Preexisting Conditions in Older Adults with Mild Traumatic Brain Injuries

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Abstract

Objective: This study examined the prevalence of preexisting conditions that could affect premorbid brain health, cognition, and functional independence among older adults with mild traumatic brain injury (MTBI), and the relationship between preexisting conditions, injury characteristics, and emergency department (ED) discharge location (home versus continued care).

Methods: Older adults (*N*=1,427; 55-104 years-old; 47.4% men) who underwent head computed tomography (CT) after acute head trauma were recruited from the ED. Researchers documented preexisting medical conditions retrospectively from hospital records.

Results: Multiple preexisting conditions increased in frequency with greater age, including circulatory and nervous system diseases and preexisting abnormalities on head CT. Psychiatric and substance use disorders (SUDs) decreased in frequency with greater age. Among participants with uncomplicated MTBI and GCS=15, preexisting nervous system diseases and preexisting CT abnormalities were associated with higher odds of continued care for all participants, whereas psychiatric disorders and SUDs were only associated with higher odds of continued care among participants <70 years-old. Preexisting circulatory diseases, loss of consciousness, and amnesia were unassociated with discharge location.

Conclusions: Preexisting medical conditions that could affect brain and cognitive health occur commonly among older adults who sustain MTBIs. These conditions can confound research examining post-injury outcomes within this age group.

Keywords: Brain Concussion; Head Injuries, Closed; Aged; Computed Tomography; Comorbidity

Introduction

There is now an enormous literature relating to mild traumatic brain injury (MTBI) in children, adolescents, athletes, civilians, active duty service members, and veterans (1–6), but fewer studies examining MTBI in older adults (6). Previous researchers have identified certain preexisting health conditions (e.g., prior brain injuries, cerebrovascular disease, mental illness) as risk factors for TBI (7,8) and predictors of worse outcome following TBI in general (9–12), and MTBI in particular (13,14). A gap in the literature, however, is having a more complete understanding of preexisting medical problems that could be related to psychological, cognitive, and brain health in the weeks, months, and years following MTBI. This gap is particularly relevant to older adults because they have greater rates of medical problems that can compromise brain and cognitive health.

Among a sample of older adults hospitalized for TBI of all severities, 98.9% had at least one preexisting medical condition, with the most common conditions including hypertension (22.7%), dementia (11.4%), diabetes (8.2%), and cancer (5.4%) (15). Medical co-morbidity occurs commonly among older adults with TBI (16), and greater disease co-morbidity has been linked to functional outcome (11,12). Moreover, preexisting health problems have major implications for researchers who study structural, microstructural, functional, and neurometabolic changes in the brain with neuroimaging, or for those who study possible later-life effects, including risk for neurodegenerative disease (such as Alzheimer's disease). The purpose of this study is to document preexisting health, psychiatric, substance use, and neurological problems in a large inception cohort of older adults who were evaluated in the emergency department (ED) with suspected MTBI, hypothesizing that (a) a substantial proportion of older adults would have preexisting cardiovascular, psychiatric, and neurological problems that could impact brain and cognitive health, (b) the rates of these preexisting conditions would increase with age, and (c) these preexisting conditions will be more related to discharge location than clinical signs of injury.

Materials and Methods

Participants

Participants were medically examined in the ED of the Tampere University Hospital between August 2010 and July 2012. The ED provides health services for a joint municipal authority of 22 municipalities (both urban and rural), the catchment area being approximately 470,000 residents. Tampere University Hospital is the only neurosurgical referral center in the geographical region, and the second largest overall in Finland. Figure 1 provides a flow diagram detailing participant inclusion and exclusion. The patient pool for this study comprised all consecutive patients who underwent computed tomography (CT) due to acute head trauma (*N*=3,023). The former Scandinavian guidelines for initial management of minimal, mild, and moderate head injuries (17) were used as referral criteria for acute head CT. Under these criteria, patients were referred for CT based on Glasgow Coma Scale (GCS) scores, the presence of loss of consciousness (LOC) or amnesia, impaired alertness or memory, or focal neurologic deficit. According to the guidelines, patients with minimal head injuries (i.e., GCS=15 and no LOC) were not referred for CT, whereas patients with mild head injuries (i.e., GCS=14-15, LOC <5 minutes or amnesia, or impaired alertness or memory) or moderate head injuries (i.e., GCS=9-13, or LOC ≥5 minutes, or focal neurologic deficit) were referred for CT. MTBI was defined according to the criteria proposed by the World Health Organization (WHO) Collaborating Center for Neurotrauma Task Force on Mild Traumatic Brain Injury (18): (a) LOC ≤30 minutes, post-traumatic amnesia ≤24 hours, and/or other transient neurological abnormalities; and (b) GCS score of 13-15 ≤30 minutes after injury or upon presentation for healthcare, with neither criterion attributable to substances, other injuries, or penetrating head or brain injuries. Ethics

