History of traumatic brain injury in prison populations: A systematic review

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Summary

Traumatic Brain Injury (TBI) can lead to cognitive, behavioural and social impairments. The relationship between criminality and a history of TBI has been addressed on several occasions.

Objective

The objective of this review was to present an update on current knowledge concerning the existence of a history of TBI in prison populations.

Methods

PubMed and PsycINFO databases were searched for relevant papers, using the PRISMA guidelines. We selected papers describing TBI prevalence among incarcerated individuals and some that also discussed the validity of such studies.

Results

Thirty-three papers were selected. The majority of the papers were on prison populations in Australia (3/33), Europe (5/33) and the USA (22/33). The selected studies found prevalence rates of the history of TBI ranging from 9.7% and 100%, with an average of 46% (calculated on a total population of 9 342). However, the level of evidence provided by the literature was poor according to the French national health authority scale. The majority of the prisoners were males with an average age of 37. In most of the papers (25/33), prevalence was evaluated using a questionnaire. The influence of TBI severity on criminality could not be analysed because of a lack of data in the majority of papers. Twelve papers mentioned that several comorbidities (mental health problems, use of alcohol…) were frequently found among prisoners with a history of TBI. Two papers established the validity of the use of questionnaires to screen for a history of TBI.

Conclusion

These results confirmed the high prevalence of a history of TBI in prison populations. However, they do not allow conclusions to be drawn about a possible link between criminality and TBI. Specific surveys need to be performed to study this issue. The authors suggest ways of improving the screening and healthcare made available to these patients.

Key words: traumatic brain injury, epilepsy, prison, prisoner, neuropsychology

Introduction

According to the World Health Organization, traumatic brain injuries (TBIs) will become the main cause of death and handicap in the world by the year 2020 [1]. They lead to greater levels of deficiency, longer hospitalizations and higher hospitalization costs than any other injuries [2]. In France the incidence of TBI, irrespective of seriousness, has been estimated at 150,000 a year [2]. The usual breakdown of all recorded TBIs shows about 80% for mild TBI, 10% for moderate and 10% for severe TBI, with a probable under-representation of mild TBI subjects, who are rarely hospitalized [3]. They typically concern young males. The first two causes of TBIs are road traffic accidents and falls [4].

The prevalence of sequellae and the lifetime prevalence of TBI are not well known. In the United States, the global prevalence of people living with significant TBI sequellae is thought to be 3.2 million, i.e. 1.1% of the population [5]. In Europe, a Danish study estimated the proportion of people in the general population with TBI sequellae preventing all professional activities to be 0.32 % [6]. There are no figures on reported history of TBIs in the general population in France.

Long-term TBI sequellae, especially cognitive and behavioural, are not well known and often underestimated so that a term often used is that of an *invisible handicap*. The disorders observed can lead to slowness in information processing, attention disorders, memory and executive impairments [7]. Anxious-depressive disorders are also frequently reported, as well as social cognition disorders, such as lack of emotional perception, or a lack of social tact or empathy [8, 9, 10]. These are thought to be occur alongside behavioural disorders, such as aggressiveness, loss of inhibition, intolerance towards frustration, and sometimes violent acts that can be limiting for social integration [8, 9, 10]. Good practice guidelines for the treatment of these disorders have been published by the French national health authority (Haute Autorité de la Santé, HAS) and have been the subject of several articles published in the Annals of Physical and Rehabilitation Medicine [11, 13]. In addition, a study carried out in Finland on a controlled cohort evidenced that a history of TBI during childhood or adolescence increased the risk of psychiatric disorder in adulthood, and that among men, a history of TBI was significantly linked to criminality [14].

In 2010, in order to counter this *invisible pandemic*, a French inter-ministerial mission for the development of an action plan to help TBI and spinal cord injury patients submitted a report to the health authorities. One of the consequences of this report was the drawing up of an action plan. Recommendation N°10 advocated a specific follow-up for the most vulnerable populations, prison populations in particular. In the present article, the term *prisoner* can refer to three situations: prisoners having received a custodial sentence, incarcerated following a legal decision (whatever the sentencing authority), individuals having received a conditional sentence, incarcerated, but with some freedom of movement (curfew system, electronic monitoring for example), and prisoners who are remanded pending trial.

