Current Evidence on the Associations between Motor Competence and Aspects of Health in Youth

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What is Motor Competence?

AKA - Motor Skill Proficiency, Motor Coordination, Fundamental Movement Skills, Skill-related fitness, Motor Ability

Skill consists in the ability to bring about some end result with maximum certainty and minimum outlay of energy, or of time and energy. (Guthrie, 1952)

The ability to perform movements at an optimal and sufficient level for a motor solution. (Mack, 1977)

The degree of skilled performance in a wide range of motor tasks as well as the movement coordination and control underlying a particular motor outcome. (Apost et al., 2009)

The capability to coordinate and control one's body and extremities in a gravity-based environment to accomplish a goal. (Stodden et al., 2009)
Why should we promote motor competence (MC)?

Does the development of MC relate to health?
- Present cumulative evidence
- Address developmental trajectories
- Strengths & weaknesses
- What next?

How do we measure MC?
- Process - Qualitative movement patterns
  - TGMD, ORIGA, Dev Sequences, CHAMPS, etc..
- Product – Outcome measures
  - KTK, MABC, BOT, MAND, etc..

Where Do We See the Importance of Developing MC? And for What Purpose?
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Developmental Mechanisms Influencing Health Trajectories of Children

Stodden, Goodway, Langendorfer, Roberton, Russell, Garcia, Garcia – Quest 2008

EC = Early Childhood, MC = Middle Childhood, LC = Late Childhood
Lubans et al. 2010 – Review Paper (21 studies)
- Addressed relationships among fundamental movement skill (FMS) and health-related fitness, physical activity (PA), body composition & perceived competence
- Most studies were cross-sectional
- Did not address strength of associations

Strong evidence for positive relationships between FMS and:
- Cardiorespiratory fitness – 4/4 studies (+ relationships)
- Composite fitness – 2/2 studies (+ relationships)
- PA – 11/13 (+ relationships); 2 studies (NS)
- *Body Composition – 5/8 studies (inverse relationships); 3 studies (NS)
  7/8 studies body comp studies assessed BMI

Holfelder & Schott (2014) Youth & Adults
- Of 23 studies, 20 found positive associations between MC and PA ($r = .10-.92$)
- Conclusion: Strong positive cross-sectional evidence in children, weak (limited) in adults
- Suggested cause-effect relationship between MC and PA, but the relationship has yet to be conclusively demonstrated - limited experimental data.

Logan et al., (in press) Youth
- Only included studies with process-oriented assessments
- Of 13 studies, 12 reported a positive correlation between MC and PA ($r = .20-.55$)
- Conclusion: Strong evidence for positive associations between MC and PA
- No change in strength of associations across time
Cumulative Evidence – MC/Health-Related Fitness
Review Paper #4

Cattuzzo et al., (in review) Examined individual fitness components (Youth) Body weight status, cardiorespiratory, muscle strength/endurance & flexibility

- **Inverse** association between MC and body weight status
  - 27/33 studies (r = -.27 to -.62)

- **Positive** association between MC and cardiorespiratory fitness
  - 12/12 studies (r = .32 - .57)

- **Positive** association between MC and muscular strength/endurance
  - 7/10 studies (r = .27 - .68)

- **Uncertain** associations between MC and flexibility
  - 3/4 (r = .22 - .26)

Associations tended to be stronger in adolescents as compared to children.

Cumulative Evidence – Physical Self-Concept/PA
Review Paper #5

Babic et al., Meta-Analysis (2014) - 64 studies included

- Perceived competence demonstrated strongest associations with PA (r = .27 - .39) as compared to perceived fitness, appearance & general physical self-concept
- Age moderated the relationship, but limited data on children

Age difference also is apparent with associations among perceived competence and actual MC