approval for the study was obtained from the Ethical Committee of Pirkanmaa Hospital District (code: R10027), Finland.

Data collection was conducted retrospectively from hospital records. A research nurse and a research physician screened the ED patient admission list for potential study participants. Participant-related data included age and sex. Injury-related variables included alcohol intoxication at the time of injury (breathalyzer and/or blood alcohol level) and mechanism of injury, coded as ground-level falls, falls from a height, car accidents, violence-related injuries, bicycle accidents, motorcycle accidents, moped accidents, traffic accidents-pedestrian, or other/unknown. Clinical variables relating to TBI included eye-witnessed LOC and retrograde and/or anterograde amnesia, identified by the on-call ED physician through an interview on pre- and post-injury events. Both LOC and amnesia were coded either yes, no, or unknown. Glasgow Coma Scale (GCS) scores were obtained either 30 minutes post injury or upon presentation to the ED, whichever occurred later. For participants where GCS was likely lowered by factors unrelated to the MTBI (e.g., alcohol intoxication), MTBI diagnosis was made based on the duration of LOC and posttraumatic amnesia. Health problems and diseases were coded from the hospital electronic medical records according to the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (19). All the available medical records were reviewed. Preinjury health problems for a larger cohort of adults and older adults have been presented in a prior study (20). Information on current medication at the time of injury was classified into 17 subgroups according to the Finnish Commercial Drug Catalog (Pharmaca Fennica), which is based on the WHO's Anatomical Therapeutic Chemical Classification System codes. The location of follow-up treatment after the ED was categorized as home, a health center, another health care facility, a hospital, or death.

Non-contrast head CT was performed on all participants in the ED with a 64-row CT scanner (GE, Lightspeed VCT, WI, USA) within 72 hours of MTBI. Of the total sample, participants were excluded if they sustained a moderate or severe TBI (n=257) or were under the

age of 55 (*n*=1,339). This cutoff for defining older adulthood was lower than some conventional research definitions (e.g., 60 or 65 years and older), but previous researchers on TBI in older adults have used age cutoffs within the 50s for inclusion (21–23), and the inclusion of those over 55 allowed for a broader examination of participants defined as older adults in previous and future TBI studies. The remaining sample of 1,427 had a clearly documented MTBI (*n*=1,067) or suspected MTBI (*n*=360), meaning that injury severity characteristics were not documented in the medical record, but the patient was referred for head CT as a result of head trauma. Two neuroradiologists analyzed and systematically coded all CT scans with separate structured data collection forms, with findings coded as acute trauma-related abnormalities or preexisting abnormalities. The acute intracranial findings, for a larger cohort of patients presenting to the ED, were examined in a separate study (24). Preexisting chronic findings were coded as ischemic lesions, posttraumatic lesions, microangiopathy, general atrophy, and intracranial tumors.

Insert Figure 1 about here

Statistical Analyses

The frequencies of all preexisting conditions from medical records and preexisting CT abnormalities were calculated as frequencies for the total sample, along with stratifications by age band (i.e., 55-59, 60-69, 70-79, and 80+ years-old). The frequencies of clinical injury characteristics (e.g., LOC, amnesia, GCS=13-14, positive head CT findings) were also prepared for the full sample and age stratifications. A series of χ^2 analyses examined whether the frequencies of clinical injury characteristics and different categories of preexisting conditions (i.e., diseases of the circulatory system; any disease of the nervous system; preexisting abnormalities on head computed tomography; and any mental or behavioral disorder including alcohol and substance abuse) varied across age bands. Among the preexisting conditions coded, the following were considered risk factors for mild cognitive impairment or dementia: circulatory system disease, any disease of the nervous system, a mental or behavioral disorder,

alcohol or drug abuse, or a preexisting brain abnormality identified on CT. The frequencies at which individual patients had one or more or two or more of these risk factors were also calculated and compared across age bands using χ^2 analyses.

