Prevalence of Driving and Traffic Accidents among People with Seizures: A Systematic Review

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Keywords

Epilepsy · Seizure · Driving · Public health · Epidemiology

Abstract

Background and Objectives: Epilepsy influences the ability to drive. We undertook a systematic review to determine the prevalence of driving or holding a driver's license among people with seizures, the prevalence of traffic accidents among those who drive, and factors that may explain heterogeneity in these point estimates. **Method:** We followed MOOSE and PRISMA guidelines in searching 8 databases from inception to June 27, 2018. All published observational studies were included, with the exception of case-control studies where prevalence could not be determined, case reports, and studies with fewer than 50 participants. We assessed external and internal validity and quality of studies, produced forest plots, and conducted meta-regression in "Stata 13." **Results:** Data were available from 67 studies published between 1967 and 2018. Across the studies there was a wide range in the prevalence of driving (3–90%) and holding a driver's license (8–98%). Up to 39% of people with epi-

lepsy drove in violation of restrictions. Prevalence of traffic accidents ranged from 0 to 61% following seizure onset, or in the past 1–5 years. The percentage of people with seizures who drove decreased as time since diagnosis increased ($p = 0.01$, adjusted $R^2 = 31\%$). The number of people with seizures who drove or held a driver's license appears to have increased over time ($p = 0.02$, adjusted $R^2 = 7\%$) but without a corresponding increase in the number of traffic accidents. There was considerable heterogeneity between studies related to definitions, design, and population differences. **Conclusions:** There is considerable variation in the prevalence of driving after a diagnosis of epilepsy and in reported motor vehicle accidents. Further efforts are required to better understand the impact of epilepsy, and epilepsy surgery, on driving and road safety, especially where driving continues in violation of restrictions. Policy changes are needed to encourage the introduction of available and affordable alternatives for driving, for example, developing public transport networks, and promoting subsidy schemes to encourage use of public transport, taxis, Uber, and Lyft, among people experiencing seizures.

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Introduction

Epilepsy restricts many aspects of life. One such area is the loss of a driver's license that can have a major adverse impact of activities and self-esteem [1]. Experiencing seizures while driving can threaten the safety of drivers, other road users, and pedestrians [2]. Various regulations are imposed around the world, as summarized by a joint commission of the International Bureau for Epilepsy and International League Against Epilepsy [3, 4]. However, there have only been 2 systematic reviews on driving or traffic accidents among people with epilepsy. One review indicated that employment and epilepsy surgery were predictive of driving, with protective factors against vehicle crashes being epilepsy surgery, seizure-free interval of at least several months, few prior nonseizure-related crashes, and regular antiepileptic drug adjustments [5]. The other emphasized inconsistency in level of risk of traffic accidents in people with epilepsy compared to the general population, ranging from no difference to a 7 times increase [6]. We undertook a systematic review with the aim of determining contemporary rates of (i) driving or holding a driver's license in people with seizures of any type and etiology, (ii) traffic accidents among those who drive, and (iii) to investigate factors (i.e., World Bank defined country income level, duration of epilepsy disease, number of years after epilepsy-related surgery, year of publication, and response rate) that may explain heterogeneity in these point estimates. Examination of these factors is exploratory given contradictory evidence on how each factor is related to the prevalence of driving and holding a driver's license. Such a review is needed to inform and guide intervention and policies focused on driving among people with seizures.

Methods

The protocol of this review was registered in Prospero (CRD42017075358) and MOOSE [7] and PRISMA guidelines were followed [8]. We restricted the review to published observational studies that reported either: (i) the prevalence of driving or holding a driver's license among people with seizures who reached the legal age to drive and (ii) the prevalence of traffic accidents among people with seizures who drive (regardless of their legal driving status). All observational study designs were accepted except for case-control studies where the prevalence of driving, holding a driver's license, or accidents could not be determined. We excluded case reports and studies with fewer than 50 participants due to potential sampling error; a sample of fewer than 50 persons can have a margin of error of up to 14% in prevalence estimation [9]. All journal articles were considered without language limitations; articles in languages other than English were translated. Published conference abstracts were excluded unless we could

identify the corresponding published journal article through database searching or by contacting authors. Studies were excluded if they limited participants to 1 sex or with a disability, to be generalizable. We judged articles to be from the same or overlapping cohorts if there was evidence of overlapping recruitment sites, study dates, authorship, and similar participant characteristics.