<table>
<thead>
<tr>
<th>Associations among Perceived Competence, Product Scores, and Process Scores by Sex &amp; Age Group</th>
<th>4-5 year olds</th>
<th>7-8 year olds</th>
<th>10-11 year olds</th>
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</thead>
<tbody>
<tr>
<td><strong>TGMD total</strong></td>
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<tr>
<td>Girls</td>
<td>0.037</td>
<td>0.231</td>
<td>0.155</td>
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<tr>
<td>Boys</td>
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<td>Total</td>
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<tr>
<td><strong>Product total</strong></td>
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<tr>
<td>Girls</td>
<td>0.078</td>
<td>0.308**</td>
<td>0.181**</td>
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<tr>
<td>Boys</td>
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<td>Total</td>
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<td><strong>Velocity, Distance</strong></td>
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<tr>
<td>Girls</td>
<td>0.078</td>
<td>0.308**</td>
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<td>Boys</td>
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<td>Total</td>
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</tbody>
</table>

*p < 0.05
**p < 0.01
Why Variable Relationship Strengths?

- Use of many different skill assessments
  - Questionable developmental validity
  - Probable ceiling (process) or floor (product) effects for some assessments
  - Sensitivity and discrimination issues (process)
  - Measure different constructs
    - Gross vs. fine
    - Object control vs. locomotor
    - Process vs. product scores
  - Cross-over of motor/fitness variables (MAND – Peabody; SLJ)

- Lack of a developmental approach?
- Need to address strength of associations across childhood, adolescence & adulthood – i.e. - Developmental Trajectories

Stodden et al. (2014). Dynamic Relationships among Selected Motor Skills and Health-Related Fitness in Youth.

Stodden et al., (2009). The Association Between Motor Skill Competence and Physical Fitness in Young Adults.

- Children & early adolescents, ages 4-13 & adults 18-25 yrs
  - N = 456 (253 boys, 203 girls)
  - N = 188 (79 men, 109 women)

- Composite HRF Measure:
  - Trunk muscular endurance
  - Cardiorespiratory endurance
  - Muscle strength
  - Muscle endurance
  - 18-25 also %BF

- Motor Skill Competence
  - Product Scores – Maximum throwing/kicking speed & standing long jump distance/height

- Statistical analysis
  - Hierarchical linear regression for each skill by age, controlled for sex
Stodden et al. (2014). Dynamic Relationships among Selected Motor Skills and Health-Related Fitness in Youth.

Stodden et al. (2009). The Association Between Motor Skill Competence and Physical Fitness in Young Adults.

Kick
- 4-5 - $R^2 = \text{NS}$
- 6-7 - $R^2 = .10^*$
- 8-9 - $R^2 = .15^*$
- 10-11 - $R^2 = .14^*$
- 12-13 - $R^2 = .37^*$
- 18-25 - $R^2 = .58^*$

Throw
- 4-5 - $R^2 = \text{NS}$
- 6-7 - $R^2 = .11^*$
- 8-9 - $R^2 = .19^*$
- 10-11 - $R^2 = .17^*$
- 12-13 - $R^2 = .25^*$
- 18-25 - $R^2 = .59^*$

Jump
- 4-5 - $R^2 = .20^*$
- 6-7 - $R^2 = \text{NS}$
- 8-9 - $R^2 = .10^*$
- 10-11 - $R^2 = .15^*$
- 12-13 - $R^2 = \text{NS}$
- 18-25 - $R^2 = \text{NS}$

MSC – PA

MSC – PA


Goodway, Stodden - Pilot Data N=411
- Equally distributed by age and sex
- MC variables (process & product)
- PA = 5 day accelerometry ≥ 9hr/day min

Fig. 1. Predicted values for change in physical activity levels in children classified by initial levels of motor coordination. MC, motor coordination.
MSC – BMI

Rodrigues, Stodden & Lopes (submitted). Developmental pathways of change in health-related fitness and motor skill performance are related to obesity development in childhood.

Assessed differential rate of change (low, average & high) in motor skill performance over 3 years N=507 (girls = 249, boys 258)

*Odds ratios of becoming overweight or obese increased across rate of change (ROC) in both motor skill performance. (OR = 1.60 – 3.42 in Low ROC)
What do These Data Demonstrate?

