



# Prevalence and psychopathologic significance of hallucinations in individuals with a history of seizures

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## Abstract

**Objective:** A relationship between seizure activity and hallucinations is well established. The psychopathologic significance of hallucinations in individuals with seizures, however, is unclear. In this study, we assessed the prevalence of auditory and visual hallucinations in individuals who reported a seizure history and investigated their relationship with a number of mental disorders, suicidal ideation, and suicide attempts.

**Methods:** Data were from the “Adult Psychiatric Morbidity Survey,” a population-based cross-sectional survey. Auditory and visual hallucinations were assessed using the Psychosis Screening Questionnaire. Mental health disorders were assessed using the Clinical Interview Schedule. Logistic regressions assessed relationships between hallucinatory experiences and mental disorders, suicidal ideation, and suicide attempts.

**Results:** A total of 14 812 adults (58% female; mean [standard error of the mean; SEM] age 51.8 [0.15]) completed the study; 1.39% reported having ever had seizures (54% female), and 8% of individuals with a seizure history reported hallucinatory experiences (odds ratio [OR] 2.05, 95% confidence interval [CI] 1.24–3.38). Individuals with seizures had an increased odds of having any mental disorder (OR 2.34, 95% CI 1.73–3.16), suicidal ideation (OR 2.38, 95% CI 1.77–3.20), and suicide attempt (OR 4.15, 95% CI 2.91–5.92). Compared to individuals with seizures who did not report hallucinatory experiences, individuals with seizures who reported hallucinatory experiences had an increased odds of any mental disorder (OR 3.47, 95% CI 1.14–10.56), suicidal ideation (OR 2.58, 95% CI 0.87–7.63), and suicide attempt (OR 4.61, 95% CI 1.56–13.65). Overall, more than half of individuals with a seizure history who reported hallucinatory experiences had at least one suicide attempt. Adjusting for psychopathology severity did not account for the relationship between hallucinatory experiences and suicide attempts.

**Significance:** Hallucinatory experiences in individuals with seizures are markers of high risk for mental health disorders and suicidal behavior. There is a particularly strong relationship between hallucinations and suicide attempts in individuals

with seizures. Clinicians working with individuals with seizures should routinely ask about hallucinatory experiences.

## 1 | INTRODUCTION

Hallucinations occur at an elevated prevalence in individuals with a history of seizures.<sup>1-4</sup> Hallucinatory experiences in epilepsy are typically viewed as sequelae of abnormal electrical activity in a variety of brain structures, most commonly the limbic system.<sup>1,2</sup> Their psychopathologic significance, however, is unclear. Given the high rate of psychiatric morbidity associated with epilepsy,<sup>5-10</sup> we wished to investigate the psychopathologic significance of hallucinations in individuals with a history of seizures. Using data from the Adult Psychiatric Morbidity Survey, we calculated the point prevalence of auditory and visual hallucinations in individuals with a history of seizures and assessed their relationship with a range of mental health disorders, suicidal ideation, and suicide attempt.

## 2 | METHODS

The Adult Psychiatric Morbidity Survey (APMS) is an assessment of the prevalence of a range of mental health disorders in the general population conducted every 7 years. The APMS represents the longest running epidemiological program in the world using consistent methods. The surveys are commissioned by the National Health Service in the UK (NHS) and conducted by NatCen Social Research and The University of Leicester. Commencing in 1993, the surveys have been repeated in 2000, 2007, and 2014. They consist of two phases; the first is a structured assessment in which data are collected on a range of general medical conditions, mental disorders, and a range of demographic, service use, and social variables. A second phase conducted by clinically trained interviewers collected data on traumatic experiences, suicidality, and self-harm behaviors, as well as psychotic experiences. At each of the four APMS assessment time points, a representative sample of the general population, identified through household probability sampling, was interviewed—approximately 7500 people aged 16 years and over. The complementary studies allow for combining data into one large data set or, alternatively, to test a hypothesis in one data set and replicate in another. A history of seizures was first recorded in the 2007 data set (N = 7403), and again in the 2014 data set (N = 7546). The sample used in this study is a combination of these two data sets (N = 14 949).

