Workplace Traumatic Brain Injury: Prevention and Rehabilitation

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www.abiresearch.utoronto.ca
NFL acknowledges link between football, brain disease

League executive Jeff Miller 1st to admit connection

The Associated Press  Posted: Mar 14, 2010 8:33 PM ET  |  Last Updated: Mar 15, 2010 0:38 PM ET

An NFL official has acknowledged a link between football and the brain disease CTE for the first time.
Traumatic brain injury now federal priority!

“The physical, emotional, economic and social toll of brain injury is not only exacted on survivors and their families, but it also reaches friends, caregivers and the community.”

Hon. Leona Aglukkaq, Minister of Health
31 May 2013

Traumatic brain injury is the most misunderstood, misdiagnosed, underfunded public health problem our nation faces.”

Susan H. Connors, President & CEO
Brain Injury Association of America
Overview of TBI
Traumatic brain injury (TBI) is...

- An “alteration in brain function, or other evidence of brain pathology, caused by an external force”
- Major cause of death and disability globally
- Major causes: Falls, motor vehicle crashes, struck by object
- Can happen to anyone!
Incidence of TBI vs. other illness/injury in Canada

Estimated Annual Incidence

More common than breast cancer, HIV/AIDS, spinal cord injury and multiple sclerosis combined
# Acquired Brain Injury

<table>
<thead>
<tr>
<th>Traumatic Brain Injury</th>
<th>Non Traumatic Brain Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mild</td>
<td>• Anoxia</td>
</tr>
<tr>
<td>• Moderate</td>
<td>• Brain tumours</td>
</tr>
<tr>
<td>• Severe</td>
<td>• Encephalitis</td>
</tr>
<tr>
<td>• Often assessed using Glasgow Coma Scale Score</td>
<td>• Metabolic encephalopathy</td>
</tr>
<tr>
<td></td>
<td>• Toxic effects</td>
</tr>
<tr>
<td></td>
<td>• Vascular insults</td>
</tr>
<tr>
<td></td>
<td>• Other brain disorders &amp; infections</td>
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</table>
TBI is more common than we think

- Over 30% with TBI by age 25 (McKinlay et al., 2008)
- 20% of Ontario High School Students (Ilie et al., 2014)
- Common in vulnerable populations
  - Homeless: 53% (Hwang et al., 2008)
  - Incarcerated: up to 87% (Shiroma et al., 2010)
- Highest incidence in children/youth and older adults (Colantonio et al., 2010)
Number of TBI Episodes & Patients in ED/Acute Care by Year (Ontario), 2003-2009

(Colantonio et al., 2011)
Healthcare burden of TBI in Canada

- Places substantial burden on the health care system
- By 2031 TBI will be the most prevalent neurological condition
- Indirect economic costs due to working-age disability will increase and will be greatest for hospitalized traumatic brain injury (rising from $7.3 billion in 2011 to $8.2 billion in 2031)

PHAC, 2014
Major Consequences of TBI

**Cognition:** concentration, memory, judgment, communication, sleep

**Movement abilities:** strength, coordination, balance

**Sensation:** tactile sensation, vision, hearing

**Emotion:** instability, impulsivity, depression

**Community Integration:** low employment, social relationships affected

**Family:** major impact on families/caregivers

Heterogeneous presentations
Post injury symptoms after a work-related traumatic brain injury in a Canadian population

Colantonio A, Comper P (2012)

Distribution of post-injury symptoms
Mild injury can have longer term consequences:

Dr. Anne Forrest, PhD in Economics, sustained a mild TBI after rear-end collision

- Did not lose consciousness
- Struggled with life/work, communication, memory, daily activities

- Most people with mild brain injuries recover
A coroner’s inquest into Rowan’s death concluded with 49 recommendations across different levels of government and multiple provincial ministries for enhanced concussion awareness and treatment.