There are in France 191 prisons. On January 1st 2016, according to the French prison administration, 76,601 people were incarcerated (custodial sentence: 66,678 and conditional sentence: 9,923). Out of the 66,678 incarcerated individuals, 18,158 were awaiting judgment (remanded) and 46,602 were unconditionally sentenced. Women numbered 2,650 (3.9%), and 715 individuals were under 18 (1% of the prison population). Since legislation dated January 18th 1994, responsibility for prisoners' health follow-up has been entrusted to the French Ministry of health and all prisons now have healthcare units (known previously as Consultation and ambulatory care units), and these hospital units are directly linked to a healthcare facility. There are also in France 52 follow-up care and rehabilitation beds shared between Marseille and Fresnes. These needs have been objectified on the one hand by the high prevalence of a number of infectious pathologies (human immunodeficiency virus, hepatitis C and tuberculosis), and on the other hand, by the high frequency of disabilities, 3 times higher than in the general population. Indeed, 10% of prisoners require assistance because of a health problem, and around 200 have a physical disability. In France, since the 1994 reform, two questionnaire surveys assessing prisoners' health before their arrival in prison, have been implemented [15, 16]. There are no questions specifically concerning the existence of a history of TBI. However, the reported prevalence of epilepsy was 2% in 2003 (1.5% in 1997). It was therefore, at the time of that survey, about 4 times higher than the prevalence found in the general population. In 2013, a survey carried out in French prisons evidenced a prevalence of 30.6% for the existence of a history of TBI for a population of 1148 new arrivals in prison. The prevalence of epilepsy was 6% for the whole prisoner population under study, i.e. 12 times higher than in the general population [17].

The objective of this literature review was to focus on the prevalence of a history of TBI in prison setting. The search methodology and article analyses were developed following the PRISMA criteria. The results of this review are presented and discussed. A certain number of suggestions concerning organization and care are detailed at the end of this article.

Methods

Electronic sources used and search strategies (Figure 1)

The methodology consisted in a search on PubMed and PsycINFO databases carried out by three of the co-authors (ED, AR and MC). This search was carried out in two stages, with a first selection of articles in 2013 and an update on this search on 02/08/2016. Any articles relating to the subject under study and published up to this date could be retained, whether published in English or in French. The keywords used, taken from the MesH, were the following: *prisoner, prison, traumatic brain injury, head injuries*. All the articles collected from the two databases were compared and duplicates were eliminated. Titles and abstracts of 118 selected articles were then scrutinized to check their relevance to the subject. The selected articles were read in full by each of the three authors independently in order to retain only those that met the inclusion and exclusion criteria of this review. A list of the articles selected by the three authors was then discussed and agreement was reached on which should be retained. The reference lists of the included articles were also examined so as to identify further possible articles. The articles retained concerned adults of both sexes and under 18-year-olds.

Exclusion and inclusion criteria

The exclusion criteria were: publication in a language other than in French or English, articles that focused on the association between criminality and TBI, but related for instance to TBI follow-up cohorts (e.g. Elbogen 2014 [18]), studies focusing on particular types of prisoners (political prisoners that were victims of torture in Vietnam, Mollica, 2014 [19]), or studies with a more sociological than medical stance (Brewer Smyth 2016 [20]). Initially, for the qualitative analysis of this review, we chose to retain published meta-analyses and literature reviews that could be of some relevance to the study, but they were not taken into account in mean prevalence calculations (Hughes 2015, for instance [21]). Two articles were also excluded for this mean prevalence calculation because they were secondary analyses on a population that had already been studied (Scholfield 2011 [22] and Durand 2016b [23]).