Search Strategy and Screening

Eight databases (from inception to June 27, 2018) were searched: MEDLINE, EMBASE, PsycINFO and COCHRANE CENTRAL via OvidSP, CINAHL via Ebsco, and TRID, PEDro and C2-SPECTR via websites (<https://trid.trb.org/>; <https://www.pedro.org.au/> and <http://www.worldcat.org/>), with assistance of librarian from the University of Sydney. The following search terms were used as free text or controlled vocabulary as appropriate for the corresponding database: epilepsy, seizures, convulsions AND automobile driving, car driving, car, motor vehicle, automobiles, motorcycles, traffic accidents, transportation accidents, driving license, driving ability (online suppl. Table 1; for all online suppl. material, see www.karger.com/doi/10.1159/000500599). Two authors (Y.X., J.S.) independently screened titles and abstracts of all references and examined full text articles to determine whether they met the inclusion criteria. Further literature was identified by examining the reference lists of included studies.

Data extraction and Quality Assessment

Data extraction was conducted independently by 2 authors (Y.X., Z.Z.), checked by a third author (J.S.), and included the author, year of publication, country, study denominator (e.g., population-based, single center hospital-based, multicenter hospital-based), study design (e.g., case-control, cross-sectional, prospective or retrospective cohort with consecutive, convenience, or random recruitment), inclusion criteria restrictions (e.g., minimum duration since the diagnosis of epilepsy, minimum frequency of seizures per month, failure of a minimum/maximum number of first-line drugs, surgical treatment), sample size, minimum age of the participants, data collection method (e.g., interview, mailed/ emailed/online survey), and the prevalence of driving, holding a driver's license, driving in violation of restrictions, and traffic accidents. For the prevalence of traffic accidents, we used a person with epilepsy rather than a crash, as the unit of measure. For cohorts reported in >1 paper, we extracted the prevalence and other data from the most recent publication. We contacted study authors for additional data, if the study was published on or after 2001. Additional data were included if received before January 3, 2019.

We assessed the external validity (generalizability of the prevalence, i.e., whether studies applied any exclusion criteria, description of the age and sex of the study population, whether recruitment was prospective or retrospective with consecutive, convenience, or random sampling) and internal validity (response rates, were the assessments consistent within each study, i.e., structured or semi-structured versus unstructured questionnaire used). We judged studies with prospective and consecutive recruitment to be of good quality, and studies with retrospective, or nonconsecutive sampling, or when either is unclear, to be of poor quality.

Statistical Analysis

Prevalence of driving, holding a driver's license, and traffic accidents in studies were listed in forest plots using Stata 13. Subgroup analysis was conducted based on time since the occurrence

Fig. 1. Flow diagram for systematic review.

of a first seizure or the diagnosis of epilepsy and before and after epilepsy surgery. For studies not involving epilepsy surgery, subgroup analyses were also performed, based on whether the study was conducted in a high versus upper and lower middle income country. Sensitivity analyses were undertaken by removing studies of poor quality. Statistical heterogeneity and consistency were assessed using the standard Q statistic, with $p < 0.05$ and I^2 . We conducted meta-regression to investigate the association between prevalence and continuous covariates (i.e., duration of the disease, years after the surgery, years of publication, and response rates). Publication bias and small-study effects were assessed by inspecting funnel plots and conducting Egger's test.

Results

The search results and selection process are summarized in a PRISMA flowchart (Fig. 1). A total of 3,371 references were identified, of which 142 full text articles were retrieved to assess for inclusion/exclusion, and a total of 67 studies (reported in 71 publications) conducted between 1967 and 2018 were considered eligible for inclusion. There were 37 studies reporting prevalence of driv-

ing or holding a driver's license, 3 reporting prevalence of traffic accidents and 27 reporting both. We will present study and participant characteristics, followed by the prevalence of driving or holding a driver's license, and then prevalence of traffic accidents. Finally, we present results from the meta-regression analyses of association between prevalence and continuous covariates, funnel plots, and results from Egger's tests to examine potential bias based on study sample sizes and prevalence estimates.