Additional χ^2 analyses examined the relationship between discharge location and clinical injury characteristics (i.e., LOC, amnesia) or different categories of preexisting conditions. Because positive acute head CT findings and GCS<15 are typically associated with continued care, this analysis focused on the subsample of older adult participant with a GCS=15 and negative head CT who did not die as a result of their injury (*n*=616). To reduce the number of analyses conducted while maintaining sufficient sample size, age groups were collapsed to produce two age groups, 55-69 years-old (*n*=243; 56.0% men) and 70+ years-old (*n*=373; 37.5% men). Each analysis was conducted separately for each age group because rates of preexisting conditions and discharge to continued care increased with age. Discharge location was dichotomized as home or continued care (i.e., a health center, another health care facility, or hospital), with each odds ratio (OR) calculated so that a value greater than 1.0 indicated higher odds of discharge to continued care with the presence of an injury characteristic or preexisting condition.

Results

Sample and Injury Characteristics

The characteristics of the study cohort are presented in Table 1. Gender differed across age groups, with men overrepresented between the ages of 55 and 69 (63.2% men), and women were overrepresented after the age of 80 (69.7% woman). Most injuries, across genders and age groups, occurred as a result of falls—and after the age of 70, more than 80% of the injuries were related to falls. Alcohol intoxication was common between the ages of 55 and 69 (37.2%), but the incidence of alcohol intoxication among patients decreased with greater age. For approximately half of the cases, injury severity characteristics, such as LOC, GCS, and amnesia were not documented in the medical

records (although head CTs were ordered for all patients included in this study). LOC was more common among participants 55-59 (17.1%) and 60-69 years-old (18.6%) compared to those 70-79 (13.3%) and 80+ years-old (9.2%). Amnesia was recorded among roughly 20% of participants with available data between 55 and 79 years-old but was recorded at a lower frequency in participants 80 years and older (12.7%). The frequencies of acute abnormalities on head CT (12.8-19.5%) and having a GCS<15 (4.6-6.8%) were similar across age groups.

Insert Table 1 about here

Age and Preexisting Health Conditions

As presented in Table 2, preexisting medical problems that could affect brain health were very common among individuals 55 years and older, and χ^2 tests indicated significant differences across age groups in the frequencies of diseases of the circulatory system (χ^2=192.97, p<.001), mental, behavioral, and substance use disorders (χ^2=176.93, p<.001), diseases of the nervous system (χ^2=135.87,p<.001), and preexisting neuroimaging abnormalities (χ^2=211.47, p<.001). Diseases of the circulatory system increased in frequency with greater age; present in just 28.7% of patients between the ages of 55-59, but 71.9% of patients in their 70s. Of patients between the ages of 55-59, 27.4% were on cardiovascular medications, compared to 63.6% of patients in their 70s. Mental health and substance abuse problems were common in patients between the ages of 55-59 (50.0%), but they were far less common in patients in their 70s (18.6%) and patients over the age of 80 (9.2%). Diseases of the nervous system were common and increased steadily with age. For those 55-59 years-old, 21.3% had a nervous system disease compared to 58.2% of those over the age of 80. Of patients over the age of 80, 27.3% had a neurodegenerative disease documented in their medical records. Moreover, in this oldest age group, 23.5% had a documented stroke or transient ischemic attack and 20.4% had cerebral atrophy and/or white matter lesions. Preexisting neuroimaging abnormalities were common and increased steadily with age. Small vessel ischemic disease and generalized atrophy were the most common, occurring in 41.7% and 27.2% of those in their 70s, respectively. In the total sample, 7.6%

had a documented prior TBI in their records and 3.4% had preexisting post-traumatic lesions on acute CT. Figure 2 visually displays differences in the frequency of preexisting conditions across four age bands.

