb to the other
• Total action appears segmented
Skipping

- Rhythmical transfer of weight during the step phase
- Increased use of arms in providing forward and upward momentum
- Exaggeration of vertical component during airborne phase (hop)

Stage 2

- Rhythmical transfer of weight during all phases
- Reduced arm action during the transfer of weight phase
- Foot of the supporting limb is carried near the surface during the hopping phase

Stage 3

Age at which 60% of boys and girls are able to perform at a specific level