Associations between a History of Traumatic Brain Injuries and Current Cigarette Smoking, Substance Use, and Elevated Psychological Distress in a Population Sample of Canadian Adults

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Abstract

This study describes the prevalence of reported history of traumatic brain injury (TBI) and its association with reports of current substance use, cigarette smoking, and psychological distress among Canadian adults in a population sample. A cross-sectional sample of 1999 Ontario adults 18–93 years of age were surveyed by telephone in 2011 as part of the Center for Addiction and Mental Health's ongoing representative survey of adult mental health and substance use in Ontario, Canada. Loss of consciousness for at least 5 min or at least one overnight hospitalization resulting from symptoms associated with the TBI injury represented minimum criteria for TBI. An estimated 16.8% (95% confidence interval, 14.8, 19.0) of adults reported a TBI in their lifetime. Men had higher prevalence of TBI than women. Adults who reported a history of TBI had higher odds of reported past-year daily smoking (adjusted odds ratio [AOR]=2.15), using cannabis (AOR=2.80) and nonmedical opioids (AOR=2.90), as well as screened significantly for recent elevated psychological distress (AOR=1.97) in the past few weeks, compared to adults without a history of TBI. Co-occurrence of a history of TBI with current elevated psychological distress and substance use warrants vigilance among medical practitioners to assess the possibility of a history of TBI during reviews of the history leading to the occurrence of these conditions.

Key words: adults; psychological distress; substance use; traumatic brain injury

Introduction

TRAUMATIC BRAIN INJURY (TBI) is a major cause of permanent disability worldwide contributing to one third of all unintentional injury-related deaths.¹ The prevalence and persistent disabilities associated with TBI render this injury particularly costly. Combined yearly, direct and indirect costs (e.g., lost productivity) associated with TBI were estimated at US\$77 billion, and over 100 billion euros in Europe.^{2,3} Residual deficits post-TBI can include decreases in the speed with which many processing operations can be executed, cognitive and memory impairments, and also psychiatric and mental health issues, all of which affect personal relationships, health, social, and vocational success.^{4–6} Over the past 15 years, the incidence of TBI has increased rapidly in the industrialized world, especially among youth.^{7–14} In 1991, it was estimated that 1.7 million people experienced TBI in the United States.¹ By 2009, the Centers for Disease Control and Prevention

(CDC) stated that TBI has become a “silent epidemic,” reporting an estimated 2.4 million TBI injuries captured through emergency department records, hospitalizations, or deaths in the United States, with children, adolescents, and older adults being the most likely age groups to sustain a TBI.¹⁵ Recent studies from northern Finland and New Zealand joined the CDC in terming TBI a “silent epidemic,” based on their own population-based prevalence estimates of TBI, while pointing out that TBI has become a world-wide public health issue that can no longer be ignored, given the long-term disabilities and serious socioeconomic consequences often emerging post-TBI.^{9,14} These reports point to the need for more population-based research on TBI that aims to understand its mechanisms, and its physical, behavioral, cognitive, and emotional correlates, as we begin to develop effective prevention as well as care and rehabilitation strategies.^{8,16}

Research indicates that the number of sports-related TBIs among adolescents has increased significantly in recent years (as high as

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almost 60% between 2001 and 2009) in the United States, rendering surveillance of TBI in youth and adult populations in North America,^{10,11,12,17} as well as other developed countries,^{9,14} a health priority.

Growing research evidence indicates that a history of TBI places the individual at greater risk of future brain injuries, and that multiple brain injuries can result in lasting cognitive impairment, substance use, mental health, and physical health harms.^{4,5,18,19,20} One area of particular concern is the association of substance use and psychiatric symptoms with TBI. Little population-based data on this association exist, and studies on the relationship between psychiatric issues (e.g., elevated psychological distress), substance misuse, and TBI have been either contradictory or disproportionately based on very small clinical samples.^{19,20} Data from an Australian survey, however, found that 5.6% of the total sample (of approximately 7500 Australian people ages 20–64) reported a TBI that resulted in loss of consciousness (LOC) for at least 15 min, and that the history of TBI reported by their participants was related to substance use and psychiatric problems postinjury.¹⁸ Two recent Canadian population-based studies of adolescents grades 7 through 12 found that 1 in 5 youth reported a TBI in their lifetime and that their history of TBI was significantly related to past-year drug and substance use, mental health issues, as well as poorer current grades in school.^{10,11}