Insert Table 2 about here

As noted earlier, circulatory system disease, any disease of the nervous system, a mental or behavioral disorder, alcohol or drug abuse, or a brain abnormality identified on CT were considered risk factors for mild cognitive impairment or dementia. The percentages of older adults who had one or more of these risk factors was 88.0% of the total sample. The frequency of having one or more risk factors increased with greater age (χ^2=134.60, p<.001): 55-59 years-old = 67.1%, 60-69 years-old = 80.6%, 70-79 years-old = 90.8%, 80+ years-old = 97.2%. The percentages of older adults who had two or more of these risk factors was 65.4% of the total sample, which also showed a positive relationship with greater age (χ^2=148.39, p<.001): 55-59 years-old = 40.9%, 60-69 years-old = 50.3%, 70-79 years-old = 65.7%, 80+ years-old = 81.9%.

Insert Figure 2 about here

Injury Characteristics, Preexisting Conditions, and Discharge Location

The rates of different clinical injury characteristics and preexisting health conditions among the subsample of participants included in the discharge location analysis (i.e., participants with MTBI with GCS=15 and negative head CT who did not die due to their injury) are presented in Table 3. The results of analyses examining the relationship between discharge location and injury characteristics or preexisting conditions are presented in Table 4. Among participants 55-69 years-old, 46.9% discharged to continued care, with preexisting diseases of the nervous system (OR=2.92), mental, behavioral, and substance use disorders (OR=3.05), and preexisting CT abnormalities (OR=3.02) associated with greater odds of continued care post ED discharge. Among participants 70-years-old or older, 74.0% discharged to continued care, with preexisting diseases of the nervous system (OR=2.60) and CT abnormalities (OR=2.12) associated with greater odds of continued care, but not mental, behavioral,

and substance use disorders. Preexisting diseases of the circulatory system, LOC, and amnesia were not associated with greater odds of continued care for either age group.

Insert Tables 3 and 4 about here

Discussion

Older adults are at risk for sustaining a MTBI, especially from falls (25). In this cohort, falls accounted for more than 80% of the injuries for those over the age of 70. In general, fall risk is associated with both medical frailty (26) and neurodegenerative disease (27,28) in older adults. Large percentages of the cohort had preinjury medical or psychiatric problems that could increase risk for mild cognitive impairment or dementia: 66.6% of patients had a disease of the circulatory system; 42.1% had a disease of the nervous system; 34.0% had a preexisting brain abnormality visible on CT; and 23.5% had a mental, behavioral, or substance abuse disorder. The rates of these health problems varied considerably across the age groups. Circulatory and nervous system diseases, along with imaging abnormalities, increased in frequency with greater age, whereas psychiatric and substance use disorders decreased in frequency with greater age. Having any one of the above health problems was very common, occurring in 86.4% of the total cohort.

Older adults with hypertension are at increased risk for mild cognitive impairment (29), white matter hyperintensities on structural imaging (30), and microstructural changes in white matter on diffusion tensor imaging (31). Older adults with late-life psychiatric or substance use problems are also at risk for cognitive deficits (32–37), abnormalities on neuroimaging (38–40), and elevated blood-based biomarkers of neurological pathology (41,42). These findings have implications for clinical practice and research. Studies attempting to examine neuropsychological or neuroimaging findings following injury in older adults can be seriously confounded by these preexisting health problems. When considering outcome from MTBI in older adults, there is notable variability in preinjury brain

health and cognitive reserve and this variability can mimic, mask, or magnify some of the short-, medium-, and long-term neurobiological and neurobehavioral effects of the injury.

Our findings also indicate that, among participants with the mildest injuries within our sample, preexisting health conditions were associated with 2-3 times the odds of continued care, whereas the presence of LOC and amnesia were not. Among participants under 70 years old, preexisting neurological diseases, mental and behavioral health conditions, and CT abnormalities were associated with greater likelihood of continued care; and among participants 70 years and older, preexisting neurological diseases and CT abnormalities, but not mental and behavioral health conditions, were associated with greater likelihood of continued care. Preexisting diseases of the circulatory system were not related to discharge location for either age group. These findings indicate the importance of preexisting neurological conditions over injury characteristics in the management of MTBI in older adults, and how the effects of preexisting mental and behavioral health conditions on outcome may decrease with greater age.

This study is consistent with a previous study that reported high rates of preexisting conditions among older adult patients presenting to the hospital with TBI of all severities (15). In contrast to the more general incidence of health conditions in Finland, the Health 2011 Survey (43) reported that the national incidence of stroke was 10.0% in men over 75 years of age and 8.5% in women. Furthermore, the incidence of depression was 0.7% and 1.3%, respectively. As an example, the burden of stroke and depression seem to be overrepresented in the TBI population. These results are informative for future research and clinical practice, in that scientists and practitioners can anticipate that older adult patients with MTBI will likely present with preexisting co-morbid conditions associated with risk of cognitive impairment (29,33–36) and worse functional outcomes following injury (11,12).