Study and Participants Characteristics

Fifty-nine studies were conducted in high-income countries and published between 1967 and 2018: 16 (18 publications) in the United States of America (USA) [10–27]; 9 (10 publications) in Japan [28–37]; 7 in United Kingdom (UK) [38–44]; 4 in France [45–48]; 3 in each of Australia [49–51] Canada [52–54], and Italy [55–57]; 2 in each of Germany [58, 59] and Sweden [60, 61]; 1 in 7 countries in Europe [62]; and one in each of New Zealand [63], Slovenia [64], Denmark [65], Hungary [66], Finland

[67], Slovakia [68], Korea [69], Ireland [1], and Greece [70] (online suppl. Table 2). One study (2 publications) was conducted in an upper middle income country, Croatia [71, 72]. Seven studies in lower middle-income countries were published between 1998 and 2017 in Sri Lanka [73], Brazil [74–76], Bulgaria [77], China [78], and Thailand [79]. Many studies were prone to selection bias because no more than half of invited people with seizures responded to the survey [18, 19, 50] or agreed to participate in the study [20].

Thirty-eight studies (39 publications) did not have any major exclusion criteria (online suppl. Fig. 1) [10, 11, 13, 14, 18, 19, 21, 22, 24–30, 33, 34, 37–39, 41–45, 47–51, 55, 56, 61, 63, 64, 66–68, 73]. Patients with concomitant paroxysmal nonepileptic events [35, 57, 75], with simple or complex partial seizures in the last 4 h or generalized tonic-clonic seizures in the last 24 h [77], or with febrile seizures [36] were excluded from 5 studies. Fifteen studies (18 publications) excluded people with a comorbid condition other than epilepsy that could potentially interfere with driving or whose ability to accurately answer questions was impaired (e.g., mental impairment or intellectual disability, or inability to read or communicate at a pre-specified level) [15, 16, 20, 23, 31, 32, 52, 53, 59, 60, 69–72, 74–77]. Some studies excluded those with psychiatric disorders (4 studies [52, 53, 76, 79]), other neurologic disorders (e.g., multiple sclerosis, dementia, cerebral palsy, polyneuritis and radiculitis, 6 studies [20, 52, 59, 65, 76, 77]), or other physical illness (e.g., cerebrovascular disease, diabetes mellitus, “senility,” and alcoholism, 11 studies [31, 32, 52, 53, 65, 69, 72, 74, 77–79]).

Prevalence of Driving or Holding a Driver’s License

Participants were classified as those whose duration or average duration of the disease was reported (Fig. 2 and online suppl. Fig. 2), those who underwent epilepsy surgery (Fig. 3), and those whose history of surgery and duration of the disease were unknown (Fig. 4 and online suppl. Fig. 3). Studies not involving epilepsy surgery were also categorized into those conducted in high versus upper and lower-middle-income countries (online suppl. Fig. 4, 5). We did not pool the prevalence because there was significant heterogeneity between studies within each subgroup (all $p < 0.005$ and all $I^2 > 85\%$).

Duration Since a First Seizure or the Diagnosis of Epilepsy

Prevalence of driving was 76% [51] or 90% [20] at the time of diagnosis, 51% [20] or 64% [51] within the first 2 years of illness (i.e., from the first seizure or the diagno-

sis of epilepsy), and ranged from 3 [77] to 78% [34] beyond 10 years (Fig. 2 and online suppl. Fig. 2). Prevalence of holding a driver’s license was 86% [43] at the time of diagnosis and ranged from 25 [33] to 98% [60] beyond 10 years of illness. Studies were conducted in countries with different economic conditions and published between 1984 [52] and 2018 [51]. The severity and comorbidity of epilepsy varied. Three studies reported on the percentage (22 [69], 0 [67] and 22% [41]) of participants who drove [69] or held a driver’s license [41, 67, 69] in violation of restrictions.

Before and after Epilepsy Surgery

Before surgery, participants had epilepsy that was drug-resistant [13, 15–17, 23, 25, 48, 54, 59], complex partial [13], temporal lobe [15–17, 23] (associated with hippocampal sclerosis) [48], or extra temporal lobe [59]. Before the surgery, prevalence of driving or holding a driver’s license ranged from 13 [15, 16, 23] to 41% [12]. After an average of 4 [13], 10 [12], 11 [25], 12 [61], and 17 [15, 16, 23] years after the surgery, prevalence of driving or holding a driver’s license, ranged from 51 [25] to 79% [13] (Fig. 3a). For studies where the prior-surgery prevalence was not reported, after an average of 6 [76], 7 [48, 54, 59], 10 [42], 15 [37] years, or a maximum of 13 years [17] post-surgery, percentages of participants who drove or hold a driver’s license ranged from 22 [42] to 68% [24] (Fig. 3b).