### Key Points

- Eight percent of individuals who report a history of seizures also report hallucinatory experiences.
- Hallucinatory experiences are strongly associated with mental ill health in individuals with seizures: 65% met criteria for one or more mental health disorder.
- Hallucinatory experiences are a strong risk marker for suicidal behaviour in individuals with seizures: 53% had one or more suicide attempt.
- Clinicians working with individuals with seizures should routinely ask about the occurrence of hallucinatory experiences.

As in previous research using these data sets, all analyses were weighted to account for participant selection and nonresponse in order to ensure the data were representative of the age 16-74 population.<sup>11,12</sup>

### 2.1 | Assessment of hallucinatory experiences

Hallucinatory experiences were assessed using the following question taken from the Psychosis Screening Questionnaire<sup>13</sup>; “Over the past year, have there been times when you heard or saw things that other people couldn’t?” Previous research has demonstrated that questionnaire items on auditory and visual hallucinations have high positive and negative predictive values for interview-verified symptoms.<sup>14</sup>

In line with previous research,<sup>15,16</sup> individuals with “probable psychosis” were excluded from the analyses. Probable psychosis was defined as a positive response to the previous question followed by a positive response to the following question, “Did you at any time hear voices saying quite a few words or sentences when there was no one around that might account for it?” This step was carried out to provide a more stringent test of our hypotheses to increase our confidence that any relationship was not driven by actual psychotic disorders. However, for the sake of completion, we have also provided results of analyses including individuals who endorsed both of the hallucination questions in the supplementary analyses.

## 2.2 | Assessment of seizure history

A history of seizures was defined as a positive endorsement of a question as to whether the individual had “ever, since the age of 16, had epilepsy or fits.”

## 2.3 | Outcome variables

### 2.3.1 | Mental health disorders

The revised Clinical Interval Schedule (CIS-R) is a validated, fully structured interview that assessed for the past week prevalence of the following International Classification of Diseases, Tenth Revision (ICD-10) diagnoses: depression, phobia, panic disorder, obsessive compulsive disorder (OCD), mixed anxiety and depression, and generalized anxiety disorder.<sup>17</sup> It also generates a total CIS-R score that reflects the severity of mental health symptoms.

### 2.3.2 | Suicidal behaviors

Suicidal ideation and suicide attempts were assessed using the following self-completed items:

#### *Suicidal ideation*

“There may be times in everyone’s life when they become very miserable and depressed and may feel like taking drastic action because of these feelings. Have you ever thought of taking your life, even if you would not really do it?”<sup>11,18</sup> Answering yes to this question indicated an individual with lifetime suicidal ideation.

#### *Suicide attempt*

“Have you ever made an attempt to take your life, by taking an overdose of tablets or in some other way?”<sup>11,18</sup> A positive response to this question indicated an individual had at least one lifetime suicide attempt.

## 2.4 | Statistical analyses

Prior to data analyses, the 2007 and 2014 data sets were combined, checked, and re-coded where necessary.

In the 2007 data set, 40 individuals with “probable psychosis” were dropped before analyses, leaving a total N = 7363. Similarly, 91 individuals were excluded from the 2014 data set before analyses leaving a total N = 7445. Those excluded from analyses represented 0.88% of the total sample (N = 131). Therefore, a combined total N of 14 818 was used for analyses.

## 2.5 | Prevalence of mental health disorders

We used logistic regression to compare the prevalence of the following six mental health disorders in individuals with and without a history of seizures: depression, phobia, panic disorder, OCD, mixed anxiety and depression, or generalized anxiety disorder, as well as “any mental health disorder.” We also used logistic regression to compare the prevalence of suicidal ideation and suicide attempts in individuals with and without a history of seizures.