The current study has limitations that affect the generalizability of the findings. First, participants were only recruited from the ED, although older patients with MTBI are less likely to seek medical care following injury (44). Second, participants were recruited from a single hospital, limiting

the representativeness of the sample beyond the population in surrounding area of Tampere, Finland. Third, there is significant missing data in regards to clinical signs of injury, including LOC, amnesia, and GCS score. In turn, analyses pertaining to these signs of injury were conducted on different subsamples of the overall cohort because a listwise deletion approach would have resulted in the exclusion of a very large portion of participants. This type of missingness is not uncommon in the ED, in which these injury characteristics are not consistently documented. Lastly, the study was cross-sectional, and did not involve an assessment of functional outcome. Discharge location was likely associated with acute outcome, but patients who discharged to continued care settings may have arrived at the ED from these settings. In such a case, home discharge may have not been an option; but due to the cross-sectional nature of the study, pre-injury living accommodations are unknown. Although most patients had preexisting conditions, the actual impact of these conditions on treatment and functional outcome among these patients remains unknown and requires future investigation.

The relationship between MTBI and dementia risk is likely a concern for many older adults who experience a MTBI. There is a steadily growing literature relating to TBI and risk for later-in-life dementia (45). Relatively few studies have focused specifically on MTBIs sustained after the age of 60 and risk for a future neurodegenerative disorder. Some studies suggest increased risk for Parkinson's disease and dementia in the years following an MTBI experienced during older adulthood (21,22). As demonstrated through this study, older adults carry numerous risk factors for cognitive impairment prior to experiencing a MTBI, thus the mechanisms by which, and the extent to which, MTBI influences dementia onset and course is difficult to study. Limited research has examined outcomes from MTBI among older adults (46–48) and the interaction between geriatric MTBI, preexisting risk factors, and dementia onset requires further examination by future researchers.

This study examined preexisting health conditions among older adults presenting to the ED with MTBI, most commonly due to falls. A substantial percentage of patients presenting to the ED with MTBI have preexisting medical and psychiatric conditions. Diseases of the circulatory system,

neurological conditions, and preexisting CT abnormalities increased in prevalence with greater age, and psychiatric diagnoses decreased in prevalence with greater age. Preexisting CT findings, neurological conditions, and psychiatric diagnoses were associated with greater odds of discharge to a continued care setting among patients with very mild injuries, whereas injury characteristics of LOC and amnesia were unassociated with discharge. These preexisting conditions could have an impact on cognitive and functional recovery following MTBI and should be considered when determining prognosis and rehabilitation planning, because previous studies have shown worse functional outcomes following MTBI among older adults with co-morbid medical conditions (11,12). The management of MTBI in older adults is limited by a lack of evidence-based guidelines to direct standards of care (6). The current findings can inform the development of guidelines for MTBI management in older adults, in whom clinical variables such as LOC or amnesia may be less relevant to acute management (e.g., determining location of discharge) than preexisting neurological conditions, preexisting head CT findings, and – in older adults under 70 – preexisting mental, behavioral, or substance use disorders.

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Table 1. Characteristics of the mild traumatic brain injury cohort.

