Establishing a Public Health Surveillance System for TBI in California

California Department of Rehabilitation: TBI Advisory Board

CLARIFY THE HCBS WAIVER!!

TALK ABOUT FURTHER WAIVER EFFORTS!

## Introduction

Establishing a Public Health Surveillance System for TBI in California

Traumatic brain injury (TBI) is the leading cause of death and disability among all trauma-related injuries in the United States (U.S. Center for Disease Control and Prevention [CDC], 2019), which is defined as a head injury from an external force that disrupts the normal function of the brain that occurs from the sudden impact of acceleration or deceleration forces (Greve & Zink, 2009; Vos et al., 2012). In 2020, there were over 64,000 TBI-related deaths in the US, which translates to 167 Americans per day. 2 In the United States, more than 2.87 million TBIs occur annually, including more than 837,000 TBIs in children. These TBIs account for 2.5 million emergency department visits, and 288,000 hospitalizations (APA, 2022). Among individuals presenting to an emergency department with TBI, the rates for men are 547.6 per 100,000 and for women are 385.9 per 100,000. The leading causes of TBI in the United States are falls (178.4 per 100,000), “struck by/against” events (92.7 per 100,000), motor vehicle accidents (74.7 per 100,000), and assaults (50.6 per 100,000). Concussion in sport is increasingly recognized as a cause of mild TBI with annual rates of all contact sports estimated between 5-10% (McCrae, 2023). TBI of any severity (e.g., mild, moderate, severe) have been associated with dysfunctional outcomes such as substance abuse (Corrigan et al., 2012), incarceration (Durand et al., 2017; Schofield et al., 2015), and homelessness (Stubbs et al., 2019). Thus, incorporating community reintegration efforts (e.g., neuropsychiatric sequelae education, psychosocial programming, screening evaluations) in the acute, subacute, and post-acute periods of rehabilitation are important targets to reduce long-term adverse outcomes that are costly to society. Despite being a rising public health concern, there remain considerable disparities between survivors’ rehabilitation needs and service provision at the local, state, and national levels.

Currently, the nationwide prevalence rate is extrapolated from the medical incidences of a few states, and no single state has been able to accurately capture the true number of individuals who are living with long-term difficulties of concussion or TBI; four states (i.e., Ohio, North Carolina, South Carolina, California), to date, have reasonably estimated. Several other states have attempted with varying degrees of success. For example, the state of Maryland has a law that mandates medical centers to provide incidence data on TBI but does not provide funding or enforcement to do so, whereas Alabama maintains a limited data registry with restrictive funding. California, the nation’s largest state by population, also does not have a dedicated state-funded TBI registry, but for a different reason than Maryland, and is loosely connected to the state’s designated trauma registry (California Trauma Registry, 2020; NASHIA, 2014; U.S. Census Bureau, 2016). The California Trauma Registry collects annual medical discharge incidence data from the 81 Level-1 trauma centers in the state, but medical incidence does not necessarily reflect the dysfunctional impact of TBI in California for community-based survivors. According to the CDC (2022), there are 13 ICD-10-CM codes, none of which include the S09.09 code, that are used as TBI indicators for nonfatal hospitalizations and nonfatal emergency department visits (Table 1). 2 A concern with medical coding is that 20% to 30% of the estimated two and a half million emergency department visits were classified as unspecified head injury (S09.90; p. 57) 2 but had sufficient evidence to meet a formal TBI diagnosis. 1 According to the California Department of Public Health, from the years 2016 to 2020, there was an average of 73,761 nonfatal TBI emergency room visits, but an average of 171,966 unspecified head injury cases (S09.90); these rates highlight a discrepancy in medical coding. Moreover, many Californians who experience head trauma (e.g., motor vehicle accidents, sporting/recreational activity, domestic violence/intimate partner violence) may not seek medical attention for a variety of reasons (e.g., minimize symptoms, minimal or no medical insurance, fear of retaliation); therefore, the available data suggest that current rates may be underestimated.