The inclusion criteria were the following: the articles were to give a clear definition of the term *traumatic brain injury* and the term *prevalence*. Perusal of the articles aimed to provide a clear picture of the type of population under study: ordinary prisoners, prisoners in psychiatric units, percentage of men and women, and under 18-year olds as applicable. We did not use inclusion and exclusion criteria concerning the year of publication or the size of the sample (in particular, we did not exclude small-sized samples (< 20)).

Selection and article assessment criteria

The main objective of this literature analysis was to calculate mean prevalence across the articles selected, taking into account population characteristics (age, sex), the trauma (age of occurrence, cause, initial severity) whenever possible, comorbidities (epilepsy, psychiatric disorders, psycho-active drugs use), and the methodology used.

Each article was analysed according to the following criteria (table 1): name of main author and year of publication, country where the study took place, total number in the study sample, mean age of the population, percentage of male prisoners in the sample, type of methodology used, comorbidities, particularly epilepsy.

Each study was assessed according to the French national health authority criteria (HAS), with reference to its epidemiological study classification (table 2) [24]. A mean prevalence for a history of TBI was calculated from the studies considered relevant, without taking meta-analyses or the two literature reviews already published into account.

Results

In all and taking into account all duplicates, 118 articles were retained, 81 were excluded and finally, 37 articles met the criteria of this research (figure 1). Thirty-three articles concerned the prevalence of a history of TBI in prison populations (Table 1 [17, 25 to 56]). Two articles were meta-analyses on the prevalence of a history of TBI among prisoners [57, 58], and two articles were reviews of the literature [20, 58]. Finally, two articles the subject of which was the prevalence of a history of TBI in prison populations concerned the validity of the questionnaires used and the degree of confidence in the prisoners' responses [22, 46].

Out of the 33 articles relating to the prevalence of history of TBI, 17 concerned exclusively male adults, four concerned under 18-year-olds exclusively, and 12 concerned male and female adults. Only one study was exclusively on female adults [43]. Finally, one study focused on adults and under 18-years-olds of both genders [17]. For 2 articles, the description

did not mention the gender of the subjects of the study. The mean age of participants ranged from 15.5 years (studies on under 18-year-olds) to 37.5 years for studies on adults. The populations were composed of subjects who were either remanded or convicted, or both. The types of facilities in which these studies took place were prisons of various security levels or closed psychiatry units for patients under legal commitment. Two articles reported study results on death-row prisoners. The number of subjects under study ranged from 14 [26] to 1148 [17], with an average of 290 prisoners included. Seven studies included more than 500 prisoners [17, 30, 37, 41, 47, 52, 54].

Two thirds of the studies (22/33) were carried out in the Unites States. The others were carried out in Australia, Canada, New Zealand, Spain and the United Kingdom. A study has recently been performed in France. In 25 studies out of 33, the methodology used was a self- or hetero-administered questionnaire. In 3 cases, the studies were retrospective on the basis of case files. In 9 studies, questionnaires were backed up with an interview. In one case, the methodology consisted in an ecological analysis, taking into account the prisoners' family history (physical violence, sexual abuse during childhood), medical history, psychiatric history (TBI in particular), difficulties in community integration and failure of care provided in various institutions (schools, psychiatry units…).

The prevalence of reported history of TBI varied according to the studies from 9.7% [29] to 100% [25]. The study finding a prevalence of 100% concerned a small sample of 15 prisoners on death row. The mean prevalence calculated from the 33 selected studies for this review was 46% (total number of subjects taken into account: 9342 prisoners). In most studies, there were no control groups (subjects having suffered from TBI but with no prison history). The two meta-analyses found a mean prevalence of a history of TBI among prisoners of 60.25% and 41.2% respectively [57, 58]. A significant difference was also evidenced between the estimated prevalence of TBIs in the general population and that in prison populations [58]. The authors of the two literature reviews made the decision not to calculate the mean prevalence but to present the studies they had selected [21, 59].