	Total Sample Age 55-104		**Age 55-59**		**Age 60-69**		**Age 70-79**		**Age 80+**	
	N=1,427		*n*=164		*n*=360		*n*=338		*n*=565	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Gender										
Men	677	47.4	105	64.0	226	62.8	175	51.8	171	30.3
Women	750	52.6	59	36.0	134	37.2	163	48.2	394	69.7
Mechanism of injury										
Ground-level falls	1,074	75.3	89	54.3	239	66.4	274	81.1	472	83.5
Falls from a height	123	8.6	19	11.6	37	10.3	23	6.8	44	7.8
Car accidents	61	2.4	16	9.8	19	5.3	14	4.1	12	2.1
Violence-related injuries	19	1.3	9	5.5	10	2.8	0	0	0	0
Bicycle accidents	34	2.4	8	4.9	13	3.6	5	1.5	8	1.4
Motorcycle accidents, moped accidents, traffic accidents-pedestrian	25	1.8	4	2.4	8	2.2	9	2.7	0	0
Other or unknown	91	6.4	19	11.6	34	9.4	13	3.8	25	4.4
Follow-up treatment										
Home	397	27.8	78	47.6	144	40.0	99	29.3	76	13.5
Health center	537	37.6	23	14.0	91	25.3	122	36.1	301	53.3
Other health care facility	72	5.0	4	2.4	6	1.7	17	5.0	45	8.0
Hospital	399	28.0	58	35.4	113	31.4	95	28.1	133	23.5
Death	22	1.5	1	0.6	6	1.7	5	1.5	10	1.8
Alcohol intoxication										
Yes	218	15.3	61	37.2	103	28.6	44	13.0	10	1.8
No	678	47.5	48	29.3	92	25.6	154	45.6	384	68.0
Unknown	531	37.2	55	33.5	165	45.8	140	41.4	171	30.3
Loss of Consciousness										
Yes	192	13.5	28	17.1	67	18.6	45	13.3	52	9.2
No	313	21.9	43	26.2	73	20.3	73	21.6	124	21.9
Not witnessed / Unknown	922	64.6	93	56.7	220	61.1	220	65.1	389	68.8
Amnesia										
Yes	259	18.1	31	18.9	82	22.8	74	21.9	72	12.7
No	417	29.2	67	40.9	118	32.8	82	24.3	150	26.5
Unknown	751	52.6	66	40.2	160	44.4	182	53.8	343	60.7
Glasgow Coma Scale										
15	740	51.9	97	59.1	184	51.1	177	52.4	282	49.9
14	60	4.2	9	5.5	15	4.2	15	4.4	21	3.7
13	16	1.1	0	0	3	0.8	8	2.4	5	0.9
N/A	544	38.1	50	30.5	150	41.7	126	37.3	218	38.6
Acute abnormalities on head computed tomography										
Yes	251	17.6	21	12.8	62	17.2	66	19.5	102	18.1
No	1,176	82.4	143	87.2	298	82.8	272	80.5	463	81.9

Table 2. Frequencies of preexisting conditions in mild traumatic brain injury cohort.

	Total Sample Age 55-104		**Age 55-59**		**Age 60-69**		**Age 70-79**		**Age 80+**	
	N=1,427		*n*=164		*n*=360		*n*=338		*n*=565	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Diseases of the circulatory system	950	66.6	47	28.7	197	54.7	243	71.9	463	81.9
Any mental or behavioral disorder incl. alcohol and substance abuse	335	23.5	82	50.0	138	38.3	63	18.6	52	9.2
Chronic detrimental alcohol use (during the last two years)	194	13.6	65	39.6	98	27.2	28	8.3	3	0.5
Regular substance abuse (during the last two years)	5	0.4	5	3.0	0	0	0	0	0	0
Schizophrenia, schizotypal, or delusional disorder	30	2.1	3	1.8	11	3.1	7	2.1	9	1.6
Affective disorder (during the last year)	127	8.9	16	9.8	38	10.6	30	8.9	43	7.6
Neurotic, stress-related, and somatoform disorder	7	0.5	2	1.2	4	1.1	1	0.3	0	0
Adulthood personality disorder or disturbance of conduct	11	0.8	3	1.8	7	1.9	1	0.3	0	0
Mental retardation	9	0.6	3	1.8	4	1.1	1	0.3	1	0.2
Mental developmental disorder	2	0.1	0	0	1	0.3	1	0.3	0	0
Any disease of the nervous system	601	42.1	35	21.3	88	24.4	149	44.1	329	58.2
Brain tumor	18	1.3	3	1.8	3	0.8	4	1.2	8	1.4
Neurodegenerative disease	227	15.9	6	3.7	17	4.7	50	14.8	154	27.3
Demyelinating disease	2	0.1	0	0	2	0.6	0	0	0	0
Stroke or a transient cerebral ischemic attack	257	18.0	13	7.9	37	10.3	74	21.9	133	23.5
Cerebral atrophy and/or white matter lesions	188	13.2	10	6.1	21	5.8	42	12.4	115	20.4
Epilepsy	64	4.5	12	7.3	22	6.1	19	5.6	11	1.9
Prior brain injury	108	7.6	25	15.2	42	11.7	18	5.3	23	4.1
Preexisting abnormalities on head computed tomography	846	59.3	48	29.3	142	39.4	210	62.1	446	78.9
Preexisting post-traumatic lesions	49	3.4	9	5.5	23	6.4	9	2.7	8	1.4
Preexisting ischemic lesions	189	13.2	10	6.1	28	7.8	52	15.4	99	17.5
Microangiopathy/small vessel ischemic disease	570	39.9	13	7.9	55	15.3	141	41.7	361	63.9
Generalized atrophy	435	30.5	27	16.5	89	24.7	92	27.2	227	40.2
Brain tumor	17	1.2	2	1.2	2	0.6	5	1.5	8	1.4
More than 1 preexisting abnormality on head computed tomography	362	25.4	13	7.9	49	13.6	77	22.8	223	39.5
Medications										
Cardiovascular medication	845	59.2	45	27.4	167	46.4	215	63.6	418	74.0
Medication affecting blood clotting and anemia	568	39.8	21	12.8	84	23.3	148	43.8	315	55.8
Central nervous system medication	518	36.3	43	26.2	111	30.8	116	34.3	248	43.9