TBI represents a neuropsychiatric disorder that begins as a medical condition and may develop into significant cognitive, perceptual, and affective disturbances. This way of conceptualizing TBI acknowledges the condition as a disease process rather than a discrete injury. Furthermore, there are mental health categorizations (e.g., neurocognitive disorders; APA, 2022, p. 679) that may describe functional deficits in addition to medical incidence. Therefore, estimating state-specific needs would be important for directing local legislation, especially considering that national rates, five-years post-injury, estimate as high as 50% of survivors are still unable to perform many pre-injury activities and 40% still experience at least two neuropsychiatric disorders with at least one unmet need (e.g., vocational, functional; Rao et al., 2020; Vanderploeg et al., 2019). The Mental Health Parity and Addiction Equity Act (MHPAEA) and the Mental Health Parity Compliance Act (H.R. 3165/S. 1737) were enacted in 2008 to improve coverage and treatment accessibility to mental health services like other medical services. Currently, health plan insurers use defined criteria to determine “medical necessity” and cover only nine mental health diagnoses: bipolar disorder, major depressive disorder, panic disorder, anorexia nervosa, bulimia nervosa, obsessive compulsive disorder, autism spectrum disorders, schizophrenia, and schizoaffective disorder (California Mental Health Parity Act Section 1374.72 of the Health and Safety Code and Section 10144.5 of the Insurance Code, 1999). However, at the end of 2020, Governor Newsom of California signed a collection of senate bills (SB 803 Peer Specialists; SB 855 California Mental Health Parity) that were enacted in January of 2021. SB 855 expands state mental health parity law by broadening the statutory definition of “medical necessity” to include all diagnoses in the most current edition of the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision (DSM--TR) and mandates coverage at parity (Weiner et al., 2020). The current version of the DSM (APA, 2022) continues to include neurocognitive disorder due to TBI (F02.80-81; p. 707).

At the end of 2021, California joined the 23 states in the US that receive CDC Federal funds to establish the State Injury Prevention Program (CORE SIPP; [https://www.cdc.gov/injury/stateprograms/coresipp](https://www.cdc.gov/injury/stateprograms/coresipp/index.html)), which is currently beginning their work and planning to collaborate with the State TBI Advisory Board to establish prophylactic practices for TBI. Recently, California applied and successfully received $5 million in additional Federal funds from the Administration of Community Living (ACL) to establish a “TBI waiver” for the Medicaid Home and Community-based Services program (HCBS; e.g., cognitive rehabilitation, accessibility modifications, supported employment), which currently only exists in 38 states (for further information, please go to: <https://www.cms.gov/Outreach-and-Education/American-Indian-Alaska-Native/AIAN/LTSS-TA-Center/info/1915-c-waivers-by-state>). The California-based organizations to form the California Association of TBI (CATBI) began funded-activity in April 2022, and enhanced federal funding was awarded and distributed in July 2022.

The present retrospective cohort study utilized two state-level methods: a Health Assessment & Research for Communities (HARC) administered needs assessment and a representative survey administered using the California State Survey Panel (*CalSpeak*). The Departmentaspires to use the retrieved data and the revealed insights to generate a meaningful legislative ask to both the House and Senate. U.S. Senator Dianne Feinstein of California expressed support in March of 2022 at Brain Injury Awareness Day on Capitol Hill and both Representative Young Kim and U.S. California Senator Alex Padilla were invited to join the Congressional Brain Injury Task Force. In May 2022, Senator Padilla also signed on to the National Association of State Head Injury Administrators (NASHIA) initiative in support of funding for brain injury proposed by U.S. Maryland Senator Van Hollen; this letter supports increasing TBI State Grant program from $11.821 million to $19 million and secures $5 million for the CDC Concussion Surveillance, which supplements the $2 million to establish the system in FY 2022. Moreover, at this virtual event on Capitol Hill, it became clear that California is one of 28 states that receive an “ACL TBI State Grant” and that we receive the same amount as the 27 other states, even though California is the most populated state in the country. Senator Feinstein’s staffers expressed their willingness to write a letter of support to request additional funding (possibly in the form of 2 grants). The hope is for an adequately funded statewide network to facilitate the successful community reintegration of survivors in the “Golden State” before taking our insights to NASHIA.

### Hypotheses

After contrasting community prevalence, it was expected that the reported medical incidence would be underestimating the occurrence and impact of head injury. Relative to the general population, survivors of TBI in California were expected to have higher rates of homelessness, at-risk of homelessness, employment instability, housing instability, caregiver burden, difficulty with activities of daily living (ADL), justice system involvements, and neuropsychiatric disorders (i.e., PDD, GAD, NCD). In the general population in California, neuropsychiatric disorders were further expected to be significantly associated with negative community outcomes (e.g., homelessness, employment instability).

### Method

**Participants**

Participants in the HARC needs assessment was conducted both as a survey and qualitative interviews; both recruited participants using a convenient-sampling strategy. A sample of TBI stakeholders in California were recruited: TBI professionals (*n* = 79), TBI Family Caregivers (*n* = 53), and Survivors of TBI (*n* = 135). Survivors were White (67.8%), middle-aged (M = 49 years, SD = 10), had at least some college (86%), and in a median HH income of $29,141 (11.5% ≤ Federal Poverty Line; FPL). Forty percent had a family caregiver (44.7% were spouses, 29.8% were parents). Each stakeholder survey was 40 close-ended questions and 5 open-ended questions. Surveys were available in English and Spanish. Surveys were distributed statewide, however, the bulk of responses among persons with TBI, family caregivers, and professionals all came from San Diego County. Participant demographics did not match California population demographics for race and ethnicity.

