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Screening for Traumatic Brain Injury: Findings and Public Health Implications

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Abstract

Objective—To provide an overview of a series of projects that used a structured self-report screening tool in diverse settings and samples to screen for lifetime history of traumatic brain injury (TBI).

Setting—Diverse community settings.

Participants—Homeless persons ($n = 111$), individuals with HIV seeking vocational rehabilitation ($n = 173$), youth in the juvenile justice system ($n = 271$), public schoolchildren ($n = 174$), substance users ($n = 845$), intercollegiate athletes ($n = 90$), and other community-based samples ($n = 396$).

Design—Cross-sectional.

Main Measure—Brain Injury Screening Questionnaire.

Results—Screening using the Brain Injury Screening Questionnaire finds that 27% to 54% of those in high-risk populations report a history of TBI with chronic symptoms. Associations between TBI and social, academic, or other problems are evident in several studies. In non-high-risk community samples, 9% to 12% of individuals report TBI with chronic symptoms.

Conclusion—Systematic TBI screening can be implemented efficiently and inexpensively in a variety of settings. Lifetime TBI history data gathered using a structured self-report instrument can augment existing estimates of the prevalence of TBI, both as an acute event and as a chronic condition. Identification of individuals with TBI can facilitate primary prevention efforts, such as reducing risk for reinjury in high-risk groups, and provide access to appropriate interventions that can reduce the personal and societal costs of TBI (tertiary prevention).

Keywords

prevention; public health; screening; traumatic brain injury

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TRAUMATIC BRAIN INJURY (TBI) has been defined by the Centers for Disease Control and Prevention (CDC) as “a bump, blow or jolt to the head that disrupts the normal function of the brain” that can result from external force to the head, including whiplash, blast exposure, or penetrating injury.¹ There are 2 critical elements of this definition: (1) a blow to the head, resulting in (2) altered mental status, that is, loss of consciousness or a feeling of being dazed and confused. Throughout this article, we use the term TBI or “TBI event” when these criteria are met. The consequences of TBI can range from mild symptoms (eg, headache, confusion) that quickly resolve to significant lifelong impairments in cognitive functioning,^{2,3} behavior and mood,^{4–6} and physical functioning (eg, fatigue, balance problems).⁷ Because not all TBI events have lasting consequences,⁸ we refer herein to TBI with lasting symptoms as “chronic TBI.”

Obtaining an accurate estimate of the incidence and prevalence of TBI in the United States is a major challenge. The CDC uses population-based data on TBI-related healthcare encounters and deaths to estimate the number of individuals who sustain a TBI each year. This method excludes individuals who do not seek medical care, whether in an emergency department (ED) or physicians’ office, those whose TBI is not indicated in the medical record, and those who are treated at a federal, military, or Veterans Affairs hospital. The CDC estimates in 2009 were based on ED visits, hospitalizations, and physician visits, and indicated that at least 3.5 million people sustained a TBI that year,⁹ and that 5.3 million people in the US are living with cognitive, physical, and/or emotional sequelae of chronic TBI.¹⁰

However, the 2009 incidence estimate was recently revised downward to 2.4 million when the CDC removed physician visits from the estimation formula because of the potential for duplication in the count.¹¹ Both of these methods, although reasonable and data-driven, grossly underestimate the true incidence of TBI in the United States. One Internet-based survey found that among respondents who indicated that they had incurred a TBI (as defined by the CDC case definition), 42% never sought medical attention.¹² Other studies suggest that the true count of individuals who sustain a TBI each year may be 3 to 5 times higher than CDC’s estimate, although many of these are limited by selection bias.^{13,14} Community-based epidemiological studies in the United States and other developed countries further augment these estimates and demonstrate that including TBI for which medical attention is not sought and/or gathering TBI incidence data from multiple sources (healthcare providers, hospitals, ambulance services, national healthcare databases, prisons, death registry, schools, and other community services) yields considerably higher estimates of the incidence and prevalence of TBI^{15–17} than do studies that rely solely on ED or hospital admission data.