Table 3. Frequencies of clinical signs of injury and preexisting conditions in mild traumatic brain injury cohort.

	Age 55-69		**Age 70+**		**Total**	
	n	*%*	*n*	*%*	*n*	*%*
Loss of consciousness (n=243)	40	37.4%	40	29.4%	80	32.9%
Amnesia (n=345)	51	30.2%	56	31.8%	107	31.0%
Diseases of the circulatory system (n=616)	126	51.9%	291	78.0%	417	67.7%
Diseases of the nervous system (n=616)	52	21.4%	191	51.2%	243	39.4%
Any mental or behavioral disorder incl. alcohol and substance abuse (n=616)	87	35.8%	45	12.1%	132	21.4%
Preexisting findings on head computed tomography (n=616)	73	30.0%	280	75.1%	353	57.3%

Table 4. Relationship between discharge location, clinical signs of mild traumatic brain injury, and preexisting health conditions among participants with uncomplicated mild traumatic brain injury and Glasgow Coma Scale of 15.

			Discharge Location, *n* (%)				
			Home (*n*=226)	**Continued Care** (*n*=390)	χ^2	*p*	*OR* (95% *CI*)
55-69 years-old	**Clinical Signs and Characteristics**						
	Loss of consciousness (*n*=107)	Present	28 (70.0)	12 (30.0)	2.29	.130	.53 (.23-1.21)
		Absent	37 (55.2)	30 (44.8)			
	Amnesia (*n*=169)	Present	34 (66.7)	17 (33.3)	0.35	.552	.81 (.41-1.62)
		Absent	73 (61.9)	45 (38.1)			
	Preexisting Conditions						
	Diseases of the circulatory system (*n*=243)	Yes	68 (54.0)	58 (46.0)	.08	.775	.93 (.56-1.54)
		No	61 (52.1)	56 (47.9)			
	Diseases of the nervous system (*n*=243)	Yes	17 (32.7)	35 (67.3)	11.05	.001	2.92 (1.53-5.58)
		No	112 (58.6)	79 (41.4)			
	Mental/behavioral disorders incl. alcohol/sub. use disorders (*n*=243)	Yes	31 (35.6)	56 (64.4)	16.58	<.001	3.05 (1.77-5.27)
		No	98 (62.8)	58 (37.2)			
	Preexisting head computed tomography abnormalities (*n*=243)	Yes	25 (34.2)	48 (65.8)	14.87	<.001	3.02 (1.71-5.37)
		No	104 (61.2)	66 (38.8)			
70+ years-old	**Clinical Signs and Characteristics**						
	Loss of consciousness (*n*=136)	Present	20 (50.0)	20 (50.0)	1.82	.177	.60 (.29-1.26)
		Absent	36 (37.5)	60 (62.5)			
	Amnesia (*n*=176)	Present	51 (42.5)	69 (57.5)	0.16	.687	1.14 (.59-2.18)
		Absent	22 (39.3)	34 (60.7)			
	Preexisting Conditions						
	Diseases of the circulatory system (*n*=373)	Yes	72 (24.7)	219 (75.3)	1.10	.295	1.33 (.78-2.29)
		No	25 (30.5)	57 (69.5)			
	Diseases of the nervous system (*n*=373)	Yes	33 (17.3)	158 (82.7)	15.50	<.001	2.60 (1.60-4.21)
		No	64 (35.2)	118 (64.8)			
	Mental/behavioral disorders incl. alcohol/sub. use disorders (*n*=373)	Yes	8 (17.8)	37 (82.2)	1.80	.180	1.72 (.77-3.84)
		No	89 (27.1)	239 (72.9)			
	Preexisting head computed tomography abnormalities (*n*=373)	Yes	62 (22.1)	218 (77.9)	8.71	.003	2.12 (1.28-3.52)
		No	35 (37.6)	58 (62.4)			