For the *CalSpeak* approach, a representative sample of adult respondents (≥18 years) stratified on demographics retrieved from state voter registration and United States Postal Service sequence files (e.g., race, gender, urbanicity versus rurality) was collected in English (%) and Spanish (%) from residents in California (*N* = 1,057). All survey data, which was collected using the *CalSpeak* panel for sampling and survey administration, was weighted to compensate for practical limitations of sample surveys (e.g., under coverage, differential nonresponse). The weighting improved the external validity of the survey data by improving representation of respondents relative to estimated population parameters. From the total sample (*n* males = 475; *n* females = 555; *n* other = 13), 42% (*n* = 605) of them reported a history of at least one event of head trauma (M = 3.89, SD = 10.07). Thirty-five percent of responding Californian residents who reported at least one incident of head trauma experienced an associated period of lost consciousness (*n* = 153), thereby fitting the definition of a positive TBI screen (15% of total sample). Mechanisms of injury and degrees of lost consciousness for the TBI sample are shown on Figure 1 and Figure 2.

A total of 442 survivors of head injury (41.8%) identified in a representative sample of Californians (N = 1057). The TBI sample: males (47.8%), females (50.4%), and non-binary (1.2%). SEXUAL ID: Heterosexual (82.5%), Gay/Lesbian (5.4%), Bisexual (9.0%), Declined to State (3.0%). RACE/ETHNICITY: Identified as at least partially White (84.3%), Hispanic – yes (28.1%). EDUCATION: had at least some college (46.5%), FT student (5.5%), PT student (8.2%). URBANICITY: cities (48.6%), suburbs (31.4%), rural (20.1%) with average residence of 10+ years. INCOME ASSISTANCE: ≤ FPL (at least 12.5%), Participating in Medicaid (11.6%), SSI (3.5%). AGE: Current (M = 48.8, SD = 16.7), At Injury (M = 18.7, SD = 14.7), Years since (M = 30.4, SD = 16.2).

### Materials

Using the comprehensive and representative panel described above, 24 questions were used for this project, which were constructed by combining the optional TBI module from the Behavioral Risk Factor Surveillance Study (BRFSS), insights from State and National organizations (e.g., World Health Organization Disability Assessment Schedule), expert judgments from members of the California TBI Advisory Board (e.g., CATBI, Mayo-Portland Adaptability Inventory-4), DSM-5-TR (APA, 2022), and three widely used TBI screeners: the Ohio State University TBI Identification method (OSU-TBI-ID; Corrigan & Bogner, 2007); the Brain Injury Screening Questionnaire (BISQ; Dams-O’Connor et al., 2016); and the ACE, which was developed for the CDC as part of the Heads Up: Brain Injury In Your Practice tool kit (Gioia & Collins, 2006). The finalized questions were translated into Spanish to capture the population of monolingual survivors in California.

The first two questions assessed for affective disturbance as assessed by the DSM-5-TR criteria (APA, 2022) for persistent depressive disorder (PDD; F34.1, p. 178), major depressive disorder (MDD; F32.9, p. 183), and generalized anxiety disorder (GAD; F41.1, p. 250). These questions included the presence of characteristic criteria as dichotomous variables using the longest diagnostic duration. For example, question 1 used “2 years” time frame of PDD over the 2 weeks for MDD. In question 2, the time frame for persistence of GAD symptoms was the diagnostic “6 month” duration.

For Questions 3, 4, and 5, respondents were asked about the presence of symptoms for “more days than not” in the past month. Question 3 inquired respondents about the presence of events related to Criteria A and Criteria D for neurocognitive disorders (APA, 2022, p. 679). Moreover, Question 3 also included the Emotional Symptom checklist for CDC’s ACE (Gioia & Collins, 2006). Question 4 included Criteria A1 and Criteria A2 for neurocognitive disorder as defined by the current version of the DSM (DSM 5-TR; APA, 2022, p. 679). Moreover, Question 4 also included the Cognitive Symptom Checklist for CDC’s ACE (Gioia & Collins, 2006). Question 5 inquired about “physical difficulties” experienced that are included in the Physical Symptom Checklist of the CDC’s ACE (Gioia & Collins, 2006) and also evaluates the presence of Criteria B for neurocognitive disorders (APA, 2022).

For Questions 6, 7, 8, respondents were asked if they had ever had a lifetime experience of any of the listed events. Question 6 inquired about involvements in the justice system; the anchors were retrieved from the MediCaid Home and Community-based Services (HCBS) Menu published as a result of the enhanced Federal funds released to the Department of Rehabilitation in California to establish the HCBS TBI-waiver. Question 7 inquired about the risk factors most directly associated with homelessness (Stubb et al., 2019). Question 8 inquired about activities of decompensation as defined by the Social Security Administration that were most related to work instability and difficulties related to maintaining Substantial Gainful Activity.