SYSTEMATIC SCREENING FOR TBI EVENTS AND CHRONIC TBI: A PUBLIC HEALTH RESPONSIBILITY

Identification of TBI is particularly important when the injury results in continuing symptoms (chronic TBI) that can lead to reduced productivity, poor community integration, and other social problems. History of TBI is rarely queried in primary care or other health service and educational settings, and its symptoms (if reported) may be inappropriately

attributed to other causes such as aging,¹⁸ depression, or, in schools, to learning or emotional disabilities.¹⁹ Failure to recognize the etiology of these symptoms precludes appropriate treatment or symptom management.²⁰

Even in the absence of lasting symptoms, prospective identification and recording of the TBI events themselves can be important. Recent literature^{21–27} on delayed or late effects of single and multiple TBI events makes a compelling case for systematic screening for and documentation of TBI, even if an individual is asymptomatic at the time of screening. For example, a child could have few acute symptoms after TBI but may begin to experience difficulties when academic and social demands become more complex. If the TBI event had been documented when it occurred or was identified later through screening, appropriate accommodations could be made. In both athletes and community samples, a history of TBI increases the risk for reinjury.^{22,23} When risk for reinjury is modifiable (eg, removal from contact sports or other high-risk environments), awareness of prior TBI provides important information to allow individuals and parents, coaches, clinicians, and other parties to make informed decisions about risk tolerance. Moreover, prior TBI may negatively affect recovery from a subsequent TBI.^{22,28,29} Individuals who are reinjured may suffer more severe consequences because of the cumulative effects of multiple injuries.^{23–26} Information about lifetime TBI history can assist in accounting for current symptoms and altered trajectories of recovery in athletic contexts and primary care settings. Moreover, although the evidence remains mixed, a history of TBI may increase the risk for accelerated cognitive decline, dementia, depression, and other health problems later in life.^{21,22,27,30–33} A known history of recent or remote TBI events may signal a need for more intensive medical management, particularly in later adulthood. Together, these findings suggest that identification of TBI as an injury event (whether or not it results in chronic symptoms) may have important personal and public health implications.

The disproportionate rates of TBI seen in settings such as homeless shelters, prison systems, and vocational rehabilitation facilities (relative to the rates in the general population)^{34–37} further underscore the need for systematic TBI screening. It is logical to assume that untreated TBI-related sequelae (such as impaired cognitive and social functioning, mood or behavior changes, and job loss³⁸) may increase one's risk for chronic unemployment, homelessness, committing acts of violence, or incarceration, and the prevalence of TBI in these settings is alarming.^{32,34,39–43} Conclusions as to causality are limited in cross-sectional studies, but studies conducted in Canada and the United Kingdom indicated that 70% to 90% of homeless people with a history of TBI report that their first TBI preceded the onset of homelessness.^{39,44}

At the individual level, systematic screening for TBI events and chronic TBI using validated tools can provide a useful starting point for a comprehensive evaluation to establish a TBI diagnosis, if necessary and appropriate, and for linking a person to rehabilitation interventions,^{45,46} school or work accommodations,⁴⁷ and educational programming. At the population level, systematic TBI screening can provide data to correct current underestimates of the incidence and prevalence of TBI. Better estimates can support the expansion of educational efforts both for the general population and for professionals in health care, social service, education, and criminal justice settings to increase their

understanding of TBI and to support delivery of services that take TBI into account. Better estimates may also support the creation of accessible treatment opportunities for people with chronic TBI-related challenges and be used to advocate for needed research funding.

METHODS FOR TBI SCREENING

Self-report elicited through structured screening tools is increasingly recognized as the best, or perhaps only, way to estimate TBI incidence and chronic TBI prevalence.⁴⁸⁻⁵² Because many (but not all) cases of unidentified TBI are mild injuries,⁵³ there may be no medical record of the original injury. Even when medical evaluation and treatment is sought, standard neuroimaging results, such as a computed tomographic scan or electroencephalogram, are often normal after mild TBI.⁵¹ Advanced neuroimaging, such as magnetic resonance imaging, can result in normal findings even in cases of known TBI,⁵² and costly imaging techniques are simply unrealistic to be used as screening tools. The Veterans Health Administration and Department of Defense recognize that many TBIs sustained by service members during deployment were neither witnessed nor documented shortly after the event and implemented TBI screening systems in 2008-2009 to identify individuals in need of medical services. Several structured TBI screening tools have been developed for military and civilian use in response to the clear need to accurately document lifetime history of TBI events and enduring TBI-related symptoms.^{48-50,54,55}