## 2.6 | Hallucinatory experiences

We calculated the proportion of individuals with a seizure history who reported hallucinatory experiences in order to compare this to the prevalence of hallucinatory experiences in the general population. We then used logistic regression to compare the odds of suicidal ideation and suicide attempts across the following groups: (1) individuals with neither a history of seizures nor hallucinatory experiences (reference group), (2) individuals without a history of seizures but who did report hallucinatory experiences, (3) individuals with a history of seizures but who did not report hallucinatory experiences, and (4) individuals with a history of seizures and who also reported hallucinatory experiences. We used chi-square analyses to test for differences in the prevalence of suicidal ideation and suicide attempt in group 4 compared to both groups 2 and 3.

Our main analyses of interest were to compare the prevalence of suicidal ideation and suicide attempt among individuals with a history of seizures who did vs did not also report hallucinatory experiences, as this would tell us whether knowledge about hallucinatory experiences is clinically informative with regard to suicidal behaviour risk in individuals with seizures. Specifically, we used logistic regression to calculate the odds of suicidal ideation and suicide attempts in individuals with a history of seizures who also reported hallucinatory experiences compared to individuals with a history of seizures who did not report hallucinatory experiences. Furthermore, to assess whether a difference in the odds of suicidal ideation or suicide attempt was explained by co-occurring psychopathology, we then carried out our analyses adjusting for the total CIS-R score.

All analyses reported in text were adjusted for age and sex and conducted using StataSE 14.

## 3 | RESULTS

The total sample used for analysis was 14 812 (58% female). Six individuals had missing data on seizure history and were

therefore not included in the analyses. Age ranged from 16 to 95 years with the mean age of the respondent being 51.8 years of age.

Two hundred six individuals (1.39% of the sample) reported a history of seizures, 54% of whom were female.

### 3.1 | Prevalence of mental health disorders in individuals with a history of seizures

Among individuals who did not have a history of seizures, 16.8% had one or more lifetime mental health disorders. Among individuals who did have a history of seizures, 31.5% had one or more lifetime mental health disorders. (See Table 1 for prevalence of all disorders in individuals with a history of seizures.)

#### 3.1.1 | Aim 1: Prevalence of Hallucinatory experiences in those with a history of seizures

Among individuals who did not have a history of seizures, 4.08% reported hallucinatory experiences (59% female). Among individuals with a history of seizures, 8.25% reported hallucinatory experiences (71% female; adjusted odds ratio [aOR] 2.05, 95% CI 1.24-3.38).

#### 3.1.2 | Aim 2: Psychopathologic significance of hallucinatory experiences

##### *Prevalence of mental disorder*

Among individuals with a history of seizures who did not report hallucinatory experiences, 29% met criteria for one or more mental health disorder. By comparison, among individuals with a history of seizures who did report hallucinatory experiences, 65% met criteria for one or more mental disorder (aOR 3.5, 95% CI 1.14-10.56). Table 2 shows the prevalence of six mental health disorders in individuals with seizures who did (n = 17), vs did not (n = 189), report hallucinatory experiences.

##### *Relationship with suicidal ideation and attempts*

Among individuals with no history of seizures, 17% reported ever experiencing suicidal ideation. This was compared to 33% of individuals with a history of seizures. Among individuals with no history of seizures, 6% reported one or more suicide attempt. By comparison, 19% of individuals with a history of seizures reported at least one suicide attempt (see Table 3).

#### 3.1.3 | Aim 3: Seizures, hallucinations, and suicidal ideation and attempt

Table 4 shows the prevalence of suicidal ideation and suicide attempts across four groups: (1) individuals with neither a history of seizures nor hallucinatory experiences (reference group), (2) individuals without a history of seizures but who did report hallucinatory experiences, (3) individuals with a history of seizures but who did not report hallucinatory experiences, and (4) individuals with a history of seizures and who also reported hallucinatory experiences.

The prevalence of suicidal ideation in group 4 (individuals with a history of seizures and who also reported hallucinatory experiences) was significantly elevated compared to group 3 (individuals with a history of seizures but who did not report hallucinatory experiences;  $\chi^2 = 5.58$ ,  $P = .018$ ) but not compared to group 2 (individuals without a history of seizures but who did report hallucinatory experiences;  $\chi^2 = 1.97$ ,  $P = .16$ ).