Three studies mentioned the age of TBI occurrence [17, 25, 53]. In five studies, information was provided on the aetiology of the TBI [17, 25, 50, 54, 56]. It was found to be similar to the general population but with different proportions. Thus, in Lewis' study on 15 prisoners on death row, they had all had two or more TBIs that had occurred during their childhood: their

trauma was connected to violence in 6 cases, to road traffic injuries (3 cases), falls (3 cases), traumatic birth delivery or a perinatal problem (2 cases), or other cause (1 case) [25]. In Perkes' study, 45% of the TBIs were due to an assault, 26% to a fall, 16% to a sports injury, and 10% to a road traffic accident [17]. In Ray's study, the identified causes were sports injuries (20.9%), road traffic injuries (17.7%), interpersonal violence (14.2%), and being victim of an explosion (4.7%) [54]. In Moore's study, interpersonal violence was the cause of the TBI in 37.6% of cases (road traffic injuries16.8%, sports injuries 30.7%, and falls 12.9%) [56].

In terms of initial TBI severity, no analysis was possible due to the fact that the definitions used were not consistent across studies. In most studies, access to the initial Glasgow score was impossible because the methodology used was based on self-report.

Only a few studies focused on female prisoners, probably because of the low percentage of women in prisons. In Shiroma's meta-analysis [57], the authors examined articles that referred to female populations (4 studies) and found a higher prevalence of history of TBI than in male populations (69.9% versus 64.4%).

The analysis of the studies included in this review evidenced that several comorbidities occurred more frequently among prisoners with a history of TBI than among those without: psychiatric disorders, anxious-depressive disorders in particular [40, 41, 44, 48, 54, 56], a larger percentage of alcohol and marijuana users [33, 42, 45, 49, 56], and a greater use of hospital care facilities [37]. Furthermore, in a study gathering 118 prisoners, all the subjects with a history of TBI (86.4%) reported memory impairments and socializing difficulties. No correlation was found between daily life problems and the seriousness of the TBI. Substance use on the other hand was linked to more problems in relationships with others or with the family, and to financial difficulties [32].

The search for a history of epilepsy was carried out in 10 out the 33 studies (Table 3). The prevalence varied from 3.7% [50] to 71% [26]. In 3 studies [26, 29, 33], electro-encephalograms were carried out, evidencing higher prevalences (71%, 40% and 15% respectively) than in the other studies based on an epilepsy diagnosis. Finally, only one study compared the prevalence of epilepsy among prisoners with and without a history of TBI,

evidencing a significantly higher prevalence among prisoners with a history of TBI (11.8% versus 3.4%; $p < 0.0001$) [17].

Because the reliability of the prisoners' responses was often questioned, some authors compared data from prisoners' statements to data from their hospital files. Schofield et al. thus demonstrated in a questionnaire-based study on 200 prisoners that 84% of the responses obtained held true after checking the prisoners' medical files [22]. Furthermore, the validity and reproducibility of the questionnaire results on the existence of a history of TBI were also demonstrated [46].

Discussion

The objectives of this literature review were to make an assessment of the prevalence of a history of TBI in prison setting and to discuss the validity of the surveys carried out in prisons on the subject.

We calculated a mean prevalence for the existence of a history of TBI of 46% across all the studies retained for this review, which concurs with the two published meta-analyses which concluded to a mean prevalence of history of TBI of 41% and 60% respectively. The results of these two meta-analyses differ on account of the numbers of articles analysed (24 versus 20). These figures are much higher than the reported prevalence in the general population, even though precise data on prevalence are lacking in Europe. These results were obtained using different methodologies. According to the French national health authority criteria, most studies were level 4 descriptive cross-sectional surveys, i.e. with a low level of scientific proof. Only 4 studies could be classified as level 3 since they included control subjects [17, 42, 50, 53]. Despite their limitations, the results of these studies overall concur and reach the same conclusion, that a history of TBI is frequent among prisoners. In the two recent literature reviews, the authors decided that it was not possible to calculate a mean prevalence because of the heterogeneity of the data and the populations under study [21, 59]. The variability of the prevalence (from 9 to 88%), if Lewis' studies are not considered [25, 26], could be explained by the fact that the prison populations are not homogenous. They variously comprise both remanded and sentenced subjects, or exclusively sentenced subjects, or again psychiatric patients accommodated in closed units. The same goes for the 2 meta-analyses which gathered studies concerning different types of prisoners (sentenced to death,