Structured TBI screening tools are preferred over single-item methods (“Have you ever had a TBI?”), which may have lower reliability and validity, and tend to underestimate TBI history. The way in which TBI history is queried has a nontrivial impact on prevalence estimates. For example, some studies suggest that single-item questions about TBI history miss more than 35% of the individuals found to have sustained a TBI via a subsequent structured interview.^{56,57} Carefully worded single-item queries can of course provide valuable data in large-scale health outcomes studies designed to evaluate the association of TBI with other health issues or behaviors but do not suffice for estimating TBI prevalence.

THE BRAIN INJURY SCREENING QUESTIONNAIRE

The Brain Injury Screening Questionnaire (BISQ) was developed with the goal of creating a TBI screening tool that could be used to document lifetime history of self-reported TBI and the presence of current symptoms, if any, as well as to rule out alternative explanations for reported symptoms (eg, other neurological or developmental conditions). The BISQ is divided into 3 parts: TBI History, Symptoms, and Other Health Conditions (see Table 1 for sample items from each part, or request a copy of the BISQ at www.tbicentral.org). Part I is loosely based on the HELPS card,⁵⁸ which queries lifetime TBI by asking, “Did you ever hit your head?” and “Were you ever seen in an ED, by a doctor, or hospitalized?” to broadly elicit recall of prior injuries. The BISQ provides more structured and detailed cueing by asking respondents whether they have ever experienced a blow to the head in 19 specific situations in which a blow may have occurred (see the Table). The provision of structured recall cues is intended to serve as a memory jog and has been shown to enhance recall of situations in which a TBI event may have occurred.⁵⁶⁻⁶⁰ For every event endorsed, the informant is asked whether he or she experienced either a loss of consciousness or a period

of being dazed and confused and, if so, for how long. Next, respondents are asked whether they have ever been hospitalized or treated in an ED for any of 13 specific medical events (eg, electrical injury, near drowning) to document alternative explanations for clinically significant symptoms. People who report no TBI events on part I are considered a negative screen and are not asked to complete parts II or III.

Part II is an inventory of 100 cognitive, physical, emotional, and behavioral symptoms that can be used to characterize transient or chronic symptoms after brain injury (see the Table for sample items). The list of symptoms is based on symptom checklists disseminated by researchers at The Institute for Rehabilitation and Research,⁶¹ as well as at the Medical College of Virginia.⁶² These lists were modified to cover a comprehensive range of symptoms based on an extensive literature review and clinical expertise. Respondents are asked to rate on a 4-point Likert scale the extent to which each symptom has been a problem for them in the past month. Research indicates that while a healthy adult control group reported an average of 3 symptoms, and those with a disability (spinal cord injury, people who are HIV positive, or have undergone a liver transplant) endorsed an average of 10, individuals with mild TBI reported an average of 15.⁶³ This research identified 25 symptoms that are commonly reported by individuals with TBI and uncommonly by those without TBI.⁶³ Of the symptoms that reliably distinguished the TBI and control (non-TBI disability or healthy control) samples after controlling for age, sex, ethnicity, education, income, and self-reported depression, those that were endorsed by at least 33% of the TBI participants *and* endorsed by less than 10% of the healthy control group *and* less than 25% of the non-TBI disability group were included in this cluster of symptoms.⁶³ Because these 25 symptoms are relatively unique to TBI, researchers who have used the BISQ have considered endorsement of these symptoms in defining a “positive screen” for TBI, as described later.

Part III of the BISQ is designed to help clarify the relationship of reported symptoms to prior brain injury. It asks for age at the first and most recent blow to the head resulting in alteration in mental status, as well as the presence of other health conditions that may contribute to or explain the symptoms a person reports, including use of certain medications, developmental delays, or neurological conditions.