For Questions 9, 10, 11, 12, and 13, respondents were asked if they about their current status. Question 9 was a dichotomous question asking if the respondent is currently receiving regular assistance from a family member, relative, spouse, friend, or non-relative for a health-related (physical or mental) disability. Question 11 asked about whether the respondent is currently providing regular assistance to a family member, relative, spouse, friend, or non-relative for a disability related to a head or neck injury. Questions 10 and 12 asked for the number of caregiving hours received or provided, respectively. Question 13 asked about the type of medical or health-care insurance respondents are currently receiving (e.g., Medicaid, Medicare, commercial).

The remaining nine questions screened for lifetime head or neck trauma to estimate the presence or absence of concussion or TBI. Questions 14, 16, 17, and 18 were designed to estimate the presence and severity of head or neck trauma as defined by Craig Hospital in Colorado, which is the lead site that collects data from the 16 sites that create the TBI Model Systems (Eagye, 2021). Severity of mild head trauma was furthered separated into Grades I, II, or III as defined by the Boston Assessment of TBI-Lifetime (BAT-L, Translational Research Center for TBI and Stress Disorders, 2021). Question 15 asked about the presence of alcohol during any lifetime head or neck injury (e.g., California excise tax). Question 19 asked about any formal diagnoses of concussion or TBI to estimate the degree of disparity between medical identification and actual occurrence. Questions 20, 21, and 22, were are all categorical anchors designed to evaluate the etiology of any head or neck injury reported in this representative Californian sample (e.g., falls, sports, motor vehicle accident, interpersonal violence, any activity during military service).

## Procedure

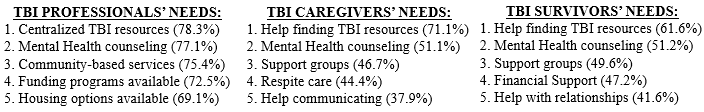
The present retrospective cohort study is establishing an initial surveillance study by utilizing the California State Survey Panel (CALSPEAK), the first California-focused panel that uses probability-based sampling methods, to collect high-quality data that is secured, HIPAA-compliant, and representative of the state’s population. CALSPEAK recruits a random sample of Californians using three primary methods, such that virtually everyone in the population has a non-zero chance of being recruited but must voluntarily elect to participate. First, a mixed-mode random probability selection method was applied using the United States Postal Service Delivery Sequence File (geographically stratified by population density; *n* = 25,000) and comprehensive telephone number listings with Computer Assisted Telephone Interviewing technology (65% mobile/cellular; *n* = 15,000). Second, Californian participants (*n* = 10,000) of the National Behavioral Risk Factor Surveillance Survey (BRFSS; established by the CDC in 1984) were recruited using a random digit-dialing telephone survey (mobile, cellular, landline) by the Public Health Survey Research Program at California State University, Sacramento. Lastly, a quota-based recruitment method was applied using California demographic statistics obtained from voter registration based on age, gender, race, ethnicity, income, and political party identification.

During recruitment (and at the beginning of each subsequent survey), panelists learn that their participation is entirely voluntary and that they have the right to opt out at any time. They also learn that their survey responses are strictly confidential. Immediately upon agreeing to join the panel, panelists complete a 15-minute survey that includes questions pertaining to demographics, political identity, background, interests, personality, and household composition. This profile information is merged with future survey data collections, thereby reducing survey burden (i.e., redundant questioning) on panelists over time. CALSPEAK uses the Qualtrics Research Suite online survey platform to administer surveys. The research team optimizes all CALSPEAK surveys for completion on mobile phones and tablets and provides Spanish translations.

All surveys include “attention check” questions, embedded in the survey to ensure that panelists are maintaining attention throughout completion. Completed surveys that fail the attention check questions or that were completed in less than one-half of the mean completion time are excluded. Qualtrics also prevents “ballot box stuffing” - individual IP addresses submitting more than one survey. Every time a CALSPEAK panelist completes a survey, s/he receives a $5 Tango gift card, delivered directly to his or her email inbox (or home), which is redeemable at most online retailers. The research team designs CALSPEAK surveys to be completed in under ten minutes. When the mean completion time for a survey exceeds 15 minutes, CALSPEAK panel administrators award respondents larger incentives. Finally, CALSPEAK researchers follow AAPOR standards for response rate reporting, as published in AAPOR’s Standard Definitions. Thus, we include contact rates, break-off rates, and overall response rates, as applied to each stage of the respondent participation process (panel recruitment, retention, and individual survey sub-sampling). The present survey was reviewed and approved by California State University, Sacramento’s Institutional Review Board.