high security, low security, sentenced, remanded, etc.). They did not use a validated quality assessment for studies on prevalence, such as the Newcastle Ottawa Scale, which is used to assess the quality of non-randomized studies included in meta-analyses. Finally, international data are not directly transferable to France because of the differences in the penal system (with regard to under 18-year-olds in the United-States or in the United-Kingdom, for instance…) and in behavioural patterns…

Few studies differentiated TBIs according to their severity. This could be explained by the fact that access to the Glasgow score at the time of the TBI is often impossible in this sort of survey. The most important aspect of Shiroma's meta-analysis [57] was that it analysed the severity of TBIs and took loss of consciousness into account to assess differences in prevalence. The mean prevalence is lower (50.1% versus 60.25%) when loss of consciousness, whatever its duration, is taken into account. The date of occurrence of the TBI and its chronology in relation to first incarceration are often not known. In a study carried out in Fleury-Mérogis, 86% of prisoners who reported a TBI said they had sustained it before their first incarceration [17]. These observations once again confirm that the populations under study cannot be considered as homogenous. Indeed, cognitive and behavioural consequences are not the same, depending on the seriousness of the TBI and the age of occurrence, while information on these aspects is given in only a small number of studies.

TBI aetiology was rarely explored in the studies selected. To our knowledge, only five studies have addressed the question [17, 25, 50, 54, 56]. The first two causes of TBIs among prisoners are road traffic accidents and interpersonal violence. Interpersonal violence could concern up to 37% of reported TBIs [56], which is higher than in the general population. In the United States in the general population, 10% of TBIs result from an assault. However, it was reported that, among female prisoners, the prevalence of a history of TBI was higher than among male prisoners [57], whereas the opposite is true in the general population, which could suggest a stronger link among women between TBI occurrence and incarceration than among men. Another factor worth noting in this respect is women's potentially greater exposure to domestic violence, even if no studies have confirmed this point.

A comparison between data collected from prisons and data from the general population requires caution on account of a lack of precise information on prevalence in France or in Europe. According to Taglafferi [3], the prevalence of a history of TBI having required

hospitalisation in European countries is around 0.2 to 0.3% in the general population. This information on the general population is not available in the articles analysed in this review. However, in the survey carried out in Fleury-Mérogis, 12% of male prisoners who took part in the study had been hospitalized following a TBI (60 times more than in the general population if this figure is compared to that reported by Taglafferi et al. [3]). In the English-speaking countries where the studies that served as basis for the two meta-analyses of this review were conducted, we can hypothesize that the prevalence of TBIs in the general population is unlikely to reach the levels found in prisons (between 40 and 60%). In addition, Farrer et al. in their meta-analysis were the first to evidence that the mean prevalence of TBIs among new arrivals in prison was significantly higher than the estimated prevalence in the general population, basing their results on the lowest and the highest estimations (in the general population and in prisons) [58]. In closed psychiatric units, the prevalence of a history of TBI was estimated at 22%, which is lower than that reported in the literature on prison arrivals [28, 57, 58].

The literature data overall evidences a strong association between TBIs and delinquency. Nevertheless, no causal link has yet been demonstrated. Therefore conclusions from this study should be drawn with extreme caution. Indeed, this link could simply be related to a social risk linked to factors usually associated with delinquency and risks and consequences of TBIs: psychoactive substance use, need for psychiatric follow-up, alcohol and related falls, psychotropic drug use and falls, illegal substance use and violence etc.). There is also more frequent risk-related behaviour in this population compared to the general population. This being said, the question of screening and care needs to be addressed, and justifies specific care in prisons provided in the same way as in a free environment.