The data we report here are unique in expanding on recent adolescent population-based studies^{10,11} by examining province-wide data pertaining to adults from the same geographical location that were surveyed the same year (2011). This study describes not only current estimates of adult TBI from a jurisdiction without such previous data, but also investigates a range of substance types. Further, unlike many epidemiological studies, the current study looks at mental health as measured by a standard psychiatric screener and its association with reports of history of TBI among adults. The study also reports on prevalence estimates of adult TBI that captures hospitalized as well as nonhospitalized incidents of adult TBI, which most current adult TBI studies fail to capture.

Methods

Our data were derived from the 2011 cycle of the Center for Addiction and Mental Health's (CAMH; Toronto, Ontario, Canada) *Monitor*, a continuously-fielded cross-sectional telephone survey of Ontario adults age 18 or older, administered by the Institute for Social Research at York University (North York, Ontario, Canada). Excluded from selection were adults who were phoneless, institutionalized, and unable to speak English. The design employed a stratified, two-stage probability sample drawn quarterly through random digit dialing of listed and unlisted landline and mobile telephone numbers. Each calendar year, the four quarterly non-overlapping samples are combined to provide a single annual data set. Although 3039 adults (response rate, 51%) completed the survey in 2011, our analysis is based on a random subsample of 1999 respondents who were asked the TBI question. A complete description of the survey and discussion of potential nonresponse bias is available on the *Monitor's* webpage.²¹ All procedures followed were in accord with institutional and national ethical standards on human experimentation as well as with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all patients included in the study. The study was approved by the Research Ethics Committees of CAMH, St. Michael's Hospital (Toronto, Ontario, Canada), and York University.

Traumatic brain injury

Head injuries sustained in one's lifetime were assessed by a single question prefaced as follows: "We are interested in any head

injuries that resulted in you being unconscious (knocked out) for at least 5 minutes, or you had to stay in the hospital for at least one night because of it." Respondents were then asked: "How many times, if ever in your life, have you had this type of head injury?" Responses were recoded to create a binary lifetime TBI measure (yes = 1; no = 0). Similar questions assessing TBI have been previously validated.^{10,11,18,20} Whereas respondents were normal adults, able to participate in regular adult activities, we cannot rule out the possibility of cognitive impairments affecting responses of TBI-injured adults. Of relevance here, we found that TBI adults were no more likely than non-TBI adults to assess questionnaire difficulty as "difficult" (10.2% [95% confidence interval [CI], 6.8, 15.0] vs. 6.7% [95% CI, 5.4, 8.2]; second-order Rao-Scott adjusted chi-square $[X^2]_{(1, 1966)} = 5.04; p > 0.05$).

Elevated psychological distress

The 12-item General Health Questionnaire (GHQ-12) was used to detect current psychological distress. The GHQ-12 assesses depressed mood, anxiety, insomnia, and social dysfunction and is extensively used as a screening instrument for common mental disorders or nonpsychotic psychiatric problems in epidemiological studies.²² A cut score of 3 or more on the binary-scored GHQ-12 is considered the validated threshold identifying someone as experiencing elevated psychological distress during the past few weeks. Cronbach's reliability-coefficient (α) for these 12 items in this sample is 0.89.

Cigarette smoking

Smoking (daily or occasionally) was derived from the following questions: (1) "At the present time do you smoke cigarettes daily, occasionally, or not at all?"; (2) "Have you smoked at least 100 cigarettes in your life?"; and (3) "How long ago was it that you last smoked?" Cigarette smoking, binary-coded (yes = 1), was defined if the participant reported smoking daily or occasionally, having smoked over 100 cigarettes in their lifetime, as well as having smoked at least one cigarette within the past 30 days.

Use of substances

Also appraised was past-year use of cannabis and any past-year use of opioid pain relievers (e.g., Percocet, Percodan, Tylenol-3, Demerol, OxyContin, or codeine) without a prescription or without a doctor's consent. For both items, responses were binary-coded (yes = 1).