Only 2 studies (4 publications, from Fig. 3a) reporting the prevalence of driving [13, 15, 16, 23] and one reporting the prevalence of holding a driver’s license [61] before and after surgery are of good quality. For studies where the prior-surgery prevalence were not reported (Fig. 3b), only one of each study reporting the prevalence of driving [24] and holding a driver’s license [48] are of good quality. Sensitivity analyses were not conducted because of the small number of studies.

History of Epilepsy Surgery and Duration of the Illness Were Unknown

Prevalence of driving ranged from 16 [39] to 83% [29, 30], and prevalence of holding a driver’s license ranged from 8 [36] to 87% [35] (Fig. 4 and online suppl. Fig. 3). Five studies reported prevalence in the past year [14, 31, 32, 36, 75] or in the year after a change in driving legislation [35], while the others reported prevalence of current driving or licensing, except for 4 studies where the period was unclear [22, 47, 50, 70]. Six studies reported on the prevalence (3% [39] to 39%) [31, 32] of participant driving [14, 22, 31, 32, 39, 49] or hold a driver’s license [22] in violation of legal restrictions.

Fig. 2. Prevalence of driving or holding a driver's license among people with seizures, where duration of the illness was reported (21 studies). ^a ?, No specific epilepsy characteristics. ^b All participants had been diagnosed as epilepsy for 1 year and for 2 years in 2 studies (Australia 2018, Xu et al. [51] and USA 2011, Perucca et al. [20]); for the other studies, numbers are average years after a first

seizure or the diagnosis of epilepsy. ^c ?, Not reported; 8m in the past 8 months; numbers represent in the past number of years; C, current; C&P, current and past. ^d ?, Not reported; numbers are the number of participants who drove or held a driver's license in violation of restrictions; ×, all participants who held a driver's license were not in violation of restrictions.

Prevalence of Traffic Accidents

The prevalence of traffic accidents ranged from 0 [39, 52, 67] to 61% [14] across individual studies (Fig. 5). There was a significant decrease in the proportion of participants who had traffic accidents, from 61% before surgery to 7% after surgery ($p < 0.001$) in the only before and after surgery study that reported this [12]. We did not pool prevalence because there was significant heterogeneity between studies and in sensitivity analyses (both $p < 0.001$ and both $I^2 > 95\%$, Fig. 5 and online suppl. Fig. 6). Studies were categorized into those conducted in high versus upper and lower-middle-income countries (online suppl. Fig. 7).

In a third of the studies, the time frame for the prevalence was reported, covering the past 1 [53, 57, 67], 2 [10],

3 [40], 4 [11], 5 [27, 29, 30, 69], and 10 years (Fig 5) [65]. Half of the study authors stated whether the traffic accidents were seizure-related [12, 14, 19, 21, 31, 46, 56, 73, 78, 79] or not [29, 30], or reported the number of participants involved in traffic accidents who had seizure-related accidents [27, 32, 33, 58, 74]. It was clear in 2 studies that participants who were driving in violation of restrictions had more traffic accidents (41%) [14] than those driving legally (0%) [67].

Meta-Regression

For studies on participants who underwent epilepsy surgery, prevalence of driving and of holding a driver's license were combined to achieve a sufficient number of

Fig. 3. Prevalence of driving or holding a driver's license before and after epilepsy surgery (13 studies). **a** studies reporting prevalence before and after surgery. **b** studies reporting prevalence after surgery. ^a ?, No specific epilepsy-related characteristics. ^b There were

some patients lost to follow-up in these 2 studies, numbers are the number of participants before and after surgery. ^c A maximum of 13 years.

observations. There was no evidence of association between the prevalence and years of publication or response rates before or after surgery (all $p > 0.2$). There was no evidence of association between the postsurgery prevalence of driving or holding a driver's license and number of years after the surgery ($p = 0.60$).

For studies not involving epilepsy surgery, meta-regression (online suppl. Fig. 8) indicated decreases over time since first seizure or diagnosis, in prevalence of driving ($p = 0.01$, adjusted $R^2 = 31\%$) and the combined outcome of driving or holding a driver's license ($p = 0.04$, adjusted $R^2 = 12\%$), but not in prevalence of holding a driver's license ($p = 0.25$). There is some evidence for an increase, as year of publication increased, in prevalence of driving ($p = 0.08$, adjusted $R^2 = 6\%$, online suppl. Fig. 8), holding a driver's license ($p = 0.07$, adjusted $R^2 = 7\%$), and in the combined outcome of driving or holding a driver's license ($p = 0.02$, adjusted

$R^2 = 7\%$). There is no evidence of an association between response rates and prevalence of driving ($p = 0.38$), holding a driver's license ($p = 0.38$), or the combined outcome ($p = 0.90$).