The prevalence of epilepsy in the studies that focused on the subject was much higher than that found in the general population, whether in France or in other countries in the world. The differences found in prevalence could be explained by differences in assessment methodologies (Table 1). In France, it has been observed that this prevalence is on the increase, from 1.5% in the first study in 1999 to 6% in the most recent study in 2013 [15 to 17]. Some authors have suggested that these figure are attributable to false report, the aim of which was to obtain secondary advantages (for instance benzodiazepine prescriptions…). The prevalence figures could also be explained by post-traumatic epilepsy, even though this

mostly affects severe TBIs. A high prevalence of alcohol and benzodiazepine use could also be a cause, with the occurrence of seizures particularly during withdrawal.

Conclusions and suggestions

This literature review confirms the strong prevalence of a history of TBI in prison settings. It also calls attention to the validity of the declarative survey results on health questions addressed to prisoners on their arrival in prison. Its methodological limitations are mainly the difficulty in making comparisons with the general population, and the lack of control groups in the studies. Indeed, this review does not allow a conclusion to be drawn on the potential link between delinquency and TBIs, as a result of a multitude of confounding co-factors. In addition, it is important to remain cautious when presenting results, so as to avoid any stigmatization of people with traumatic brain injuries.

It would therefore be appropriate for public health professionals to address the question so as to go further into the causes of the link between TBIs and criminality. Control group studies or cohort studies are required to examine this link. A clinical study could be carried out to compare prison populations with and without a history of TBIs in terms of associated factors or cognitive functions. Finally, because the attempt to make comparisons with the general population failed for lack of data, the need for a study on the prevalence of TBI in the general population is required, by analysing for instance the INSEE surveys (National institute of statistics and economic studies) on disability as has been done for the sequellae of TBI.

The results from this review therefore lead the authors to make a certain number of suggestions:

- Improving screening (as recommended by the French national health authority (HAS) and the French Society for physical and rehabilitation medicine (SOFMER) concerning management of behavioural disorders among TBI patients in 2013). The questions used in the Fleury-Mérogis survey could be integrated into the questionnaire routinely used on arrival in prison.
- Implementing training courses on TBI and its consequences for prison staff. Indeed, the cognitive and behavioural sequellae are likely to have repercussions on life in

prison, and they can be difficult to identify if the staff are not trained and find it difficult to adapt. In addition, the 2013 HAS/SOFMER report stresses the risk of an aggravation of behavioural disorders if the environment does not take this problem into account.

- Developing healthcare solutions and/or specific social and medical-social follow-up during the incarceration period in order to participate in the development of a life plan taking into account the sequellae of TBIs (initiatives with the French departmental centres for the disabled (MDPH), advice on professional orientation, etc.). When a prisoner is released, a link could be established between rehabilitation and probation services and TBI follow-up and rehabilitation services, particularly with community re-entry centres. These patients could benefit from the creation of medical-social facilities specialised in the care of TBI patients with behavioural disorders and prisoners at the time of their prison release.
- Implementing training courses for professional teams in physical and rehabilitation medicine and psychiatry units on the specificities of vulnerable and socially excluded populations. These teams could thus be encouraged to think about the best-suited measures to prevent delinquent acting-out. Caution is needed, as it this does not just involve a definition of risk-related profiles on the sole basis of assessment tools, it also means taking into account clinical, environmental and personal factors as a whole.

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Figure 1 : Search strategy flow diagram