Note. The following were considered risk factors for dementia or mild cognitive impairment: circulatory system disease, any disease of the nervous system, a mental or behavioral disorder, alcohol or drug abuse, or a brain abnormality identified on computed tomography.

Figure 1. Flow diagram of participant inclusion and exclusion.

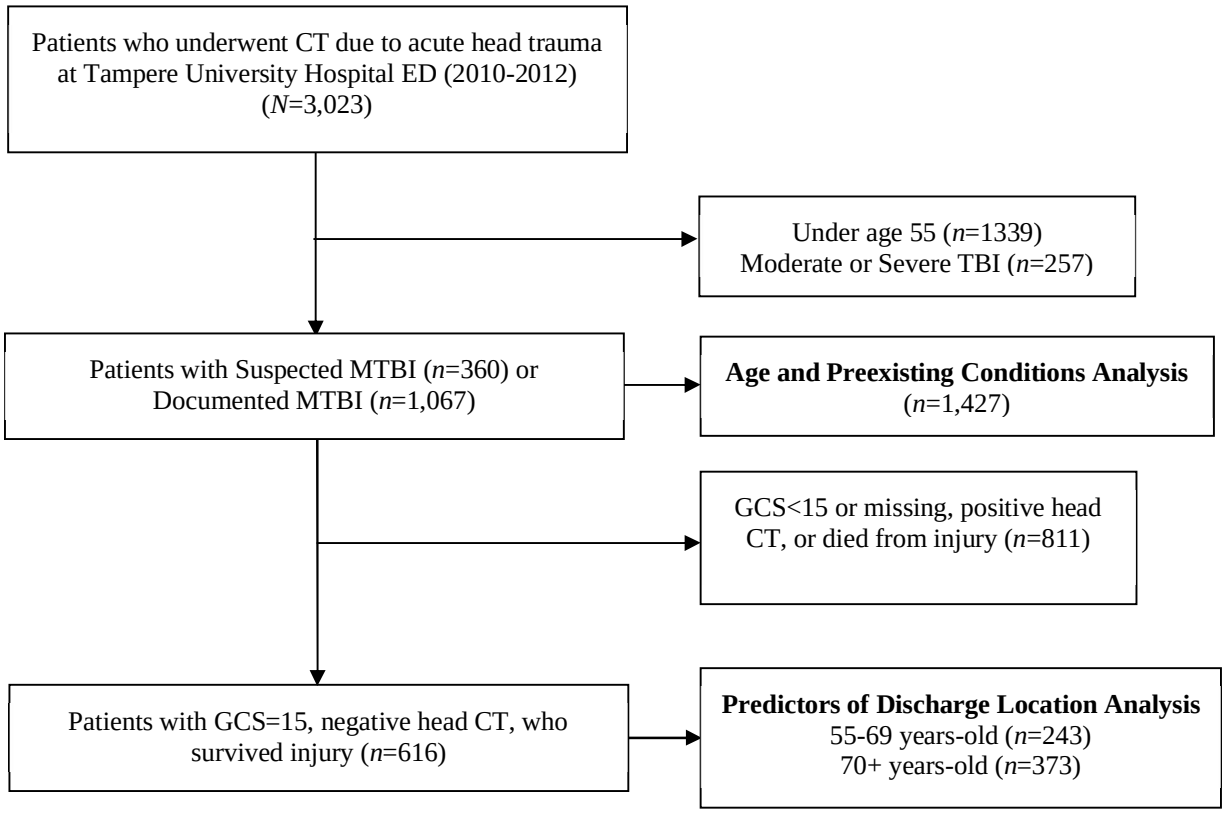

Figure 2. Frequencies of preexisting health conditions by age band