Preventing Joint Injury & Subsequent Osteoarthritis:

A Population Health Prospective

Carolyn Emery PT, PhD
Public Health Burden of Injury in Alberta

The leading cause of death and hospitalization among youth under 19 years is unintentional injury.

Every day in Alberta:
- 382 children are taken to ER
- 17 children are hospitalized

Every 3 days:
- 1 child dies

Sport related injury is the leading cause of injury ages 11-18 (30%)
Injuries in Youth Sport and Recreation

- **Sport participation** is the leading cause of injury, accounting for *30% of all injuries* reporting to ER or requiring medical attention in youth.

- *1 in every 3 youth* (ages 11-18) in Alberta will seek medical attention for a sport injury this year.

- **Lower extremity injuries** account for 60% of all injuries in youth sport.

- 60% of these are *knee and ankle joint* injuries.
Canada
Medical Attention Injuries

Injury in previous year:  
- 35 medically treated injuries/100 adolescents (ages 11-18)
- 8 injuries treated in the ER/100 adolescents (ages 11-18)

Emery et al 2006, 2008
Consequence of Youth Sport Injury

- ↓ Participation in sport (8% annually)
- ↓ Performance
- ↓ Physical activity = ↑ overweight/obesity
- Knee & ankle injury ➔ osteoarthritis (4X)
- Health care & indirect costs are high
- Psychosocial outcomes

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Osteoarthritic Knee

COSTS

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Arthritis Alliance of Canada
Alliance de l’arthrite du Canada

University of Calgary

Sport Injury Prevention Research Centre
Sport Injury Prevention
Primary Prevention of Post-traumatic OA

I. Establish extent of problem

II. Identify risk factors and causal mechanisms

III. Develop and implement prevention strategies

IV. Evaluate prevention strategies

PRACTICE

Players
Coaches
Administrators
Parents
Physiotherapists
Physicians
Trainers

POLICY

I. Establish extent of problem

II. Identify risk factors and causal mechanisms

III. Develop and implement prevention strategies

IV. Evaluate prevention strategies
Risk Factors for Youth Soccer Injury

1 in 4 will be injured this outdoor season

- Previous Injury
- Games > Practices
- Female > Male (knee injuries)
- More elite levels of play
- Older age group (>14 years)
- High risk single leg squat
Solution – Neuromuscular Training Warm-up

Warm-up
- aerobic, dynamic stretching, agility

Strength
- hamstring, quadriceps, calf, hip/trunk

Agility/technical/coordination
- jumps, lateral shuffle, bounding, zigzag

Balance
- single leg, dynamic, foam pad, wobble board
Objective:
To summarize the evidence evaluating injury prevention strategies in youth sport.

Results:
25 original studies
14 Randomized controlled trials (RCTs) evaluating Neuromuscular Training Warm-up strategies in youth soccer, European handball, American football, Basketball, Australian rules football, multi-sport.

36% reduction in LE injury risk
NMT- Youth Lower Extremity Injury Outcome

36% reduction in LE injury risk handball, soccer, basketball

Emery, Roy, Whittaker, Nettle-Aguirre, van Mechlan 2015
Soccer Evidence
FIFA 11+

- Coach workshops
- Coach delivery – knowledge, time, space, flexibility
- Player Champion
- Focus on prevention and performance
- Sport Association mandate
- Translate to other sports and school physical education setting
Targeted Implementation Strategy: 

>50% reduction with excellent adherence

- Distinct phases
- Uptake ≠ maintenance
- Behavioural approach to coach workshop content may facilitate longer term behaviour change
- Consider player and coach risk perception, self-efficacy, expectations, action plan, facilitators and barriers

McKay et al 2013
Recommendations

Prevention of Youth Sport Related Joint Injury

1. Implementation of evidence-informed injury prevention strategies in youth sport and recreation
   - community stakeholder engagement
   - coach, teacher and clinician workshops
   - social media
   - policy change
   - legislation

2. Continue interdisciplinary evaluation of injury prevention programs, protective equipment changes and legislation to inform implementation and maintenance that will have broader reach and a greater public health impact