#RowansLaw

Rowan Stringer: 17 year-old captain of high school rugby team died after fatal hit to the head. She had received 2 previous hits to head
TBI at Work

- Large percentage among seriously or fatally injured workers
- An injury with any loss of consciousness is considered “critical”
- Tremendous need to increase employment opportunities, workplace accommodations, technologies, and policies!
- Employment can make enormous difference in lives of people with a brain injury and their families
TBI Awareness

- Invisible disability
- Stigma
- Can be lifelong: considered a chronic condition
- Need for long term support for individuals/families
- Can be a risk factor for other conditions, for example Alzheimer’s Disease, epilepsy
Focus of CIHR Research Chair in Gender, Work and Health:

1. Epidemiology of work-related TBI: Cross-jurisdictional comparisons and implications for prevention
2. Return to work after work-related (wr)TBI
3. Impact of sleep disorders on vocational outcomes of men and women with wrTBI
4. Knowledge translation using research-informed dramatic productions, apps, online fact sheets
5. Capacity building
Focus of Program of Research

Study of the practices and policies surrounding injury prevention, return to work & workplace accommodations that affect women and men with traumatic brain injury through conceptually related projects, applying a sex & gender lens.
What is ‘sex’ and ‘gender’?

<table>
<thead>
<tr>
<th>Sex</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typically refers to “...the biological and physiological characteristics that distinguish males from females”</td>
<td>Typically refers to the “...socially constructed roles, relationships, behaviours, relative power, and other traits that societies ascribe to women and men”</td>
</tr>
</tbody>
</table>

- Although sex (male/female) and gender (men/women) are both commonly discussed as discrete and binary concepts, CIHR acknowledges that both are fluid and dynamic.
- Sex and gender are interrelated; the relationships are complex.

(CIHR, 2010)
Epidemiology of work-related TBI
Epidemiology of work-related traumatic brain injury: a systematic review

Chang V, Guerriero N, Colantonio A (2015)

- Searched electronic databases (e.g. Medline, Embase)
- 98 studies from worldwide literature were included, 23 specifically focused on wrTBI
- Estimates of burden (incidence, proportion of occupational injuries or TBI), demographics, injury characteristics, outcomes
Based on worldwide estimates, approximately 2-24% of all TBI incidents are work-related.

In Ontario, 7.3% of TBI-related cases identified from the Ontario Trauma Registry are work-related (Kim et al., 2006).

In the US, the proportion of TBIs that are work-related ranged from 4-14%.
TBI accounts for a large proportion of severe and/or fatal work-related injuries:

- **TBI contributed to approximately half** of all workplace fatalities in Ontario, based on a review of coroners’ records (Tricco et al., 2006)

- **20%** of traumatic occupational injuries and **60%** of work-related deaths in Washington State involved TBI (Sears et al., 2013)
• Increasing trend of wrTBI in Ontario

• Annual number of **claims for TBI** involving time off work **increased steadily** from 790 (0.8%) in 1996 to 1,644 (3.0%) in 2012

• Total number of claims decreased over this timeframe

Workplace Safety & Insurance Board, 2012
• A large proportion of work-related TBIs are mild

• In Ontario, there is an increasing trend in the number of concussions (mild/moderate TBI) vs intracranial injuries (e.g. cerebral hemorrhages).
  - In 2012: approx. 80% of TBI claims filed to the WSIB are for concussion (~50% prior to 2010)

• In the US, concussions account for approx. 90% of nonfatal wrTBI  (Bureau of Labor Statistics, 2012)
Brain injury in the workplace in Ontario: Lost-time claims

Nature of injury

Lost Time Claims

Year

Concussion

Intracranial injuries, excluding concussion

Industries affected

**Primary industries**
- eg. agriculture, forestry, fishing / trapping, mining
- Highest mortality rate in Ontario (Tricco et al., 2006) and the US (Tiesman et al., 2011)