The prevalence of suicide attempts was significantly elevated in group 4 compared to both group 2 ( $\chi^2 = 13.19$ ,  $P < .01$ ) and group 3 (group 3;  $\chi^2 13.31$ ,  $P < .001$ ).

### 3.2 | Main analyses

Our principal hypothesis was that hallucinatory experiences would be a risk marker for increased suicidal behavior in individuals with a seizure history: that is, that individuals with a seizure history who also reported hallucinatory experiences would have a higher odds of suicidal behavior than individuals with a seizure history who did not report hallucinatory experiences. Among individuals with a seizure history who

**TABLE 1** Prevalence of all mental health disorders by history of seizures

Mental health disorder	No seizures n (%)	Seizures n (%)	Unadjusted OR	95% CI	Adj. for age & sex	95% CI
Any mental health disorder	2454 (16.8)	65 (31.6)	2.29	1.70-3.07	2.34	1.73-3.16
Mixed Anxiety and Depression	1207 (8.3)	26 (12.6)	1.6	1.06-2.43	1.62	1.07-2.46
Generalized anxiety Disorder	750 (5.1)	29 (14.1)	3.03	2.03-4.51	3.05	2.04-4.57
Depression	467 (3.2)	18 (8.7)	2.9	1.77-4.75	2.91	1.78-4.77
Any phobia	300 (2.1)	11 (5.3)	2.69	1.45-4.99	2.74	1.46-5.12
OCD	157 (1.1)	8 (3.9)	3.72	1.80-7.67	3.74	1.79-7.79
Panic Disorder	124 (0.9)	0(0)	-	-	-	-

**TABLE 2** Prevalence of mental health disorders in individuals with a history of seizures, by hallucinatory experiences

Mental health disorder	Seizures, no HE n (%)	Seizures, with HE n (%)	Unadjusted OR	95% CI	Adj. for age & sex OR	95% CI
Any mental health disorder	54 (28.6)	11 (64.7)	4.58	1.60-13.13	3.47	1.14-10.56
Mixed Anxiety and Depression	19 (10.1)	7 (41.2)	6.26	2.12-18.54	4.42	1.35-14.48
Generalized Anxiety Disorder	25 (13.2)	4 (23.5)	2.02	0.60-6.75	2.1	0.59-7.44
Depression	17 (9)	1 (5.88)	0.63	0.78-5.16	0.46	0.04-5.01
Any phobia	9 (4.8)	2 (12)	2.67	0.52-13.66	2.43	0.33-18.06
OCD	8 (4.2)	0 (0)	-	-	-	-

Note: No individuals with a history of seizures had panic disorder.

Abbreviations: HE, hallucinatory experiences.

**TABLE 3** Suicidal ideation and attempt in individuals with a history of seizures

	No seizures n (%)	Seizures n (%)	Unadjusted OR	95% CI	Adj. for age & sex	95% CI
Suicidal ideation	2519 (17%)	68 (33%)	2.36	1.76-3.17	2.38	1.77-3.20
Suicide attempt	821 (6%)	40 (19%)	4.05	2.85-5.75	4.15	2.91-5.92

did not report hallucinatory experiences (group 3), 31% reported suicidal ideation. By comparison, among individuals with a seizure history who also reported hallucinatory experiences (group 4), 59% reported suicidal ideation (aOR 2.58, 95% CI 0.87-7.63).

Among individuals with a seizure history who did not report hallucinatory experiences (group 3), 16% had one or more lifetime suicide attempt (group 3). By comparison, among individuals with a seizure history who also reported hallucinatory experiences (group 4), 53% had one or more lifetime suicide attempts (aOR 4.61, 95% CI 1.58-13.65). Adjusting for psychopathology severity, using total CIS-R score, did not account for the relationship between hallucinatory experiences and suicide attempt (aOR 3.75, 95% CI 1.09-12.91).