The BISQ is a widely used and clinically relevant tool that can be used to document a TBI event and/or to detect possible chronic TBI. When parts I, II, and III are used as a part of a clinical evaluation, inferences about the extent to which a person’s current symptoms are attributable to TBI history can be made.⁶³ The BISQ can be used as a self-report measure or can be completed by a proxy and is available in English, Spanish, Chinese, and Greek. The full BISQ takes 10 to 15 minutes to complete, and less time is needed by someone who reports no blows to the head. The BISQ shares many of the limitations found in other structured TBI screening tools that rely on self-report information,^{48–50,54,55} such as biased recall of injury events and under-/overreporting of symptoms. The absence of an appropriate reference standard against which self-report can be compared precludes traditional approaches to validating a screening tool. Thorough reviews of TBI screening methods in the military have concluded that screening will result in both false-positive and false-negative results but acknowledge that false positives are in fact an intended consequence of

thorough screening and may be eliminated by a more extensive clinical evaluation.^{64,65} The possible iatrogenic effects of screening (eg, worry, unnecessary resources lavished on false positives)⁶⁶ should not be dismissed. In keeping with the distinction between TBI events and chronic TBI outlined previously, the BISQ can be used to address both potential goals of systematic TBI screening: documenting TBI events that are currently asymptomatic as well as those that result in lasting symptoms.

Here, we describe the full portfolio of projects conducted to date by researchers at the Brain Injury Research Center of Mount Sinai and colleagues that have used the BISQ in TBI screening efforts across North America. By describing the use of the same screening instrument across samples and settings, we hope to illustrate the feasibility of systematic TBI screening and also the prevalence of unidentified TBI as elicited using a structured self-report tool.

ESTIMATING PREVALENCE OF TBI IN COMMUNITY SAMPLES

Study 1: New York City public schools

Cantor et al^{67,68} conducted a study in which schoolchildren and their parents were invited by mail or in person to complete the BISQ after providing informed consent. Approximately 29% of the 600 children who were invited to participate in the study provided complete data on the BISQ. Participants were 174 adolescents (aged 12-17 years) from 3 New York City schools; all participants were given comprehensive neuropsychological testing to determine whether positive TBI screens were associated with objectively measured cognitive problems.⁶⁸ In 74% of the cases, the BISQ was completed by a parent and a child together, in 21%, the child completed the BISQ independently, and in the remaining cases, the parent completed the BISQ independently. While none of the students had been previously identified by the school system as having had a TBI, 44% of the children reported a TBI event. A “positive screen” for chronic symptomatic TBI in this study was made when a parent or a child reported a TBI event and also reported at least 5 of the 25 symptoms that have been associated with TBI.⁶⁸ Approximately 10% of the total sample screened positive for chronic TBI, and 79% of these students had scores on the Conners Parent Rating Scale-Revised indicative of a “significant problem” (compared with 31% of negative screens), and 80% of these students demonstrated impaired performance in more than 2 domains of cognitive functioning on objective neuropsychological testing.⁶⁸

Study 2: Community-based sample of adult research volunteers

Individuals who volunteer for participation in a TBI study as “non-TBI controls” are theoretically people who do not believe that they have ever sustained a TBI. Volunteers from the New York metropolitan area were recruited using flyers, mailings, and Internet advertisements; those who self-identified as either healthy controls or individuals with depression or chronic pain (but no history of TBI) were invited to complete the BISQ.⁶⁹ Prior to scheduling a study visit, candidates for the non-TBI control group were reminded of the eligibility criterion of never having sustained a TBI. Yet, of the total sample of “non-TBI controls” ($n = 396$), 12% reported having sustained 1 or more TBI events when they completed the BISQ. To explore whether these individuals with previously unidentified TBI

reported symptoms that were similar to those of people with (self-)identified, or known TBI, we compared their symptom report with that of a subsample (demographically matched 2:1) of individuals from the known TBI group ($n = 141$ included in these analyses). The 2 groups reported similar levels of cognitive and behavioral symptoms (P values ranged from 0.11 to 0.85).⁶⁹ Those with previously unidentified TBI reported slightly more (rather than less) mood and physical symptoms, but the difference was not significant. Individuals in both groups performed similarly on the Automated Neuropsychological Assessment Metrics (ANAM 4)⁷⁰ computerized assessments of processing speed, attention, encoding, spatial processing, and accuracy (P values ranged from 0.20 to 0.95), but individuals with unidentified TBI demonstrated poorer working memory ($P = 0.049$). These findings indicate that, while individuals in the community with previously unidentified TBI have similar symptom profiles as individuals with known TBI and in some areas may demonstrate poorer functioning, they do not causally associate their symptoms with a prior brain injury.