**Transportation & storage**
- Highest rate when all injury severity levels are included
- equally high for men and women (Colantonio et al., 2010)
Manufacturing

- Accounts for high percentage of mild \( \text{wrTBI} \) (Kristman et al., 2008)

Service industry

- Government and related services (eg. healthcare and social services), business and finance, sales and services
- High frequency of mild TBI (Kristman et al., 2008)
- Higher rates among women (Colantonio et al., 2010)
• Males account for the vast majority (>85%) of severe/fatal wrTBI cases
• Percent male decreases when milder injuries are included

In Ontario, more than 40% of wrTBIs were sustained by females (Colantonio et al., 2010)
### Rates of work related TBI by industry sector (N = 1,047)

| Industry Sector             | Female | Male 
|-----------------------------|--------|------
| Manufacturing               | 20     | 25   
| Construction                |        | 30   
| Retail and wholesale trades | 30     | 20   
| Other services*             | 40     | 25   
| Other primary**             |        | 40   
| Government and related      | 50     | 50   
| Transportation and storage  | 80     | 80   

**Other primary for female group - † (small cell size) Colantonio et al., 2010)

*Includes finance and insurance, business services, accommodation, food and beverage industries.

**Includes mining, forestry, fishing and trapping, agricultural and related industries.
**Traumatic brain injuries in the construction industry**


**Construction industry** ranked among the top in terms of:

- number and rates of severe/fatal wrTBI
- High claim costs and long layoffs
- Males have higher risk

**Mechanism of injury:**
- Older workers: falls
- Younger workers: struck by/against

**Temporal trends:**
- Most wrTBI occur in the summer, second peak in October
- Highest number of injuries in the morning for younger workers/older workers more likely to be injured in the p.m.
Work-related traumatic brain injury due to assault, by sex

Mollayeva T, Mollayeva S, Lewko J, Colantonio A.
(accepted in Work)
Methods/variables

- Case series design, examined all claims with 2004 injury date, categorized as “intracranial injury” or “concussion”
- Denominator: Statistics Canada 2004 data on employment, by sex
- Qualitative and qualitative data analyses

Applications for injury prevention

- Workers with less experience: training, testing on ability to identifying risks prior to release to independent duty
- Working with persons with mental health challenges: conflict management, training to predict and react to aggression
- Guarding property: restraint and self-defense training

Results

- Age range = 20-64 (median 37 y.o.); assault-related wrTBI claim rate = 9.85/1 mil Ontario employees; claim rate for women = 11.79/1; men = 8.4/1 mil workers

Sex differences:
- Health care/social services sector: rate of wrTBI six-fold higher for female workers
- Education sector: rate of wrTBI four-fold higher for female workers
- Police/guard/law enforcement sector: rate of wrTBI 13-fold higher for male workers

Objectives

- Assess extent of assault resulting in TBI by sex, across occupational sectors in Ontario
- Examine related demographic and workplace characteristics
- Provide better understanding of circumstances of incidents
Epidemiology of wrTBI: Cross-jurisdictional comparisons and implications for prevention

Objective:
1. To advance rigorous sex- and gender-informed epidemiological knowledge about occupational TBI

Methods:
- Cross-jurisdictional comparison of claims data from workers who sustained a wrTBI
- Stratify data by sex to identify sex/gender themes
- Identify gender-based differences in exposure and vulnerability to risk for a wrTBI, and in receiving appropriate workers’ compensation & health services
Examining the epidemiology of work-related traumatic brain injury through a sex/gender lens: An analysis of workers’ compensation claims in Victoria, Australia