3. Greater focus on secondary prevention and rehabilitation to prevent long-term consequences
Prevention of Post-traumatic OA
Timeline of Events & Interventions

1º Prevention
Healthy
Prevent Injuries

Knee Injury
Optimize Rehabilitation

Period between joint injury and OA onset (10-15 years)

2º Prevention

3º Prevention
Osteoarthritis
Improved function (exercise, weight control, arthroplasty)

Prevention of Post-traumatic OA
Timeline of Events & Interventions

TIMELINE

1° Prevention
Healthy

2° Prevention
Knee injury
Period between joint injury and OA onset (10-15 years)

3° Prevention
Osteoarthritis

INTERVENTION
Neuromuscular prevention programs in sport & school populations

Improved understanding could inform;
Early Diagnostics
Secondary prevention strategies

Therapy aimed at improved function (exercise, weight control, arthroplasty)
**Alberta Youth PrE-OA Study**

Overview

**Whittaker et al 2015**

**Ongoing longitudinal cohort study**

200 participants (15-26 years of age)
- 100 with a sport-related knee injury sustained ≤ 18 years of age. [Age of injury: Median, range; 16 years (9-18)]
- 100 age, sex and sport matched controls

Followed on a diverse number of outcomes annually for a minimum of 3 yrs.
Do youth/young adults with a history of knee injury (sustained ≤ 18 yrs) differ from healthy matched (age, sex, sport) controls 3-10 yrs post-injury?
### Cohort Characteristics

Follow-up 1 (n=200, 100 matched pairs)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Uninjured n=100</th>
<th>Injured n=100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (% female)</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>Age (yrs; median, range)</td>
<td>22 (15-26)</td>
<td>22 (16-26)</td>
</tr>
<tr>
<td>Age at Injury (yrs; median, range)</td>
<td>-</td>
<td>16 (9-18)</td>
</tr>
<tr>
<td>Injury to Follow-up 1 (yrs; median, range)</td>
<td>-</td>
<td>6.9 (3-10)</td>
</tr>
<tr>
<td># Index Knee Surgeries</td>
<td>0</td>
<td>63*</td>
</tr>
<tr>
<td># Contralateral Knee Injuries</td>
<td>0</td>
<td>23$</td>
</tr>
<tr>
<td># Contralateral Knee Surgeries</td>
<td>0</td>
<td>15$</td>
</tr>
</tbody>
</table>

*54 ACL reconstructions, $11 of these were ACL reconstructions
MRI Defined OA
Primary Outcome (n=76, 38 matched pairs)

MRI defined OA (Culvenor et al 2015)
Osteophyte AND full-thickness cartilage loss
OR
1 of the above plus 2 of the following:
Sub-chondral bone marrow lesion
Meniscal disruption
Partial thickness cartilage loss

<table>
<thead>
<tr>
<th>Injury Detail</th>
<th>Uninjured (n=38)</th>
<th>Injured (n=38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI defined OA (#/%)</td>
<td>3 (8%)</td>
<td>13 (36%)</td>
</tr>
<tr>
<td>Radiographic OA (KL grade ≥2; #,%)</td>
<td>---</td>
<td>5 (13%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Surgery / Injury Type</th>
<th>Unadjusted Conditional Odds Ratio, (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee Injury</td>
<td>6.0 (1.3,26.8)*</td>
</tr>
<tr>
<td>Knee Surgery</td>
<td>9.0 (1.1,71.0)*</td>
</tr>
<tr>
<td>3° ACL</td>
<td>7.0 (0.9,56.9)</td>
</tr>
<tr>
<td>3° ACL &amp;/or meniscal injury</td>
<td>10.0 (1.2,78.1)*</td>
</tr>
</tbody>
</table>
KOOS
2º Outcome (n=200, 100 matched pairs)