Weights for this survey were computed using the *WgtAdjust* procedure of SUDAAN, which relies on a constrained logistic model to predict the likelihood of responding as a function of a set of explanatory variables[[1]](#footnote-1). These variables, which represent the geodemographic characteristics of adults residing in California, are summarized in Tables 2 - 7. The needed population benchmarks used for weighting were secured from the Current Population Survey (CPS) 2021 March Supplement. In order to improve the stability of the resulting survey estimates, extreme weights were identified and trimmed at both ends of the weight distribution. This important gain in precision, however, is achieved at the expense of some minor diversions between weighted totals and their corresponding population benchmarks. In the final step, analysis weights were rescaled to sum to the total number of respondents for this survey (1,057). It should be noted that before the weighting processbegan, missing values for all variables needed for weightingwere imputed. For this purpose, the *Survey Impute* procedure of SAS (Statistical Analysis Software) was used to select eligible donors based on a *hot-deck* algorithm[[2]](#footnote-2). As such, respondent counts in the following tables are based on imputed variables, which are what should be used for all subsequent data analyses.

**Results**

For the HARC needs assessment, results were separated into three stakeholder groups (TBI professionals, TBI caregivers, and TBI survivors). The most frequently identified needs both in the survey and from the coded qualitative interviews were as follows:

For the CALSPEAKS data, two-block binary logistic regression models were calculated to assess adjusted risk ratios for persistent depressive disorder (provisional; PDD), generalized anxiety disorder (provisional; GAD), and neurocognitive disorder (provisional; NCD). These models included age, gender, race, education, ethnicity, income, and marital status as continuous and categorical covariates, which all significantly improved classification rates beyond the null model (*p*’s < .001). The second block included a dichotomous TBI variable based on whether respondents experienced a head trauma with an associated period of lost consciousness, which significantly improved classification rates beyond the covariates model (*p*’s < .001). For the PDD model, the Hosmer and Lemeshow test was non-significant, X2 = 20.64, *p* = .008. After controlling for the covariates, those with a TBI (*B* = .75) were significantly more likely to endorse PDD than those without (Adjusted Risk Ratio = 2.11 95% CI [1.41, 3.17]), *Wald* = 13.09, *p* < .001. For the GAD model, the Hosmer and Lemeshow test was significant, X2 = 45.19, *p* < .001. Those with TBI (*B* = 1.70) were significantly more likely to endorse GAD than those without (AR = 5.48 [3.46, 8.70]), *Wald* = 52.20, *p* <. 001. For NCD, the Hosmer and Lemeshow test was non-significant using a stringent alpha level (X2 = 26.26, *p* = .001). Those with TBI (*B* = .88) were significantly more likely to endorse NCD than those without (AR = 2.41 [1.60, 3.62]), *Wald* = 15.73, *p* < .001.

PDD was significantly associated with employment difficulties (*r* = .198, *p* < .001) and housing difficulties (*r* = .379, *p* < .001), but not justice system involvements (*r* = .034, *p* = .290). GAD was significantly associated with employment difficulties (*r* = .174, *p* < .001) and housing difficulties (*r* = .355, *p* < .001), but not justice system involvements (*r* = .009, *p* = .290). NCD was significantly associated with employment difficulties (*r* = .164, *p* < .001), housing difficulties (*r* = .352, *p* < .001), and not justice system involvements (*r* = .070, *p* = .032). Relative to the general population without TBI (*M* = 0.69, *SD* = 1.02), survivors of TBI (*M* = 1.18, *SD* = 1.06) reported significantly more employment difficulties, *t*(984) = -5.40, *p* < .001 (*d* = 1.03). Survivors of TBI (*M* = 1.08, *SD* = 1.27) reported significantly more housing difficulties than the general population (*M* = 0.58, *SD* = 0.95), *t*(185.93) = -4.68, *p* < .001 (*d* = 1.01). In terms of justice system involvements, survivors of TBI (*M* = 0.45, *SD* = 0.89) reported significantly more housing difficulties than the general population (*M* = 0.15, *SD* = 0.62), *t*(161.72) = -3.79, *p* < .001 (*d* = 0.67).

### Discussion

A joint effort with California’s DOR, California’s Department of Public Health, and the State survey panel collected data from a representative random sample of California residents 18 years and older (*M* age = 52.78, *SD* = 15.89). 5 State population-level data revealed that 15% or an estimated 4.4 million residents endorsed a lifetime history of head trauma with an associated period of lost consciousness, thereby fitting the medical definition of “TBI.” Of this 15%, half or approximately 2.2 million residents reported never receiving TBI-specific medical attention. These lifetime prevalence estimates were from California residents who reported an average of 30 years (*SD* = 16.23) elapsing since their initial injuries. In the past three decades, survivors of head trauma, relative to the general population, endorsed significantly more housing insecurity (AR = 1.43 [1.26, 1.63]), employment instability (AR = 1.52 [1.33, 1.74]), justice system involvements (AR = 1.46 [1.18, 1.80]), and mental health difficulties (i.e., depressive, anxiety disorder; AR = 2.03 [1.50, 2.75]). Therefore, the total number of people likely to be impacted by this project as it continues to develop is potentially in the millions, and potentially tens of millions when considering family caregivers and intersectionality (e.g., race). Early intervention begins with early identification; therefore, screening for and addressing neuropsychiatric disorders at earlier stages following injury is an important step to avoid persisting conditions that may pose a barrier to recovery. Victims of domestic and intimate partner violence, military personnel, older adults, individuals who are incarcerated, high-risk occupations (e.g., construction, manufacturing, policeman), and sports at all levels (e.g., Olympic, professional, collegiate) are at elevated risk of TBI. 6-11

