Ergonomics for Children

... Rethinking assumptions

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"Child Ergo" Challenges

- Range of body sizes
- Rate of growth
- Strength capabilities
- Cognitive & functional characteristics

Child Anthropometrics

- Infants, Children & Youths to 18

- CHILData: Handbook of child measurements
  www.humanics-es.com/recc-child.htm

Developmental stages are predictable, but the timing varies between children

CDC's growth charts by age (birth to 36 months)
www.cdc.gov/growthcharts

CDC's growth charts by age (2 to 20 years)
www.cdc.gov/growthcharts
Children's bone growth

- By 7, girls' bone size = 80% peak
- Bone Mineral Content (BMC) = 40%

(Bass et al, J Clin. Invest, 1999)

Body Mass Index, by age (boys, 2 to 20 years)

Body Mass Index, by age (girls, 2 to 20 years)

Body Mass Index, by age (boys, 2 to 20 years)

Body Mass Index, by age (girls, 2 to 20 years)

Obesity among children

Child obesity tripled 1960's → 1990s
- Among children, aged 6-11
  → Increased from 4% in 1965 to 13% in 1999
- Among adolescents, aged 12-19
  → Increased from 5% in 1970 to 14% in 1999
- Similar increase among boys and girls

Child strength

- Boys & girls 2-15 years did not differ sig.
  (150 subjects - Peebles & Norris, IEA 2000)
- Boys stronger than girls by the age of 10
- By the 16th year, males much stronger
- Max. strength does not increase after 16.
**Child strength**

- Poor correlation between types of grip (finger push / hand push / twist / pinch etc.)

(150 subjects - Peebles & Norris, IEA 2000)

**Child Physical Abilities**

- Children's abilities are often over-estimated.
- Exceed limits → increase risk

North American Guidelines for Agricultural tasks

**Children & MSDs**

- Children experience MSDs.
- Child MSDs differ from adults.
- These affect...
  - Product designs
  - Design of the built environment
  - Task design

**Muscle dynamics change with age...**

Younger children have...
- Slower muscle relaxation
- Slower rapid alternating movements
  - Muscle relax time: 90 ms at age 3 → 40 ms at 10 (half-times)
- Smaller muscle fiber diameters
  - Significant increase in muscle fiber diameters at 10

Lin & Walsh (1994) Physiological maturation muscles in childhood. The Lancet

**MSDs**

- Stretches & exercise promote slow-twitch
- Disuse → fast-twitch & muscle spasticity
- This can → to dynamic muscle imbalance
- Hinders recovery from muscle tension

Lin & Walsh (1994) Physiological maturation muscles in childhood. The Lancet
Children & MSDs

- 10-15% of over-use patients (Markison interview, 2002).
- Highly correlated with repetition & prolonged, awkward postures.

MSDs in children

- Sub-maximal Repetition
  1. Micro-trauma
  2. Inflammation
  3. Tissue fatigue & damage
  4. Loss of flexibility
  5. Weakness, discomfort & pain

Soft-tissue Injuries

- Ligament & tendon injuries uncommon in children with immature bone growth plates.
- Ligaments 2-3 X stronger than child’s bones.
- Tendons: high water content, collagen turnover.
- Fibroblasts (connective tissue) → flexibility.

Child Postures

- Patterns begin at around 7
- Wide range postures & movements
- Conscious control of posture → over-correction, over-control & tension.

Child Over-use

- Sports
- Web-surfing
- Video games (“Nintendo thumb”)
- Musical instruments
- Handwriting

Computers & Over-use

- 40% 3rd–5th graders in high-risk postures (Findings from 11 schools – Hedge, Johns Hopkins pres, 2000)
- 40-50% 6th–8th graders report over-use discomfort (Williams, ISSES 2002)
- 40% 6th graders report current symptoms (Most reported discomfort in the last year) (321 6th graders - Jacobs, Work 2002)
Computer Over-use

- 64% 6th grade laptop users report neck discomfort (Fraser, ISOES 2002).
- 60% discomfort rate among laptop users (Harris & Strooker, Int'l J Ind Erg., 2000).
- 51% neck & 44% back pain in the last month (Murphy & Buckle, IEA 2000).

Computer Over-use

- 152 6th graders: MS discomfort increases with hrs on computer & if can’t touch type (Jacobs & Baker, Work 2002).

Video games & TV

- 2/3 U.S. homes have video games.
- 60% children watch TV > 2 hours → pain.