Outcome | Uninjured Median (range) | Injured Median (range) | Pair Difference Mean (95%CI)
--- | --- | --- | ---
KOOS (higher score = better) | | |
Pain | 100 (69.4-100) | 88.9 (52.8-100) | -4.9 (-7.0, -2.7)*
Symptoms | 96.4 (64.3-100) | 85.7 (32.1-100) | -8.1 (-11.2, -5.0)*
ADL | 100 (86.8-100) | 98.6 (63.2-100) | -2.8 (-4.2, -1.4)*
Sport/Rec | 100 (75.0-100) | 94.4 (47.2-100) | -5.8 (-7.8, -3.7)*
QoL | 100 (83.3-100) | 91.7 (63.9-100) | -8.3 (-10.2, -6.3)*

Whittaker et al 2015
## Physical Activity

2° Objective (n=200, 100 matched pairs)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Uninjured Median (range)</th>
<th>Injured Median (range)</th>
<th>Pair Difference Mean (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Activity Participation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total weekly METS (^\varphi)</td>
<td>52 (7-124)</td>
<td>52 (0-166)</td>
<td>-3.0 (-10.8, 4.8)</td>
</tr>
<tr>
<td>No Sport participation in last year (%)</td>
<td>4</td>
<td>13</td>
<td>---</td>
</tr>
<tr>
<td>Aerobic Fitness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(VO_2^{max} (ml/kg^2)) (^\varphi)</td>
<td>43.1 (20.6-59.6)</td>
<td>39.8 (20.1-59.6)</td>
<td>-2.4 (-4.5,-0.2)*</td>
</tr>
</tbody>
</table>

\(^\varphi\) Estimated from Godin Leisure Time Questionnaire

Injured participants are 2.1 time more likely to be in the lower 25\(^{th}\) percentile of total physical activity than controls (COR; 95%CI 1.1,4.0)

Toomey et al 2015, Whittaker et al 2015
## Adiposity

### Exploratory Outcomes (n = 200, 100 matched pairs)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Uninjured Median (range)</th>
<th>Injured Median (range)</th>
<th>Pair Difference Mean (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adiposity</td>
<td></td>
<td></td>
<td>1.78 (0.94,2.63)*</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>23.5 (18.1-31.3)</td>
<td>25.0 (18.9-38.9)</td>
<td></td>
</tr>
<tr>
<td>Fat Mass Index (kg/m²)</td>
<td>4.5 (2.1-11.2)</td>
<td>5.6 (1.7-16.4)</td>
<td>1.05 (0.53,1.57)*</td>
</tr>
<tr>
<td>Abdominal fat (g)</td>
<td>1240 (560-3750)</td>
<td>1480 (586-4926)</td>
<td>460 (220, 690)*</td>
</tr>
</tbody>
</table>

*Toomey et al 2015*
Index Leg Strength

2º/Exploratory Objectives (n = 200, 100 matched pairs)

[Graph showing muscle strength differences for Hip Abduction, Hip Adduction, Knee Flexion, and Knee Extension.]

Null Value

Upper 95%CI limit

Mean within pair difference

Lower 95%CI limit

Whittaker et al 2015
Functional Performance
Exploratory Outcomes \((n = 200, \text{ 100 matched pairs})\)

**Triple Single Leg Hop**

**Unipedal Balance**

**Star Excursion Balance**

Whittaker et al 2015
Biomechanics
Exploratory Outcomes (n = 100, 50 matched pairs)

Baseline (3-10yrs ago)  Follow-up 1

Knee Flexion Angle (degrees)
Knee Valgus Angle (degrees)
Knee Adduction Moment (Nm)

Laboratory balance tests: Injured participants have increased sway and make fewer postural adjustments during single leg balance.

Single Leg Squat

Prevention of Post-traumatic OA
Timeline of Events & Interventions

1° Prevention
Healthy

2° Prevention
Period between joint injury and OA onset (10-15 years)

3° Prevention
Osteoarthritis

Neuromuscular prevention programs in sport & school populations

Acute | Surgical Post-surgical care

Intervention focused on exercise & nutrition;

Ready to return to sport / physical activity

Therapy aimed at improved function (exercise, weight control, arthroplasty)

Behaviour & Behaviour Change
Thank You

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