### Suggestions for Reseachers and Policy Makers from the CDC

Access here: <https://www.cdc.gov/features/traumatic-brain-injury/index.html>

**TBI researchers and the TBI Model System Program should continue to:**

1. Study TBI as a chronic health condition.
2. Investigate the contribution of pre-existing and co-occurring conditions.
3. Identify risk factors, such as sleep, weight, depression, aging, and alcohol use.
4. Study the benefits of exercise, diet, social support, and engagement in the community.
5. Test treatments for depression, irritability, sleep disorders, and cognitive impairment.

**At the federal level, decision-makers can:**

1. Recognize TBI as a chronic health condition.
2. Review policies that affect access to rehabilitation services over the life span.
3. Further research that addresses the future management of TBI.
4. Enhance surveillance to monitor the national burden of TBI.

**At the state level, decision-makers can:**

1. Identify the prevalence of disabilities due to TBI among their residents.
2. Screen for TBI history among persons who receive state-funded health and social services.
3. Train health and social service professionals to recognize and minimize the effects of TBI on behavior.
4. Make home and community services more accessible to people with TBI.

**Health care providers can:**

1. Determine if their patients have experienced TBI and understand the impact of TBI on the current health status of patients.
2. Screen for and treat common, late-developing problems, such as depression, substance misuse, and weight gain.
3. Encourage lifestyles that promote brain health.
4. Educate patients and their families to prevent or reduce late-occurring problems.

### References

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders – Text Revision* (5th ed. TR). Washington, DC: American Psychiatric Association.

Belanger, H. G., Curtiss, G., Demery, J. A., Lebowitz, B. K., & Vanderploeg, R. D. (2005). Factors moderating neuropsychological outcomes following mild traumatic brain injury: A meta-analysis. *Journal of the International Neuropsychological Society, 11*(3), 215-227. https://doi.org/10.1017/S1355617705050277

Center for Disease Control and Prevention (2019). Surveillance Report of Traumatic Brain Injury-related Emergency Department Visits, Hospitalizations, and Deaths—United States, 2014. *Centers for Disease Control and Prevention, U.S. Department of Health and Human Services*. Center for Substance Abuse Treatment. (2010). Treating clients with traumatic brain injury. *Substance Abuse Treatment Advisory, 9*, 1-8.

Centers or Disease Control and Prevention (2022). State injury indicators report: Instructions for preparing 2020 data. Retrieved from <https://www.cdc.gov/injury/pdfs/2020_state_injury_indicator_instructions-508.pdf>

Corrigan, J. D., Bogner, J., & Holloman, C. (2012). Lifetime history of traumatic brain injury among persons with substance use disorders. *Brain Injury, 26*, 139–150. <https://doi.org/10.3109/02699052.2011.648705>

Dams-O’Connor, K., Cantor, J. B., Brown, N., Dijkers, M. P., Spielman, L. A., & Gordon, W. A. (2016). Screening for Traumatic Brain Injury: Findings and public health implications. *Journal of Head Trauma Rehabilitation*, *29*(6), 479-489.   
doi:10.1097/HTR.0000000000000099

Durand, E., Chevignard, M., Ruet, A., Dereix, A., Jourdan, C., & Pradat-Diehl, P. (2017). History of traumatic brain injury in prison populations: A systematic review. *Annals of Physical and Rehabilitation Medicine, 60*, 95–101. <https://doi.org/10.1016/j.rehab.2017.02.003>

Gioia, G., & Collins, M. (2006). Acute Concussion Evaluation (ACE): Physician/clinician office version. *Heads Up: Brain Injury In Your Practice toolkit, Centers for Disease Control and Prevention (CDC)*.

Greve, M. W., & Zink, B. J. (2009). Pathophysiology of traumatic brain injury. Mount Sinai Journal of Medicine, 76(2), 97–104. <http://dx.doi.org/10.1002/msj.20104>

Ignacio, D. A., & Serpas, D. G. (2020). Lost in translation: A call to action addressing the disparities in postinjury rehabilitation for community-dwelling survivors of Traumatic Brain Injury*. APA Division 56: Journal of Trauma Psychology*, 22-24.