There is no evidence of an association between prevalence of traffic accidents and year of publication ($p = 0.94$), time periods for which prevalence were calculated ($p = 0.17$), or response rates ($p = 0.95$).

Funnel Plots and Egger's Tests

The funnel plots (online suppl. Fig. 9) of studies involving epilepsy surgery showed absence of bias and the Egger's test provided no evidence for small-study effects before or after surgery ($p = 0.17$ and 0.67). The funnel plot (online suppl. Fig. 10) of studies not involving epilepsy surgery showed absence of bias, and the Egger's test provided no evidence for small-study effects ($p = 0.43$). The funnel plot (online suppl. Fig. 11) of studies reporting

Fig. 4. Prevalence of driving or holding a driver's license among people with seizures, whose duration of the illness and history of surgery were not reported (30 studies). ^a ?, No specific epilepsy- or driving-related characteristics. ^b C, Current; numbers represent in

the past number of years; ?, not reported; RA 1 year after regulations amendment. ^c Numbers are the number of participants who drove in violation of restrictions; ?, not reported; ✓, all participants who drove or held a driver's license were in violation of restrictions.

prevalence of traffic accidents showed absence of bias, and the Egger's test provided no evidence for the presence of small-study effects ($p = 0.75$).

Discussion

The prevalence of driving ranged from 3 [77] to 90% [20], and the prevalence of holding a driver's license ranged from 8 [36] to 98% [60], with up to 39% [31, 32] of people with epilepsy driving in violation of legal restrictions. The prevalence of traffic accidents ranged from 0 [39, 52, 67] to 61% [14]. Heterogeneity across studies was related to different study designs, recruitment strate-

gies, source countries, regions and years of conduct, time periods of observation, case mix, and relationship to restrictions and whether only seizure-related traffic accidents were included.

Since the first study published on seizures and driving in 1967, there has been a steady increase in research on this topic as documented in this review. This indicates an increased awareness of safety and importance of driving for people with seizures. However, we note the limited number of studies in lower-middle-income countries, where there is a higher median incidence rate of epilepsy (68.7/100,000) than in high-income countries (43.4/100,000) [80]. Our review suggests there has been an increase in the prevalence of people with seizures who drive, as year of publication in-

Fig. 5. Prevalence of traffic accidents among people with seizures who drove (30 studies). ^a ?, No specific epilepsy- or driving-related characteristics. ^b ?, Not reported; numbers are average years after a first seizure or the diagnosis of epilepsy. ^c ?, Not reported; numbers are traffic accidents occurred in the past number of years.

^d ?, Not reported; numbers are the number of participants who had seizure-related traffic accidents; ✓, seizure-related; ×, not seizure-related. ^e ?, Not reported; ×, not in violation, numbers are the number of participants who had traffic accidents that were driving in violation; ✓, in violation.

creased, but only less than one-tenth of the prevalence variation could be explained. Driving is increasing globally in line with economic prosperity and reduced car ownership price. Since the first Bureau of Statistic Motor Vehicle Census in 1955, Australian car ownership rates have continued to rise [81]. Bureau of Infrastructure, Transport, and Regional Economics reported that the rate of driver's license holder in Australia had continued to rise from 3% in 1922 to 71% in 2016 [82]. According to reports from the British Broadcasting Corporation [83] and the Royal Automobile Club Foundation for Motoring [84], the number of cars per head of population and per household have grown almost linearly since 1971, and the vast majority of journeys were by car in the United Kingdom in 2016. Further, driving restrictions for people with a single seizure or epilepsy have been amended since the 1960s to allow more of those with a low risk of seizure-related traffic accidents to drive [27, 35]. These changes have facilitated an early return to driving for people with seizures.

Despite increased car and license ownership rates in Australia, the annual kilometers driven per person and per household have decreased [81]. Light vehicle ownership rates and distances driven per person each year reached peaks a decade ago in the United States and have started decreasing since then [85]. A peak in annual distance per capita traveled by car for the European Union was also documented in 2009 and trends differ between countries [86]. Four clusters were discerned: 5 countries facing economic crisis, 4 western countries that peaked, 6 western countries with stable growth, and 11 east European countries with sustained growth [86]. Uncertainty remains on whether the proportion of people, and people with seizures, who drive has been increasing over time.