Statistical analysis

To accommodate the complex survey data, variances were estimated using Taylor Series Linearization available in the Complex Sample module in SPSS software (V20.0; SPSS, Inc., Chicago, IL). The final analyses were based on a design with six strata (region) and 1988 adults. Logistic regression assessed the association between reported TBI status (reported history vs. not reported history of TBI during one's lifetime) and the four outcomes, while holding constant age, sex, family income, education, and marital status. To assess gender differences in TBI, a two-way TBI $\times$ sex interaction was added to each model separately and was assessed with the likelihood test. Mean age of participants was 46.6 years (range, 18–93; standard deviation = 17.0) and 47.4% were men.

Results

Estimated lifetime prevalence of TBI among Ontario adults was 16.8% (95% CI, 14.8, 19.0). Men had net odds 2.2 times higher (95% CI, 1.63, 2.97) than women of reporting a lifetime TBI. Table 1 shows logistic regression results fitting the four outcomes on TBI

TABLE 1. REPORTED CIGARETTE SMOKING, SUBSTANCE USE, AND MENTAL HEALTH BY ONTARIO ADULTS WITH ($n = 326$) OR WITHOUT ($N = 1662$) A HISTORY OF TBI, 2011 CAMH MONITOR

	Adults without a history of TBI, % (95% CIs)	Adults with a history of TBI, % (95% CIs)	OR (95% CI)	AOR (95% CI)
Total	83.2 (81.0, 85.2)	16.8 (14.8, 19.0)		
Daily or occasional smoking	13.1 (11.3, 15.2)	27.5 (21.5, 34.4)	2.51* (1.74, 3.62)	2.15* (1.47, 3.14)
Cannabis use ^a	11.1 (9.1, 13.4)	27.6 (21.2, 35.0)	3.05* (2.03, 4.59)	2.80* (1.79, 4.39)
Nonmedical use of prescribed opioids ^a	3.0 (2.1, 4.2)	8.8 (5.1, 14.9)	3.14 [†] (1.58, 6.23)	2.90 [†] (1.50, 5.59)
Elevated psychological distress ^b	13.0 (11.1, 15.2)	22.5 (17.0, 29.1)	1.93 [†] (1.31, 2.85)	1.97 [†] (1.32, 2.95)

Unadjusted odds ratios (OR) and adjusted odds ratios (AOR) were calculated using logistic regression. AOR were evaluated while holding fixed values of age, sex, marital status, family income, and education.

^aPast 12 months.

^bPast few weeks.

* $p < 0.001$; [†] $p < 0.01$.

TBI, traumatic brain injury; CAMH, Center for Addiction and Mental Health; CIs, confidence intervals.

status. Adults who reported a history of TBI in their lifetime had higher adjusted odds of smoking (adjusted odds ratio [AOR] = 2.15), consuming cannabis (AOR = 2.80), and using prescribed opioids nonmedically (AOR = 2.90) than adults who did not report a history of TBI. Brain-injured adults also had increased odds of screening positively for elevated psychological distress (AOR = 1.97). Comparison of the log-likelihood ratios for models with and without the TBI $\times$ sex interaction did not show discernible improvement. Thus, the associations presented in Table 1 did not vary between men and women.

Discussion and Conclusion

One in six adults surveyed reported sustaining at least one TBI in their lifetime. This estimate is comparable to adult TBI estimates based on hospitalization records in the United States alone.¹ Corroborating the existing literature, a history of TBI was more common among men than women.^{1,8,9,10,11} This estimate is 10 percentage points higher than a 5.7% lifetime TBI prevalence found among Australian adults in 2004.^{18,23} However, this difference is likely owing to the operational definition employed in the Australian survey, which assessed a history of TBI associated with LOC for 15 min or longer. Our definition was based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criterion, which requires a minimum of 5-min LOC threshold TBI and thus includes milder forms of the injury, commonly referred to as concussions.^{24,25} Last, the estimate reported here is closely related to the lifetime TBI estimate (20.2%) of a population-based sample of adolescents surveyed the same year (2011), in the same geographical area.¹⁰ The 3.4 percentage point difference in lifetime TBI prevalence in the adult sample reported here and the adolescent sample we reported on previously¹⁰ may reflect reports of increases (of as high as 60%) among sport-related TBIs among youth in the past 10 years in the United States reported by the CDC.¹⁷ Indeed, the most common mechanism of teen TBI, worldwide, is sport related.^{9,10,12,13,16,17} The close estimates between the Ontario adult and adolescent samples surveyed in the same year (2011), in the same geographical area, provides additional support for the need for future research and injury prevention efforts against TBI, as posited by recent studies.^{1,4,9,17,26}