Mayo, C. D., Scarapicchhia, V., Robinson, L. K. & Gawryluk, J. R. (2019). Neuropsychological assessment of traumatic brain injury: Current ethical challenges and recommendations for future practice. Applied Neuropsychology of Adults, 26(4), 383–391. https://doi.org/10.1080/23279095.2017.1416472

National Association of State Head Injury Administrators NASHIA (2014). TBI/ABI HCBS Waiver programs and other options for long-term services and supports.   
Retrieved from [www.nashia.org/pdf/tbi\_hcbs\_waiver\_ltss\_overview.pdf](http://www.nashia.org/pdf/tbi_hcbs_waiver_ltss_overview.pdf)

Rao, V. A., Bechtold, K. T., Arciniegas, D. B., Samus, Q. M., Albreecht, J., Pugh, B. T., Jacoby, A., & Buenaver, L. (2020). Establishment of a patient-centered outcomes research network for individuals with TBI and neuropsychiatric symptoms. *Brain Injury*, *34*(4), 548-555. doi:10.1080/02699052.2020.1725980

Schofield, P. W., Malacova, E., Preen, D. B., D’Este, C., Tate, R., Reekie, J. Wand, H., & Butler, T. (2015). Does traumatic brain injury lead to criminality? A whole-population retrospective cohort study using linked data. *PLoS ONE, 19*, e0132558. <http://dx.doi.org/10.1371/journal.pone.0132558>

Stubbs, J. L., Thornton, A. E., Sevick, J. M., Silverbeg, N. D., Barr, A. M., Honer, W. G., & Panenka, W. J. (2019). Traumatic brain injury in homeless and marginally housed individuals: A systematic review and meta-analysis. *S2468-2667*, 30225–30227.

Theadom, A., McDonald, S., Starkey, N., Barker-Collo, S., Jones, K. M., Ameratunga, S., … & Feigin, V. L. (2019). Social cognition four years after mild-TBI: An age-matched prospective longitudinal cohort study. *Neuropsychology, 33*(4), 560–567. <http://dx.doi.org/10.1037/neu0000516>

United States Census Bureau (2016). 2011-2015 American Community Survey, 5-year Estimate. Retrieved from [www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural.html](http://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural.html)

Vanderploeg, R. D., Belanger, H. G., Curtiss, G., Bowles, A. O., & Cooper, D. B. (2019). Reconceptualizing rehabilitation of individuals with chronic symptoms following mild traumatic brain injury. *Rehabilitation Psychology, 64*(1), 1–12. <http://dx.doi.org/10.1037/rep0000255>

Vos, P. E., Alekseenko, Y., Battistin, L., Ehler, E., Gerstenbrand, F., Muresanu, D. F., ... & von Wild, K. (2012). Mild traumatic brain injury. *European Journal of Neurology, 19*(2), 191–198. <http://dx.doi.org/10.1111/j.1468-1331.2011.03581.x>

Weiner, S., Beall, J., Aguilar-Curry, C. M., Chui, D. (2020). SB-855 Health coverage: mental health or substance abuse disorders. Retrieved from <http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200SB855>

Table 1

Centers for Disease Control’s proposed TBI Case Definition ICD 10 Diagnostic codes.

A screenshot of a medical report

Includes proposed TBI Case Definition Diagnosis Codes for non-fatal hospitalizations

**Table 2.** Population and Respondent Distributions by Gender and Age

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Gender** | **Age** | **Universe** | | **Respondents** | |
| Male | 18 - 24 | 1,851,911 | 6.1% | 23 | 2.2% |
| 25 - 34 | 3,050,941 | 10.0% | 51 | 4.8% |
| 35 - 44 | 2,637,220 | 8.7% | 77 | 7.3% |
| 45 - 54 | 2,394,874 | 7.9% | 60 | 5.7% |
| 55 - 64 | 2,396,447 | 7.9% | 85 | 8.0% |
| 65+ | 2,741,622 | 9.0% | 157 | 14.9% |
| Female | 18 - 24 | 1,762,971 | 5.8% | 35 | 3.3% |
| 25 - 34 | 2,826,256 | 9.3% | 93 | 8.8% |
| 35 - 44 | 2,615,318 | 8.6% | 114 | 10.8% |
| 45 - 54 | 2,506,217 | 8.2% | 88 | 8.3% |
| 55 - 64 | 2,400,802 | 7.9% | 128 | 12.1% |
| 65+ | 3,268,053 | 10.7% | 146 | 13.8% |
| **Total** | | **30,452,632** | **100.0%** | **1,057** | **100.0%** |

**Table 3.** Population and Respondent Distributions by Gender and Ethnicity

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Gender** | **Ethnicity** | **Universe** | | **Respondents** | |
| Male | Hispanic | 5,764,518 | 18.9% | 60 | 5.7% |
| Others | 9,308,497 | 30.6% | 393 | 37.2% |
| Female | Hispanic | 5,590,093 | 18.4% | 117 | 11.1% |
| Others | 9,789,524 | 32.2% | 487 | 46.1% |
| **Total** | | **30,452,632** | **100.0%** | **1,057** | **100.0%** |