IDENTIFYING INDIVIDUALS WITH UNIDENTIFIED TBI IN HIGH-RISK POPULATIONS

Study 3: New York State Office of Alcohol and Substance Abuse Services Facilities

Substance abuse is a risk factor for TBI and is also a common sequela of TBI, even among individuals who did not evidence preinjury substance abuse.^{71,72} In collaboration with the New York State Office of Alcohol and Substance Abuse Services, the BISQ was administered during intake evaluations to 845 individuals seeking substance abuse treatment at 27 participating New York State Office of Alcohol and Substance Abuse Services facilities (including inpatient detoxification short-term treatment programs, methadone maintenance programs, transitional living facilities, and outpatient treatment programs).⁴⁰ Overall, 76% reported having sustained at least 1 blow to the head, 69% reported 2 or more, 27% reported 4 or more, and 16% reported more than 10. (Not all of these injuries resulted in loss of consciousness or even a period of being dazed or confused; blows to the head not resulting in altered mental status are not considered “TBI events.”) In all, 54% of the sample screened positive for chronic TBI on the BISQ, meaning that they had sustained a blow to the head that resulted in a period of altered mental status *and* that they reported at least 5 of 25 symptoms that have been associated with TBI.⁶³ The average age of the first TBI was 14.5 years, and those who screened positive for TBI were more likely to have had substance abuse treatment episodes (eg, inpatient detoxification, outpatient treatment) prior to the index intake session; they also had more Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition) *DSM-IV* diagnoses.⁴⁰

Study 4: El Paso Juvenile Justice Department

Considerable evidence indicates that TBI is highly prevalent in individuals convicted of criminal offenses.^{9,30,32,41,73–79} Estimates from recent meta-analyses suggest that 50% to 60% of adult offenders have sustained a TBI.^{32,41} Traumatic brain injury is associated with an increased risk of violence, recidivism, and psychiatric disorders in adults and youths involved with the criminal justice system.^{76,78,80–83} Because of the lack of systematic

screening for TBI in juvenile justice departments, TBI is usually not identified and goes untreated in this population.^{84,85}

The CDC-funded Mount Sinai Injury Control Research Center (a component of the Brain Injury Research Center of Mount Sinai) has begun to evaluate an adapted, empirically validated cognitive rehabilitation intervention that was originally developed for adults with TBI in a recidivist juvenile offender population served by the El Paso Juvenile Justice Department. As of this writing, 271 adolescents have been screened with the BISQ. Of these, 76% reported at least 1 TBI (blow to the head resulting in loss of or alteration of consciousness). Based on their self-report of cognitive, physical, and emotional symptoms, approximately 29% of the sample reported clinically significant enduring TBI-related symptoms.⁶³

Study 5: Community-based vocational services organization for individuals with HIV

Jaffe and colleagues⁴² used the BISQ to investigate the frequency of TBI in individuals with HIV recruited from a community-based vocational services agency in New York City. The majority (74%) of the 173 participants (mean age [SD] = 38.0 [10.9]) reported having experienced at least 1 blow to the head in their lifetime, and 60% reported more than 1 blow. Twenty-seven percent of those who reported a history of 1 or more blows to the head sustained what would be considered moderate to severe TBI (loss of consciousness >20 minutes⁵¹).⁴² When the symptom profiles of those with and without a TBI history were compared, individuals with HIV who screened positive for TBI reported more than twice as many symptoms.⁴²

Study 6: Urban homeless shelter in Canada

A growing body of literature documents rates of TBI among homeless individuals that far exceed rates in the general population.^{34,39} Although findings differ across studies, the largest ($n = 904$) found that 53% of the sample reported a history of TBI.³⁹ Topolovec-Vranic and colleagues⁴³ used the BISQ to screen for TBI in a sample of men who received services at an urban adult homeless shelter in Toronto, Canada. Of the 111 screened, 77% reported having sustained a blow to the head, resulting in alteration of consciousness, and 45% screened positive for TBI with enduring symptoms. Importantly, 87% of the individuals who screened positive for TBI (defined in this study as having sustained a blow to the head, resulting in altered mental status and endorsing at least 8 chronic symptoms) reported that the TBI occurred before the onset of homelessness.⁴³ Individuals with a positive TBI screen were more likely than those with no history of TBI to report past arrests and mental illness.⁴³