The results reported here complement population hospital-record-based estimates and underscore that, in order to have a more complete understanding of the impact of TBI in the general pop-

ulation, it is important to also take into account the number of adult TBIs that go unreported in health care statistics. The adults who reported a history of TBI in our sample had higher odds of screening positive for psychiatric distress. These results corroborate recent research evidence showing that people who report a history of TBI also report increased mental health issues in the form of symptoms of anxiety, negative affect, and suicide ideation.^{18,20} Our results are also consistent with results from Ontario's adolescent population surveyed the same year (2011).^{10,11} Among teens surveyed in 2011, a significant association between a history of TBI and substance misuse, as well as screening positive for psychiatric problems based on self-reports, was also evident. Further, the adolescent survey also found associations between lifetime TBI and suicide attempts (even when elevated psychological distress is statistically controlled), suicide ideation, bullying, violent and nonviolent conduct behaviors, and poor school performance.^{10,11}

Although our data do not allow us to comment on the temporal ordering of history of TBI and current substance use, cigarette smoking, cannabis, and nonmedical prescribed opioids, which we report on here, these outcomes could represent a coping mechanism post-TBI.¹⁸ It is therefore important that medical practitioners assess the possibility of a history of TBI as a reason for current reported substance misuse or psychiatric conditions and consider referring such patients to a TBI clinic, in addition to providing care focused on the substance misuse and psychiatric problems. At the same time, it is possible that participants' substance use may have predated the brain injury. Whereas causal relationships cannot be established with our data, it is nevertheless the case that individuals sustaining a TBI are more likely to engage in substance use behaviors that could exacerbate any problems they may be experiencing as a result of the TBI and further complicate any treatment regimen.^{14,20,27,28} Given that substance misuse and psychiatric problems take some time to develop, it seems very possible that individuals may forget a TBI that preceded their occurrence and not link the two unless prompted to think back on any history of TBIs in their lifetime. As a result, medical vigilance on this matter is warranted and recommended.

The results we report here, however, are subject to important limitations. First of all, our results are based on self-report and thus subject to sources of bias that may affect our prevalence estimates. Whereas our postsurvey assessment of substance use and mental health indicators did not show evidence of appreciable bias, the survey's response rate (51%), though considered good, may be

subject to nonresponse bias.²¹ Another limitation of our study is the lack of information with regard to the temporal relationship between the report of lifetime TBI and the co-occurring psychiatric issues reported on here. Based on our data, we cannot establish whether these adverse correlates of TBI represent a coping mechanism to deal with the effects of TBI or predisposing factors of adult TBI. Although most clinical literature has been devoted to examining the relationship between TBI and psychiatric symptoms post-TBI, substance misuse and psychiatric problems may also be linked to risk-taking behaviors that may lead to TBI. Further, our operational definition excluded milder forms of TBI that leaves the individual confused or dazed without LOC or resulted in LOC for less than 5 min. A significant body of research shows that among large samples of brain-injured adults (including milder forms of TBI resulting in being dazed and confused or less than 5-min LOC), as many as 40–66% of these individuals also report having had a history of problem drinking behavior or use of illegal drugs.^{27,28} Additional research to assess the associations between such milder forms of TBI and the correlates we investigated here, as well research aimed at identifying causal pathways for these relationships, is needed.

These results nonetheless provide important confirmation of the high prevalence of lifetime TBI in the adult population and its strong associations with potential adverse substance misuse and psychiatric consequences. Results here corroborate evidence from adolescent population studies and adult studies from Australia and the United States that a common, preventable injury may underlie a substantial portion of substance misuse and psychiatric-related problems in the adult population.^{10,11,20,29} Without adequate assessment, follow-up by a TBI clinic (when symptoms persist), and supportive interventions, injured adults may face long-term vocational/work issues, challenges in maintaining relationships with friends and family, or even slip into poverty and homelessness.³⁰ Vulnerable populations are often victims of accidents and violence that may cause new brain injuries or exacerbate old ones.^{11,30} Thus, taken together, the magnitude of the prevalence estimates and associated risks identified within this representative sample warrant more work to understand, prevent, and respond to TBI among adults.