Chang V, Ruseckaite R, Collie A, Colantonio A (2014)
Rates of wrTBI for males and females have converged in recent years (n=4186)
Incidence of work-related traumatic brain injury among A) all workers and (B) full-time workers, Victoria, Australia, 2004-2011 (n=4186)
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at injury (median)</td>
<td>37</td>
<td>40</td>
</tr>
<tr>
<td>Pre-injury income</td>
<td>![Up Arrow]</td>
<td>![Down Arrow]</td>
</tr>
<tr>
<td>Employer size</td>
<td>Small and medium-sized companies</td>
<td>Large companies, government</td>
</tr>
<tr>
<td>Occupation</td>
<td>Machinery operators, drivers, technicians, laborers</td>
<td>Professionals, community and personal service workers</td>
</tr>
<tr>
<td>Industry</td>
<td>Manufacturing, construction, transportation/warehousing</td>
<td>Education, healthcare</td>
</tr>
<tr>
<td>Mechanism of injury</td>
<td>Fall from an elevation, motor vehicle crashes</td>
<td>Fall from the same level, struck by/against</td>
</tr>
<tr>
<td>Claim Costs</td>
<td>![Up Arrow]</td>
<td>![Down Arrow]</td>
</tr>
<tr>
<td>Duration of work incapacity (mean)</td>
<td>68 days</td>
<td>41 days</td>
</tr>
</tbody>
</table>
Conclusions

- Need for approaches to prevention tailored to sex/gender considerations, industry, occupation
- Education is needed about the nature of re-injury after TBI
Rehabilitation utilization following a work-related traumatic brain injury: A sex-based examination of workers’ compensation claims in Victoria, Australia

Guerreiro, E., Smith, P., Stergiou-Kita, M Colantonio A.
Summary of Results

- 29% of sample used at least one type of rehab
- Physiotherapy > Occupational therapy > Psychology > Speech Therapy
- No sex-differences in occupational therapy and psychology use
- Men less likely to use physiotherapy
- Need-related factors had biggest affect on relationship
Return to work after work-related TBI
Return to work after work-related traumatic brain injury

2016 (In press)

Objectives

- Employment loss can negatively impact self-identify, autonomy, and emotional well-being
- Return to work (RTW): important goal in rehabilitation process
- Study’s objectives:
  - compare patient profile of injured workers following TBI who have RTW to those who hadn’t
  - Identify RTW facilitators and barriers including demographic, clinical, psychosocial, environmental, and occupational factors
Methods

• Retrospective cohort study

• Participants recruited from TRI’s Neurology Services in 2010 who underwent a comprehensive assessment after referred by Ontario WSIB

Telephone interview, with mail-in option in 2011
Results

Socio-demographic characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Mean age</td>
<td>44.5 (SD 11.9)</td>
</tr>
<tr>
<td>Sex</td>
<td>64% male</td>
</tr>
<tr>
<td>Marital status</td>
<td>70% married</td>
</tr>
<tr>
<td>Education</td>
<td>34% high school or less, 66% &gt; high school</td>
</tr>
<tr>
<td>Return to work</td>
<td>50% mostly to same employer</td>
</tr>
</tbody>
</table>
Persons returning to work:

- were significantly younger \((p<0.05)\)
  - Mean age 40.8 years (SD 12.8) vs 48.0 (SD 10.2)

- More education:
  - 20% with high school or less versus 48%

- No significant differences: sex, marital status
Perceived facilitators of RTW (n=25)

1. support from family/friends - 92%
2. support from treatment providers - 80%
3. job modifications/employer accommodation – 76%
4. medication use – 72%
5. partial recovery from injury – 72%
6. support from co-workers – 68%
7. workplace commitment to health and safety – 64%
8. early contact from employer – 48%
9. access to RTW planners/coordination – 44%
10. supervisor trained in RTW planning – 44 %
Traumatic brain injury in the workplace: Innovations for prevention

Study rationale

To inform strategies for prevention of TBI in non-athletic workforces, it is important to first profile and understand wrTBI in different occupational settings

Therefore, we prospectively studied the nature and causes of wrTBI
Methods

Participants (n = 91) were prospectively recruited from a large, urban teaching hospital in Ontario, Canada. Participants were referred to the hospital for persistent symptoms related to head and/or brain injury. They completed an in-depth questionnaire designed to understand the following:

- Nature and causes of the injury
- Preventability of the injury
- Perceived adequacy of job and health & safety training
## Results & Discussion

**Profiling training and perceived preventability: preliminary findings**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Percent</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job training</td>
<td>75.3%</td>
<td>71.8%</td>
<td>80.0%</td>
<td></td>
</tr>
<tr>
<td>Health and safety training</td>
<td>59.1%</td>
<td>56.8%</td>
<td>62.9%</td>
<td></td>
</tr>
<tr>
<td>Injury perceived to be preventable</td>
<td>80.0%</td>
<td>80.0%</td>
<td>80.0%</td>
<td></td>
</tr>
<tr>
<td>Advised to rest after injury</td>
<td>82.4%</td>
<td>84.6%</td>
<td>80.6%</td>
<td></td>
</tr>
<tr>
<td>Advised to take time-off after injury</td>
<td>73.9%</td>
<td>76.3%</td>
<td>72.2%</td>
<td></td>
</tr>
</tbody>
</table>
Most injured workers believed their injuries to be preventable.

A considerable minority of study participants did not receive job or health & safety training, or instruction to take time-off or rest after their injury.
Qualitative Data

... examples of managing students with behavioural problems involving other students

... injury in context of health care managing higher risk patients
Implications

1. Prevention initiatives should ensure **training** is universally provided to all employees

2. Re-injury may be avoided by ensuring workers receive the **appropriate rest** prior to resuming vocation

3. Brain injury **education** may also help prevent wrTBI
Limitations

Our sample...

- May not be representative of the entire insured population with mild whTBI
- Is limited to those with persistent symptoms
Return to work challenges following a work-related mild traumatic brain injury: The injured worker perspective

When a MTBI is work-related, RTW is characterized by several distinct features

1. Workers typically return to the pre-injury workplace following a wrMTBI
2. Tensions in the workplace may escalate if employers face increased costs following an occupational injury
3. The legitimacy of an injury claim might be questioned
4. Injured workers could return to workplaces where unsafe hazards and practices have not been addressed
5. When a MTBI takes place in the workplace, the injury is a public event and eliminates the individual’s choice whether to disclose a brain injury, a stigmatizing condition that can have negative effects on one’s career
Recommendations

- Increasing knowledge of employers, co-workers and workers’ compensation representatives related to physical, cognitive and psychosocial impairments resulting from MTBI so injured workers can receive appropriate supports, and mitigate discrimination, stigmatization and re-injury.

- Structural and social elements of workplace and compensation environments should inform strategies to break down barriers to successful return to work following a wrMTBI.

- Greater OHS focus on preventing reinjury following a wrMTBI
Gender influences on return to work after mild traumatic brain injury

2016

Stergiou-Kita M, Mansfield E, Sokoloff S, Colantonio A
Key Findings

6 men and 6 women with mild TBI

- “Breadwinner”, occupational roles important for both men and women
- Women were more proactive in seeking and requesting medical assistance
- More positive return to work experiences in “feminine” versus “masculine” work environments
- Employer and co worker relations were critical elements in return to work
Investigate how sleep dysfunction, characterized by insomnia, is associated with injured workers’ perceived disability

**Diagnostic modeling study:** primary explanatory variable: insomnia; outcome variable: perceived multi-domain functional impairment, severity of disability

- The odds of perceiving higher global disability were greater in those with more severe clinical insomnia
- Insomnia was the covariate associated with greater odds of work disability
- The lack of significant findings for social and family life disability in our fully adjusted model warrants exploration of the influence of other variables such as social and family ties, and personality traits, not explored in this study
- Previous confounders (psychosocial status, depression) were not significant after full adjustment

Results highlight focus on addressing insomnia in workers with delayed recovery from mTBI/concussion
Original Article