Study 7: Intercollegiate athletes at an urban university

The number of visits to US EDs for sports and recreation-related TBIs by children and adolescents is approximately 173 000 per year.⁸⁶ These data suggest that many college-level athletes may have sustained 1 or more concussions prior to the start of their college career. Most research on sports concussions fails to assess or account for the potentially confounding role of a lifetime TBI history in evaluating outcomes of sports concussions.⁶⁰

In an ongoing study, the Mount Sinai Injury Control Research Center used the BISQ to screen college athletes at an urban Division II university for lifetime TBI history prior to the start of the 2010-2011 athletic season. Of 90 athletes, 45% reported having sustained 1 or more blows to the head (range: 1-14).⁸⁷ Few of these injuries were reported on the single-item concussion history included in the Immediate Postconcussion Assessment and Cognitive Testing (ImPACT),⁸⁸ which queries whether the respondent had been “diagnosed with a concussion” and was administered before the BISQ. Of the athletes who reported blows to the head on the BISQ but no concussions on the ImPACT, about half reported experiencing 5 or more of the 25 symptoms specific to TBI.⁶³ A small but meaningful proportion of these athletes reported injuries on the BISQ that were clinically significant (eg, 12 athletes reported a blow to the head, with loss of consciousness lasting several minutes to an hour), despite having reported on the ImPACT that they had never been diagnosed with a concussion. This finding highlights the risk of underreporting when case definitions of TBI events include only injuries for which medical attention is sought. Given that having sustained a prior TBI is associated with a slower recovery from a subsequent concussion (and is, therefore, an important consideration in most return-to-play guidelines^{89,90}), incomplete information about lifetime history of TBI can result in premature return to play and poorer recovery from injury-related deficits.⁹¹

DISCUSSION

The findings presented here come from a series of TBI screening studies that used the BISQ in diverse populations and collectively demonstrate that systematic screening for TBI, using a structured self-report measure reveals a higher prevalence of TBI events and of chronic TBI than would be expected on the basis of existing estimates.

These findings are consistent with studies that have used other structured TBI screening tools in homeless shelters, vocational rehabilitation services, mental health clinics, and among victims of domestic violence.^{54,92,93} Individuals with chronic TBI have unique treatment needs and comorbid clinical diagnoses that may create barriers to self-sufficiency. Once a TBI is identified, individuals with lasting symptoms who have received no treatment or who have been unable to benefit from other interventions (eg, substance abuse treatment, vocational rehabilitation) can access more appropriate interventions that target the TBI-related symptoms and/or modify treatments to take into account the cognitive and other deficits that commonly result from TBI.^{2,45,94-95} A growing body of research supports a range of effective interventions, even for individuals who are many years postinjury.^{45,46}

Some may argue that TBI screening is unnecessary or even harmful in military contexts due to the possibility of expectancy bias or “catastrophic reactions” to a positive screen, resulting in iatrogenic illness and costs associated with further diagnostic workup that may prove unnecessary.⁶⁶ Research in the broader health screening literature (eg, dementia, cancer) suggests that people generally want to know the results of health screens.^{85,96-101} Results of a screen should be provided along with psychoeducation about positive expectations for recovery from mild TBI¹⁰² and a clear statement that a screening tool is not capable of attributing causality or making a diagnosis. Clinically significant symptoms should be

further evaluated and all contributing factors considered—including TBI, Post Traumatic Stress Disorder, and depression.¹⁰³