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Author Disclosure Statement

No competing financial interests exist.

References

- Faul, M., Xu, L., Wald, M.M., & Coronado, V.G. (2010). Traumatic brain injury in the United States: emergency department visits, hospitalizations, and deaths: 2002–2006. Centers for Disease Control and Prevention, National Center for Injury Prevention and Control: Atlanta, GA.
- Finkelstein, E., Corso, P., and Miller, T. (2006). *The Incidence and Economic Burden of Injuries in the United States*. Oxford University Press: New York.
- Gustavsson, A., Svensson, M., Jacobi, F., Allgulander, C., Alonso, J., Beghi, E., Dodel, R., Ekman, M., Faravelli, C., Fratiglioni, L., Gannon, B., Jones, D.H., Jennum, P., Jordanova, A., Jönsson, L., Karampampa, K., Knapp, M., Kobelt, G., Kurth, T., Lieb, R., Linde, M., Ljungcrantz, C., Maercker, A., Melin, B., Moscarelli, M., Musayev, A., Norwood, F., Preisig, M., Pugliatti, M., Rehm, J., Salvador-Carulla, L., Schlehofer, B., Simon, R., Steinhausen, H.C., Stovner, L.J., Vallat, J.M., Van den Bergh, P., van Os, J., Vos, P., Xu, W., Wittchen, H.U., Jönsson, B., and Olesen, J. (2011). Cost of disorders of the brain in Europe 2010. *Eur. Neuropsychopharmacol.* 21, 718–779.
- Dean, P.J.A., and Steer, A. (2013). Long-term effects of mild traumatic brain injury on cognitive performance. *Front. Hum. Neurosci.* 7, 1–11.
- Wehman, P., Targett, P., West, M., and Kregel, J. (2005). Productive work and employment for persons with traumatic brain injury: what have we learned after 20 years? *J. Head Trauma Rehabil.* 20, 115–127.
- Yasuda, S., Wehman, P., Targett, P., Cifu, D., and West, M. (2001). Return to work for persons with traumatic brain injury. *Am. J. Phys. Med. Rehabil.* 80, 852–864.
- Billette, J.M., and Janz, T. (2013). Health at glance. Injuries in Canada: insights from the Canadian Community Health Survey. Statistics Canada, 82-624-XWE. Available at: www.statcan.gc.ca/pub/82-624-x/82-624-x2013001-eng.htm. Accessed May 1, 2014.
- Coronado, V.G., Xu, L., Basavaraju, S.V., McGuire, L.C., Wald, M.M., Faul, M.D., Guzman, B.R., and Hemphill, J.D. (2011). Surveillance for traumatic brain injury-related deaths—United States, 1997–2007. *MMWR Morb. Mortal. Wkly. Rep.* 60, 1–32.
- Feigin, V.L., Theadom, A., Barker-Collo, S., Starkey, N.J., McPherson, K., Kahan, M., Dowell, A., Brown, P., Parag, V., Kydd, R., Jones, K., Jones A., and Ameratunga, S. (2013). Incidence of traumatic brain injury in New Zealand: a population-based study. *Lancet Neurol.* 12, 53–64.
- Ilie, G., Boak, A., Adlaf, E.M., Hamilton, H., Asbridge, M., and Cusimano, M.D. (2013). Prevalence and correlates of traumatic brain injuries among adolescents. *JAMA* 309, 1–2.
- Ilie, G., Boak, A., Adlaf, E.M., Mann, R.E., Hamilton, H., Asbridge, M., Rehm, J., and Cusimano, M.D. (2014). Suicidality, bullying and other conduct and mental health correlates of traumatic brain injury in adolescents. *PLoS One* 9, e94936.
- Institute of Medicine of the National Academies. (2013). Committee on sports-related concussions in youth. Available at: www.iom.edu/Activities/Children/YouthSportsConcussions.aspx. Accessed May 1, 2014.
- National Center for Injury Prevention and Control. (2003). Report to Congress on mild traumatic brain injury in the United States: steps to prevent a serious public health problem. Centers for Disease Control and Prevention: Atlanta, GA. Available at: www.cdc.gov/ncipc/pub-res/mtbi/mtbiereport.pdf. Accessed June 2014.
- Rusnak, M. (2013). Traumatic brain injury: giving voice to a silent epidemic. *Nat. Rev. Neurol.* 9, 186–187.
- Centers for Disease Control and Prevention. (2013). CDC grand rounds: reducing severe traumatic brain injury in the United States. *MMWR Morb. Mortal. Wkly. Rep.* 62, 549–552.
- Andelic, N. (2013). The epidemiology of traumatic brain injury. *Lancet Neurol.* 12, 28–29.
- Gilchrist, J. (2011). Nonfatal traumatic brain injuries related to sports and recreation activities among persons aged < 19 years—United States, 2001–2009. *MMWR Morb. Mortal. Wkly. Rep.* 60, 1337–1342.
- Anstey, K.J., Butterworth, P., Jorm, A.F., Rodgers, B., and Windsor, T.D. (2004). A population survey found an association between self-reports of traumatic brain injury and increased psychiatric symptoms. *J. Clin. Epidemiol.* 57, 1202–1209.