Insomnia in workers with delayed recovery from mild traumatic brain injury

Tatyana Mollayeva a,b,c,* Shirin Mollayeva d,e,f, Colin M. Shapiro d,f,g, J. David Cassidy h,i,j, Angela Colantonio a,e,k
Objectives

- To describe the prevalence of insomnia and its severity
- To elucidate demographic, injury-related, clinical, psychosocial, behavioural factors associated with insomnia in workers with delayed recovery from mTBI/concussion

Results

- Nearly 69% of persons with delayed recovery from mTBI/concussion had insomnia
- Factors associated with insomnia in this population are clinical and non-clinical, majority modifiable—emphasized the need to inclusion of sleep investigation in the agenda of health care providers

Applications

- Sleep is disturbed in persons with mTBI/concussion; needs to be rehabilitated
- The construct of insomnia in this population is complex
- Timely and proper differential diagnosis followed by highly specific treatment necessary
Modeling community integration in workers with delayed recovery from mild traumatic brain injury

Mollayeva T, Shapiro CM, Mollayeva S, Cassidy JD, Colantonio A. 2015
Objectives

- To develop a model for the community integration (CI) construct in persons with traumatic brain injury (TBI)
- To investigate how sleep dysfunction, characterized by insomnia, is associated with CI in workers with TBI

Results

Variables independently associated with limited CI:
- Insomnia
- Head/neck pain
- Being married or in a relationship
- Time since injury
- Possible/probable malingering diagnosis

Applications

- Results highlight independent role of sleep in CI
- Highlight potential value for investigation of clinical and non-clinical components in addressing post-TBI outcomes
Knowledge Translation
Heads Up: What you need to know about concussions in the workplace

Canadian Centre for Occupational Health and Safety

http://www.ccohs.ca/newsletters/hsreport/issues/2015/05/ezine.html#hsreport-ontopic
Work-related brain injury app

Designed by the “Traumatic brain injury in the workplace: Innovations for prevention” research team

- Serves as an educational resource on TBI in the workplace for employees and employers
- Currently in development; to be available through iTunes and Google Play Stores in summer/fall 2016
Research informed theatre

Based on focus groups with survivors of brain injury, family members and health care providers

Shows impact of TBI and best practices for rehabilitation

AFTER THE CRASH performed by the Ruckus Ensemble

Kontos et al., 2012

www.ruckusensemble.com
Guidelines for Concussion/mTBI & Persistent Symptoms: Second Edition

© 2013, Ontario Neurotrauma Foundation


Future aim is to include a gendered approach
Archives of Physical Medicine and Rehabilitation

Table of Contents: Volume 97 / Number 2 / February 2016 / Supplement 1

SPECIAL COMMUNICATION

51 Sex, Gender, and Traumatic Brain Injury: A Commentary
   Angela Colantonio, PhD, OTR, FACRM, FCARS

REVIEW ARTICLE

   Carol Cancelliere, DC, MPH, James Donovan, DC, J. David Cifu, PhD, DMedSc

ORIGINAL RESEARCH

519 Rehospitalization After Traumatic Brain Injury: A Population-Based Study
   Cristina Saverina, MA, Bonnie Sevany, PhD, Susan Jagielski, PhD, John Leveille, PhD, Lee Versich, MSc, Jennifer Verh, PhD, Andrew Colantonio, MSc, Angela Colantonio, PhD, OT

526 Sex-Based Differences in Perceived Pragmatic Communication Ability of Adults With Traumatic Brain Injury
   Emily W. Dragan, MS, Lyn S. Turkstra, PhD, Margaret A. Struchen, PhD, Allison N. Clark, PhD

533 Gender and Transition From Pediatric to Adult Health Care Among Youth With Acquired Brain Injury: Experiences in a Transition Model
   Sally Lindsay, PhD, Meghan Peveto, MA, Joanne Maresi, MS, Yani Homii, MA, Mark Ryb, MD, Colleen MacArthur, MD, PhD, Angela Colantonio, PhD, OT