The research discussed here suggests that failing to identify TBI may have serious consequences. An accurate estimate of the true incidence and prevalence of TBI will provide an important catalyst for the dissemination of interventions found to be effective,^{45,46,104} as well as further research and development of new interventions. Limitations of the studies presented here warrant consideration. They were conducted in convenience samples, and their findings cannot be generalized to other groups or the general population. These studies are cross-sectional, and it cannot be determined whether symptoms, neurocognitive impairment, or other negative outcomes (eg, incarceration, homelessness) were causally related to TBI. The BISQ instrument itself also has limitations. The version used in all the studies reported here did not specifically ask about combat-related or blast injuries in part I and, therefore, may not be appropriate for documenting TBI history in military service members. Part II includes 100 symptoms, which may be onerous for some responders; further research is needed to inform the development of an abbreviated version. Finally, the list of medical conditions (in parts I and III) that could impact symptom report is not exhaustive, and a revised version of the BISQ will solicit more comprehensive reporting of potential contributors to current symptoms. As is the case with all structured TBI screening tools,^{48–50,54,55} the BISQ is not capable of diagnosing TBI or causally associating symptoms with an injury. The BISQ is a tool for characterizing lifetime TBI history and current symptoms. Clinically significant symptoms require further evaluation that considers contributing factors other than TBI so that treatment (if indicated) is appropriate to symptom etiology.

Systematic TBI screening is essential for accurate injury surveillance, prevention of secondary and tertiary consequences of TBI, and facilitating access to appropriate interventions for individuals with lasting symptoms. Systematic screening tools are also needed to measure the impact of injury prevention efforts. Given the public health implications of unidentified TBI, the best available tools should be used for comprehensive screening. In the absence of a “gold standard” tool for TBI ascertainment, traditional validation approaches such as sensitivity and specificity analyses are not available for self-report screening tools. A thorough screening tool will elicit more false positives than false negatives to ensure that as few individuals as possible with TBI are missed; a high specificity is sacrificed to obtain high sensitivity. Further evaluation can minimize false positives. The challenge is to identify or develop structured TBI screening tools that comprehensively query lifetime history of injury events (of any severity) using plain and understandable language and that also query about current symptomatology that may be used to distinguish TBI-related consequences from nonspecific symptoms and make appropriate clinical referrals. Research to identify constellations of symptoms that may be useful in distinguishing chronic TBI from other psychological and medical health conditions is currently underway at the Brain Injury Research Center of Mount Sinai.

The definition of TBI delineated by the CDC,¹ together with the CDC’s comprehensive list of symptoms and signs that can help in diagnosing and managing a TBI,¹⁰⁵ provides a framework for what might be considered the minimal requirements for a structured TBI

screening tool. As demonstrated here, the BISQ not only meets these minimal requirements but is also relatively brief, easy to administer in a wide range of settings and populations, has good construct validity and criterion validity,^{40,43,68,69} and appears to be more sensitive to comprehensive TBI history than many existing measures.^{56,57,59,87} The BISQ is not without limitations, and other tools may be more appropriate in some settings. A report on a subset of results of large-scale expansion of the initial BISQ validation study⁶³ is currently under review.

CONCLUSIONS

Underestimation of the rates of TBI and TBI-related disability has important personal and public health consequences. For individuals, screening for TBI events and chronic TBI can open the door for treatment and/or accommodations; and accurate documentation of TBI history in the medical or academic record can inform health-related decision making at the time of screening or years down the road. Systematic TBI screening allows for more accurate estimates of the prevalence of TBI events and chronic TBI. Such data are needed to support the development of educational efforts for clinicians and other medical and social service professionals, support the expansion of accessible primary and secondary prevention opportunities for people with TBI, and ultimately decrease the personal and social costs of TBI.

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TABLE 1

Sample items from parts I, II, and III of the Brain Injury Screening Questionnaire

Part I					
For each event listed, record the number of times you experienced a blow to the head in that type of situation.			For each blow to the head recorded in Column A...		
Column A			Column B		
			Did you ever lose consciousness?	Were you ever dazed and confused?	
Did you ever experience a blow to the head...	How many times?	How many times?	Longest period?	How many times?	Longest period?
In a car crash?					
While on the playground?					
Being assaulted or mugged?					
Part II					
Please check the boxes below to indicate how often, in the past month, you have been bothered by each of the difficulties listed.	Always	Often	Some-times	Never	N/A
Having double vision or blurred vision					
Difficulty concentrating, having a poor span of attention					
Doing things without thinking them through, being impulsive					
Part III			Yes	No	Don't Know
Were you labelled as having a learning disability or an attention deficit disorder?					
Were you ever medicated for a psychiatric condition?					
Were you ever hospitalized or seen in the emergency room for a brain infection?					

Abbreviation: N/A, not applicable.

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