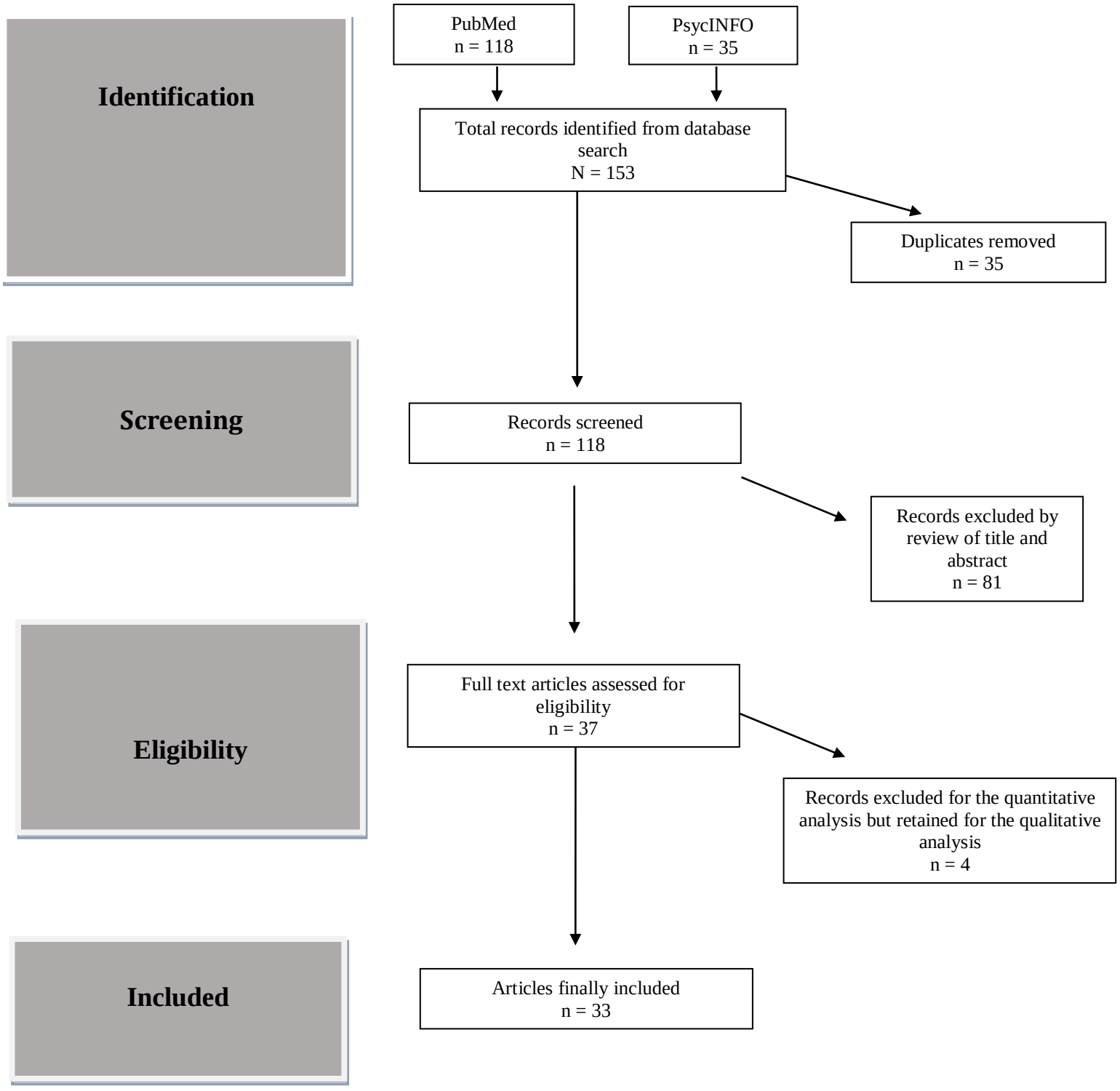

Table 1: Prevalence of traumatic brain injury in prison populations [17, 25-56]

First Author (year)	Country	Number of prisoners	Age mean	Sex (% males)	Methods	% TBI	History of epilepsy	HAS scale
Lewis (1986)	USA	15	NR	86	Interview and medical examination	**100**	yes	4
Lewis (1988)	USA	14	NR	100	Interview and medical examination	**100**	yes	4
Templer (1992)	USA	322	33,6	100	Questionnaire	**35.7**	no	4
Martell (1992)	USA	50	33,3	100	Chart review	**22**	yes	4
Blake (1995)	USA	31	32,7	100	Clinical examination	**9.7**	yes	4
Morrel (1998)	USA	1000	29,7	NR	Questionnaire	**24.9**	yes	4