540 Gender Influences on Return to Work After Mild Traumatic Brain Injury
   Mary Sargent-King, PhD, OT, Elizabeth Mangold, PhD, Sandra Solcoff, MLS, Angela Colantonio, PhD, OT

546 Sentinel Events During the Transition From Hospital to Home: A Longitudinal Study of Women With Traumatic Brain Injury
   Emily Valdez, PhD, Jennifer Fleming, PhD, Percoa Connell, PhD, Michele Foster, PhD, Elizabeth Shidmore, PhD, Carenola Bottari, PhD, Denise K. Dawson, PhD

554 Long-Term Health Service Outcomes Among Women With Traumatic Brain Injury
   Gagan K. Tse, RN, MPH, Jocelyn E. Harris, PhD, Michael Escobar, PhD, Karen Yoshida, PhD, Diana Velikangia, PhD, Sandra Rizzi, MD, PhD, Michael Cordiano, MD, Nora Callen, MD, Sandra Solcoff, MLS, Angela Colantonio, PhD, OT

564 Being a Woman With Acquired Brain Injury: Challenges and Implications for Practice
   Holli L. Huang, MS, RN, MSW, Michiko Carnegi, MHS, Sandra Solcoff, MLS, Pau Rontos, PhD, Karen Yoshida, PhD, Angela Colantonio, PhD, OT
Sex and Gender Analysis Resources

**CIHR Institute of Gender and Health**

*Sex and gender in biomedical research*


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**NIH Office of Research on Women’s Health**

*The science of sex and gender in human health*

[https://sexandgendercourse.od.nih.gov/](https://sexandgendercourse.od.nih.gov/)

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**SCIENCE FACT OR SCIENCE FICTION: TRAUMATIC BRAIN INJURY: DOES GENDER MATTER?**

[http://www.cihr-irsc.gc.ca/e/49000.html](http://www.cihr-irsc.gc.ca/e/49000.html)
Doctor's Notes: Why we need to pay more attention to women’s head injuries

Biological differences can cause men and women to experience injury in diverse ways

By: Angela Colantonio
University of Toronto
Published on: Mar 07, 2016

Many would assume that gender equity in health has been achieved. But in subtle ways, medical research has a male bias that can leave women behind. Take my area of research as an example: traumatic brain injuries. Huge advances have been made in this field over the last few decades. We now know that for some, even seemingly minor hits to the head can have long-lasting effects, and we recognize the importance of proper recovery and rehabilitation. But we don’t fully know the differences of how women and men experience brain injury, and that has consequences for how women are diagnosed and treated.

Sex and Gender Knowledge Gap

Biological differences — including muscle strength, hormones and physiology — as well as social norms and stereotypes, can cause men and women to experience injury in diverse ways. For example, women are thought to suffer greater harm from a similar level of impact than men because of physical factors like neck strength. But it could also be that women may be reporting more symptoms than men, who face societal pressures to act tough. We need a lot more research focused on these nuances to be able to offer the most relevant care.

In February, I was guest editor for a special issue on sex and gender and traumatic brain injury in the journal Archives of Physical Medicine and Rehabilitation, which is the most highly cited journal in the rehabilitation field. In one of the articles — a systematic review of over 200 studies on mild traumatic brain injury — researchers found that only 7 per cent of the studies actually
Thank You

Merci

angela.colantonio@utoronto.ca
The Rehabilitation Sciences Institute integrates research across scientific disciplines focused on understanding human function and participation in family, community, and society and its relationship to health and well-being. At RSI, we give you the tools to become a world class rehabilitation scientist.
Publications on work-related TBI


**In press**

Xiong C, Martin T, Sravanapudi A, Colantonio A, Mollayeva T. Factors associated with return to work in men and women with work-related traumatic brain injury. *Disabil Health J*