19. Jorge, R.E., Robinson, R.G., Moser, D., Tateno, A., Crespo-Facorro, B., and Arndt, S. (2004). Major depression following traumatic brain injury. *Arch. Gen. Psychiatry* 61, 42–50.
20. Tait, R.J., Anstey, K.R., and Butterworth, P. (2010). Incidence of self-reported brain injury and the relationship with substance abuse: findings from a longitudinal community survey. *BMC Public Health* 10, 171.
21. Ialomiteanu, A.R., Adlaf, E.M., Hamilton, H., and Mann, R.E. (2011). Addiction and mental health indicators among Ontario adults, 1977–2011: CAMH Research Document Series No. 35. Center for Addiction and Mental Health: Toronto, Ontario, Canada. Available at: www.camh.ca/en/research/news_and_publications/Pages/camh_monitor.aspx. Accessed July 20, 2014.
22. Goldberg, D.P., Gater, R., Sartorius, N., Ustun, T.B., Piccinelli, M., Gureje, O., and Rutter, C. (1997). The validity of two versions of the GHQ in the WHO study of mental illness in general health care. *Psychol. Med.* 27, 191–197.
23. Butterworth, P., Anstey, K., Jorm, A.F., and Rodgers, B. (2004). A community survey demonstrated cohort differences in the lifetime prevalence of self-reported head injury. *J. Clin. Epidemiol.* 57, 742–748.
24. Esselman, P.C., and Uomoto, J.M. (1995). Classification of the spectrum of mild traumatic brain injury. *Brain Inj.* 9, 417–424.
25. Frances, A., Mack, A.H., Ross, R., and First, M.B. (2000). The DSM-IV Classification and Psychopharmacology. American College of Neuropsychopharmacology: Washington, DC.
26. Dooley, J.J., Anderson, V., Hemphill, S.A., and Johan, J. (2008). Aggression after traumatic brain injury: a theoretical approach. *Brain Inj.* 22, 836–846.
27. Cherpitel, C.J. (2007). Alcohol and injuries: a review of international emergency room studies since 1995. *Drug Alcohol Rev.* 26, 201–214.
28. Corrigan, J.D. (1995). Substance abuse as a mediating factor in outcome from traumatic brain injury. *Arch. Phys. Med. Rehabil.* 76, 302–309.
29. Horner, M.D., Fergusson, P.L., Selassie, A.W., Labbate, L.A., Kniele, K., and Corrigan, J.D. (2005). Patterns of alcohol use 1 year after traumatic brain injury: a population based epidemiological study. *J. Int. Neuropsychol. Soc.* 11, 322–330.
30. Topolovec-Vranic, J., Ennis, N., Howatt, M., Ouchterlony, D., Michalak, A., Masanic, C., Colantonio, A., Hwang, S.W., Kontos, P., Stergiopoulos, V., Cusimano, M.D. (2014). Traumatic brain injury among men in an urban homeless shelter: observational study of rates and mechanisms of injury. *CMAJ Open* 2, E69–E76.

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