Sarapata (1998)	USA	61	28,3	89	Questionnaire	**50**	no	4
Barnfield (1998)	New Zealand	118	31	NR	Questionnaire	**86.4**	no	4
Frierson (1998)	USA	54	30,4	100	Chart review	**24.1**	yes	4
Hux (1998)	USA	316	15,4	67	Questionnaire and interview	**49.7**	no	4
Delbello (1999)	USA	25	34,3	100	Questionnaire and interview	**36**	no	4
Freedman (2000)	USA	16	NR	100	Qualitative assessment	**75**	no	4
Walker (2001)	USA	591	31,7	100	Questionnaire	**68**	no	4
Hawley (2003)	UK	113	35,6	82	Chart review	**41.6**	no	4

Leon-Carrios (2003)	Spain	49	37,5	100	Questionnaire	**59.2**	no	4
Slaughter (2003)	USA	69	NR	78	Questionnaire/ neuropsychological assessment	**87**	no	4
Walker (2003)	USA	661	NR	100	Questionnaire	**69**	no	4
Turkstra (2003)	USA	40	34,9	100	Questionnaire	**67**	no	3
Brewer-Smith (2004)	USA	113	33,4	0	Questionnaire/biological investigation	**42.5**	yes	4
Schoffield (2006)	Australia	200	30,6	100	Questionnaire	**82**	no	4
Colantonio (2007)	Canada	394	35,4	92	Chart review	**92**	no	4

Diamond (2007)	USA	225	35	48	Questionnaire	**88**	no	4
Perron (2008)	USA	723	15,5	87	Questionnaire	**18.3**	no	4
Gunter (2009)	USA	330	33,9	65	Questionnaire	**21.5**	yes	4
Williams (2010)	UK	196	NR	100	Questionnaire	**60.7**	no	4
Perkes (2011)	Australia	200	NR	100	Questionnaire	**82**	yes	3
Davies (2012)	UK	66	16,8	100	Questionnaire	**70**	no	4
Ferguson (2012)	USA	636	NR	50	Questionnaire	**68**	no	4
Moore (2014)	Australia	361	NR	87	Questionnaire and medical examination	**32.3** (Calculated on 316/361)	no	4

Colantonio (2014)	Canada	235	NR	56	Interview and questionnaire	**43.4**	no	3
Ray (2014)	USA	831	32,9	100	Interview and questionnaire	**35.7**	no	4
Kaba (2014)	USA	384	17,1	78	Questionnaire	**49.7**	no	4
Durand (2016)	France	1148	28,6	91	Questionnaire	**30.6**	yes	3

Table 2 Grading the guidelines [24]

Recommendation grades	Level of evidence provided by the literature
A **Established scientific evidence**	**Level 1** - Powerful randomised comparative trials - Metaanalysis of randomized comparative trials - Decision analyis based on well-conducted studies
B **Scientific presumption**	**Level 2** - Less powerful randomised comparative trials - Well-conducted non-randomised comparative studies - Cohort studies
C	**Level 3** - Case-control studies
Low level of evidence	**Level 4** - Comparative studies with considerable bias - Retrospective studies - Case series

Table 3: Prevalence of history of epilepsy [17, 25, 26, 28, 29, 30, 33, 43, 48, 50]

1st Author (year)	Prevalence*	Prevalence among TBI +	Prevalence among TBI -
Lewis (1986)	20%	20 %	No TBI -
Lewis (1988)**	71%**	71 %	No TBI -
Martell (1992)	8%	NA	NA
Blake (1995)	40%***	NA	NA
Morrel (1998)	NA	10 %	NA
Frierson (1998)	15%***	NA	NA
Brewer-Smith (2004)	11%	NA	NA
Gunter (2009)	6%	NA	NA
Perkes (2011)	3.7%	NA	NA
Durand (2016)	6%	11.8%	3.4%

*in the population as a whole **EEG abnormalities in 10 cases out of 14. ***EEG abnormalities