Strength of Associations Increase Across Time

Developmental Trajectories

Review of Evidence: A Synthesis


Key to Arrows:
- Black: Extensively tested: variable associations
- Dark Grey: Moderately tested: variable associations
- Partial Grey: Partially tested: some evidence
- White: Limited testing

Note: See direction of relationship above arrows.
Healthy Weight vs. Unhealthy Weight (16 predictor variables)
4-5 yrs - Model Variables did not significantly predict weight status
7-8 yrs - Predicted weight status (83% Correct Classification)
          (chi-square = 13.854, df = 6, p = .031)
10-11 yrs - Predicted weight status (88% Correct Classification)
           (chi-square = 53.546, df = 13, p < .001)

Dynamic Relationships among motor skill competence, physical activity, physical fitness and perceived competence. (Goodway, et al. data)

Process vs. Product Assessments
Explained Variance Difference?

Explained variance in composite HRF measure by MC
4-5 year olds (n=65)
  All MC  $R^2 = 36.9\%$  $p < .001$
  Product  $R^2 = 37.3\%$  $p < .001$
  TGMD-II $R^2 = 3.7\%$  $p = .167$

10-11 year olds (n=62)
  All MC  $R^2 = 46.7\%$  $p < .001$
  Product  $R^2 = 35.6\%$  $p < .001$
  TGMD-II $R^2 = 33.1\%$  $p < .001$
Stodden, True, Langendorfer & Gao, (2014). Associations among selected motor skills and health-related fitness: Indirect evidence for Seefeldt’s proficiency barrier in young adults?

<table>
<thead>
<tr>
<th>HRF index levels</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Total</th>
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<tbody>
<tr>
<td>Low Count</td>
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<tr>
<td>(% within)</td>
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<tr>
<td>Count</td>
<td>40</td>
<td>23</td>
<td>2</td>
<td>65</td>
</tr>
<tr>
<td>(61.5%)</td>
<td>(35.4%)</td>
<td>(3.1%)</td>
<td>(100%)</td>
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<tr>
<td>Moderate Count</td>
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<tr>
<td>(% within)</td>
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<tr>
<td>Count</td>
<td>24</td>
<td>48</td>
<td>10</td>
<td>82</td>
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<tr>
<td>(29.3%)</td>
<td>(58.5%)</td>
<td>(12.2%)</td>
<td>(100%)</td>
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<tr>
<td>High Count</td>
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<tr>
<td>(% within)</td>
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<tr>
<td>Count</td>
<td>1</td>
<td>18</td>
<td>21</td>
<td>40</td>
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<tr>
<td>(2.5%)</td>
<td>(45.0%)</td>
<td>(52.5%)</td>
<td>(100%)</td>
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<tr>
<td>Total Count</td>
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<tr>
<td>(% within)</td>
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<tr>
<td>HRF = 60%</td>
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If you are low-skilled, you will not demonstrate “good” fitness (>60th %tile).

If you are high-skilled, you will not demonstrate “poor” fitness (<35th %tile).

Direct and/or indirect relationships?

a) Place a high demand on the neuromuscular systems (Direct)

b) Demonstrate high muscle activity/loading levels and resultant force/power outputs (Direct)

c) Repeated high muscle activity/loading associated with practice and performance (Direct) promotes muscular endurance

d) Persistence in games, leisure activities & sports inherently demanding MSC promotes cardiorespiratory endurance and PA (indirect)

e) Increased persistence in physical activities inherently demanding MSC & development of Fitness variables influences body composition (indirect & direct)

Why does MC relate to Aspects of Health?

- Higher skill level within a task or activity = Higher fitness levels
- Higher fitness levels = Increased efficiency in movement performance
- Increased efficiency in movement performance = Improved competence & self-efficacy across time
What is Needed?

- Need experimental design studies (causation?)
- Context specific interventions - focus on MSC, fitness, PA separately & integrated (INT)
- Need to address adequate dose and time (across years)
- Need to address developmental trajectories and motivation to learn skills
- Can we effectively influence motor skill development in childhood? Adolescence? Adulthood?
- Address potential lifespan trajectories
- Address relationships to health markers/outcomes
- If motor skill development is related to fitness, PA, obesity, PC/self efficacy, will it relate to other health markers/outcomes?
- MSC and cognitive health? Academic achievement?

Haapala et al., 2013; Lopes et al., 2012; Kantomaa et al., 2012

Is the Development of MC Important?

Comments and Questions

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