Changes in Vision

- 80% farsighted at birth
- Farsightedness ↓ w/age and normalizes by 7-8.
- As farsightedness ↓, nearsightedness ↑ w/age.

Children and Vision

- Complex visual skills not fully developed.
- Hand-eye coordination develops by 11-12.

Children & Vision

- 25% K-6 grades have refractive errors. APHA (2002)
- Correlation between:
  - Heavy reading (< 10 yrs) & myopia.
  - Computer use (> 3 hr) & premature myopia.

Hoenig (2002)
Unpublished research at UC Berkeley
Described in Ophthalmology Times, 2002
**Children & Eyestrain: Incidence**

- 218 elementary students - 56%  
  (Williams et al, HFES Proc, 2000).
- 191 undergraduate students - 60%  
  (Ladrigan et al, 1999).
- Rates similar to adults.

**Recommendations**

- Adaptable furniture & equipment.
- Child-sized stations & equipment.
- Back support.
- Ability to move/change position.
- Knee clearance and foot support.
- Sit/stand.

**Recommendations**

- Monitor at least 2-3 feet from child eyes.
- Large fonts (14 - 16 point, bold)
- Monitor directly in front.
- Top of screen no higher than eye level  
  (at the highest).

**Recommendations**

- Touch typing.
- Replace mousing with keying.
- Mouse with non-dominant hand.
- Keyboard & mouse below elbow height.  
  (if child can touch-type and keyboard tilts back).

**Recommendations**

- Smaller keyboards.
- Light touch keyboards.
- Child sized pointing devices.
- Pointer close to midline.
- Evaluate alternative input devices  
  (e.g. trackballs)

**Recommendations**

- Limit exposure.
  - Avoid video games, e-mail, web  
    search.
- Limit usage; 1 hour limits.
- 5-10 min. breaks per 20-30 min.
Recommendations

- Emphasize posture & body awareness
- Promote movement & changing posture.
- Daily exercise.

Recommendations

- Avoid laptops.
  - Hard to position screen & keyboard.
  - Avoid carrying laptops in backpacks.
  - Limit backpack weight.
  - Wheeled carts.

More on ... child injury prevention

- humanics-es.com/recc-child.htm (Rani’s ChildErgo site)
- www.cdc.gov (Center for Disease Control)
- www.cpsc.gov (Consumer Product Safety Commission)
- consumerreports.com (Consumer Reports Magazine)
- cpsc.gov/neiss/query.asp? (Nat’l Electronic Inj Surveillance)

For more on... Children and Vision

- www.aoa.org
- www.nei.nih.gov
- www.opticalinternet.com

Children sitting

1400 BC, Egypt
1800’s, England
500 BC, Greece

Problems continue, but in a new form

Children's Ergonomics: Rethinking Assumptions
**Recommendations**

- Chair should fit & support.
- Turn off vibration.
- Hold controller loosely.
- Avoid high screens.
- Avoid glare & reflections.

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**Recommendations**

- Limit concentrated stretches.
- Move frequently.
- Stretch (at least every 20-30 min).
- Avoid static gripping.
- Neutral hand postures.
Handwriting

- Hand dexterity:
  - skill & grace
  - quickness, sureness, neatness
  - light touch.
- Hand patterns from childhood continue through adulthood.

Handwriting is affected by...

- Motor planning.
- Postural mechanism.
- Muscle strength & flexibility.
- Coordination.
- Visual system.

Hand Skill Development

- Supination.
- Stabilize forearm & wrist.
- Isolate thumb from fingers.
- Separate sides of hand.
- Stabilize thumb & index web space.
- Individualize digits.
- Palmar arching.
- Precise fingertip rotation.

Handwriting

- Pencil grip requires tri-pod grip.
- Tri-pod grip develops in kindergarten.
- Pre-mature start → poor writing patterns.
- Poor patterns damage thumb joint (metacarpal).

Handwriting

- Child can’t write effectively on flat surfaces until they reach 7.
- Tabletop activities promote flexed postures & immature motor patterns.
- Inclined & vertical surfaces → upright sitting
**Recommendations**

- Don’t encourage writing until child develops tri-pod grip.
- Pencil grips promote proper physiological position for writing.
- Relaxation techniques for handwriting.

  2 minute breaks per 20 - 30 min.

**For more on… Handwriting for kids**

- [www.allthewritenews.com](http://www.allthewritenews.com)
- [www.otideas.com](http://www.otideas.com)
- [www.hwtears.com](http://www.hwtears.com)

**Questions?**

**Thank you!**

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