The first 2 years after diagnosis of epilepsy represent a period of significant adjustment to the diagnosis and its management. The greatest risk of seizure recurrence occurs within the first 2 years [87], and restrictions on driving are applied until the locally required seizure-free pe-

riod is met [4]. Yet, we note a paucity of studies that have investigated the short-term impact of epilepsy on driving or holding a driver's license. The prevalence of people with seizures who drive has decreased, as time since seizure onset increased, but as an average duration of illness time was used across studies, participants may not been at comparable stages in their condition. Patients undergoing epilepsy surgery are almost all drug-resistant, while a median of 70% of patients achieved remission after temporal lobectomy [88]. It was also found that the ability to drive significantly increased after surgery (i.e., a higher proportion of patients was driving after epilepsy surgery) and was dependent on being seizure free [89]. Few included studies involving epilepsy surgery had prospective and consecutive recruitment.

Different legal restrictions, availability and affordability of alternative methods of transport, and personal attitudes could partly explain the variations in the prevalence of driving, or holding a driver's license. In 2011, the seizure-free period required for a private driver's license varied considerably across countries: from 3 months to 2 years in the United States; 6 months in Canada; 1 year in New Zealand; 6 months for the first unprovoked seizure and 2 years for uncontrolled epilepsy in Australia; and up to 2 years in Europe [4]. Use of public transport has been significantly influenced by available routes, cost, convenience, comfort, safety, support from family and friends, and perception of difficulty associated with driving a car [90]. There are significant differences in the accessibility of public transportation, availability of social or community services enabling people with epilepsy commute to their work or daily activities. Although digital transportation network companies, for example, Uber and Lyft, provide a convenient and more affordable service than traditional taxi companies, their impact to date has been too small to change the numbers of those driving [91], when used as nonemergency medical rides, waiting times and average per-ride costs were lower, and a high satisfaction rate was achieved [92]. Establishing Uber and Lyft as a complementary service or as an alternative to public transport could be incorporated into policy.

This systematic review included studies of people with a wide range of seizure disorders: first seizure [60], childhood onset epilepsy [34], drug-resistant epilepsy [14, 77], people collected by a free ambulance service [63], on at least 1 antiepileptic drug [79], or dependent on psychoactive drugs [68]. It is worth noting that a number of participants with drug-resistant epilepsy were still driving, despite frequent seizures or comorbidity, and up to two-fifths of people with seizures drove despite not meeting the seizure-free

requirement [31, 32]. In some studies, no traffic accidents were reported, but in other studies, over half of people with seizures who drove had a traffic accident. The prevalence of traffic accidents significantly increased when participants were driving in violation of guidelines [14] compared to those driving legally [67]. This highlights the need for research to identify those who are more likely to drive against advice, so that physicians and driver licensing authorities can identify those most at risk and target driving advice and driving prevention strategies accordingly.

A limitation of this systematic review is that the severity of the traffic accidents was not investigated. Some researchers report that accidents related to epilepsy produce more minor injuries, are less likely to involve another vehicle, and occur in less densely populated areas than accidents due to other medical causes [93]. There are also potential reporting biases due to social acceptability of reporting illegal activity, real or perceived threat of study participants losing their license, and unawareness of seizures [94, 95], which may have resulted in underestimation of prevalence. For studies using registry data, it is possible that the medical evaluations were not performed of all accident victims, with autopsies in fatal cases being neglected [93].

Further prospective research with consecutive recruitment of people with the same duration of seizures or epilepsy is required to determine the short- and long-term impact of epilepsy, and epilepsy surgery, on driving and road safety, and in particular, to reduce driving in violation of legal restrictions and seizure-related traffic accidents. Provision of affordable alternatives for driving, for example, developing public transport, promoting subsidy schemes to encourage use of public transport, Uber and Lyft-type schemes, may be a worthwhile pursuit.

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Statement of Ethics

The authors have no ethical conflicts to disclose.

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Author Contributions

Y.X.: design/conceptualization of the study, data extraction, statistical analysis, interpretation of data, first draft, and revision of the manuscript; J.S.: design/conceptualization of the study, data extraction, and revision of the manuscript; Z.Z.: design/conceptualization of the study, data extraction, and revision of the manuscript; E.S.: acquisition and interpretation of data for the work and revision of the manuscript; C.S.A. and N.G.: design/conceptualization of the study and revision of the manuscript; M.L.H.: design/conceptualization of the study, supervision, and revision of the manuscript.

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