**Table 4.** Population and Respondent Distributions by Gender and Race

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Gender** | **Race** | **Universe** | | **Respondents** | |
| Male | White | 11,135,982 | 36.6% | 331 | 31.3% |
| Asian | 2,251,602 | 7.4% | 72 | 6.8% |
| Other | 1,685,431 | 5.5% | 50 | 4.7% |
| Female | White | 10,964,873 | 36.0% | 446 | 42.2% |
| Asian | 2,723,116 | 8.9% | 65 | 6.1% |
| Other | 1,691,628 | 5.6% | 93 | 8.8% |
| **Total** | | **30,452,632** | **100.0%** | **1,057** | **100.0%** |

**Table 5.** Population and Respondent Distributions by Gender and Education

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Gender** | **Education** | **Universe** | | **Respondents** | |
| Male | UP to HS | 5,994,080 | 19.7% | 34 | 3.2% |
| Some College | 2,771,664 | 9.1% | 56 | 5.3% |
| Associate Degree | 1,093,869 | 3.6% | 29 | 2.7% |
| Bachelor's Degree | 3,210,004 | 10.5% | 140 | 13.2% |
| Master's+ | 2,003,398 | 6.6% | 194 | 18.4% |
| Female | UP to HS | 5,463,515 | 17.9% | 42 | 4.0% |
| Some College | 2,714,750 | 8.9% | 106 | 10.0% |
| Associate Degree | 1,472,425 | 4.8% | 50 | 4.7% |
| Bachelor's Degree | 3,693,673 | 12.1% | 204 | 19.3% |
| Master's+ | 2,035,254 | 6.7% | 202 | 19.1% |
| **Total** | | **30,452,632** | **100.0%** | **1,057** | **100.0%** |

**Table 6.** Population and Respondent Distributions by Gender and Marital Status

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Gender** | **Marital** | **Universe** | | **Respondents** | |
| Male | Married | 7,695,311 | 25.3% | 252 | 23.8% |
| Not Married | 7,377,704 | 24.2% | 201 | 19.0% |
| Female | Married | 7,713,711 | 25.3% | 261 | 24.7% |
| Not Married | 7,665,906 | 25.2% | 343 | 32.5% |
| **Total** | | **30,452,632** | **100.0%** | **1,057** | **100.0%** |

**Table 7.** Population and Respondent Distributions by Gender and Income

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Gender** | **Income** | **Universe** | | **Respondents** | |
| Male | Less than $15K | 760,945 | 2.5% | 21 | 2.0% |
| $15K-$20K | 363,919 | 1.2% | 10 | 0.9% |
| $20K-$25K | 393,413 | 1.3% | 9 | 0.9% |
| $25K-$30K | 363,984 | 1.2% | 23 | 2.2% |
| $30K-$40K | 786,443 | 2.6% | 14 | 1.3% |
| $40K-50K | 937,864 | 3.1% | 28 | 2.6% |
| $50K-$75K | 2,323,455 | 7.6% | 74 | 7.0% |
| $75K-$100K | 2,015,011 | 6.6% | 71 | 6.7% |
| $100K-$150K | 2,880,396 | 9.5% | 87 | 8.2% |
| $150K-$200K | 1,739,346 | 5.7% | 41 | 3.9% |
| $200K+ | 2,508,239 | 8.2% | 75 | 7.1% |
| Female | Less than $15K | 1,032,557 | 3.4% | 26 | 2.5% |
| $15K-$20K | 418,812 | 1.4% | 31 | 2.9% |
| $20K-$25K | 403,834 | 1.3% | 20 | 1.9% |
| $25K-$30K | 477,065 | 1.6% | 28 | 2.6% |
| $30K-$40K | 939,772 | 3.1% | 38 | 3.6% |
| $40K-50K | 919,615 | 3.0% | 46 | 4.4% |
| $50K-$75K | 2,428,912 | 8.0% | 100 | 9.5% |
| $75K-$100K | 2,001,610 | 6.6% | 85 | 8.0% |
| $100K-$150K | 2,721,795 | 8.9% | 114 | 10.8% |
| $150K-$200K | 1,672,733 | 5.5% | 56 | 5.3% |
| $200K+ | 2,362,912 | 7.8% | 60 | 5.7% |
| **Total** | | **30,452,632** | **100.0%** | **1,057** | **100.0%** |

Figure 1

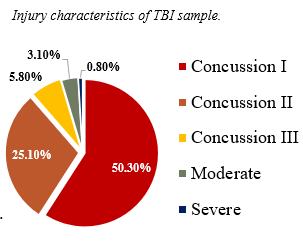
Chart, pie chart

Shows the sample of the mechanisms of injury, with the largest segment being sports and recreation.

Figure 2

Chart, pie chart

The pie chart gives the injury characteristics of TBI sample. Half involve no loss of consciousness.



1. Shah, B., Barnwell, B., & Bieler, G. (1995). SUDAAN Software for Analysis of Correlated Data, RTI International. [↑](#footnote-ref-1)
2. <https://support.sas.com/resources/papers/proceedings16/SAS3520-2016.pdf> [↑](#footnote-ref-2)