## 4 | DISCUSSION

In an English general population sample, 8% of individuals with a history of seizures reported hallucinatory experiences in the past year—twice the prevalence of hallucinations in individuals without a history of seizures. The lifetime prevalence of mental health disorders among individuals with a history of seizures was also approximately twice that of individuals with no history of seizures, at 32% and 17%, respectively. Strikingly, the lifetime prevalence of mental health disorders was 65% in individuals with a seizure history, who also reported hallucinatory experiences, compared to 29% of individuals with a seizure history who did not report hallucinations. Hallucinatory experiences, therefore, are a strong

marker of risk for mental ill health in individuals with a history of seizures.

As in previous research, there was an increased prevalence of suicidal ideation and suicide attempts in individuals with a seizure history. There was, however, a marked difference between individuals with vs without hallucinatory experiences: among individuals with a seizure history who did not report hallucinations, 16% had a previous suicide attempt; among individuals with a seizure history who also reported hallucinations, on the other hand, more than half (53%) reported one or more suicide attempt. What is more, our analyses suggested that the higher prevalence of suicide attempts was not simply explained by higher rates of co-occurring mental health disorders. Hallucinatory experiences, therefore, are strong markers of risk for suicidal behavior in individuals with a history of seizures.

There are many factors that might help to explain the association between seizures, hallucinatory experiences, and suicidality. From a biological perspective, there is overlap in neuroimaging findings in individuals with seizures and individuals with psychotic disorder. Abnormalities in the limbic system, in particular, are shared features in epilepsy and psychosis.<sup>19-22</sup> This is particularly the case for temporal lobe seizures, although in the current study we did not have information as to the type of seizures experienced.

Pulsipher et al<sup>23</sup> (2011) found reduced thalamic volumes in children aged 8-18 with idiopathic generalized seizures, something that has also been found in individuals at elevated risk for psychosis<sup>24</sup> and in patients with diagnosed schizophrenia (where it has been shown to correlate with the frequency



**TABLE 4** Suicidal ideation and attempt stratified by seizure history and hallucinatory experiences

	Seizures –ve Hallucinations –ve		Seizures –ve Hallucinations +ve		Seizures +ve Hallucinations –ve		Seizures +ve Hallucinations +ve	
	n (%)	OR (95% CI)	n (%)	OR (95% CI)	n (%)	OR (95% CI)	n (%)	OR (95% CI)
Suicidal ideation	2270 (16.2)	1 (Reference)	249 (41.8)	3.61 (3.04-4.28)	58 (30.7)	2.35 (1.72-3.22)	10 (58.8)	5.94 (2.18-16.24)
Suicide attempt	714 (5.1)	1 (Reference)	107 (18)	3.92 (3.13-4.90)	31 (16.4)	3.83 (2.58-5.70)	9 (52.9)	16.68 (6.23-44.65)

Note: Analyses are adjusted for age and sex.

Abbreviations: +ve, positive; 95% CI, 95% confidence interval; HE, hallucinatory experiences; OR, odds ratio; –ve, negative.

of auditory hallucinations).<sup>25</sup> The downstream consequences of this reduced thalamic volume could be disruption to the flow of information between cortical and subcortical brain areas,<sup>26,27</sup> which may increase the risk of hallucinatory experiences<sup>28</sup> and suicide.<sup>29,30</sup>

From a psychosocial perspective, issues such as stress, bullying, and stigma may contribute to the shared risk for hallucinatory experiences and suicidal behavior in individuals with a history of seizures. Hamiwka et al<sup>31</sup> showed, for example, that 42% of children with seizures reported being victims of bullying, compared to 18% of children with chronic kidney disease. In terms of stigma, 51% of a random sample of the general UK population believed that individuals with seizures were treated differently by society from those without seizures.<sup>32</sup> Similarly, chronic illnesses can have profound effects on self-concept/self-esteem,<sup>33</sup> a factor that also correlates with psychotic experiences.<sup>34</sup> Stress may precipitate or exacerbate seizures,<sup>35,36</sup> and could also play a role in both hallucinatory experiences and suicidal behavior.<sup>37,38</sup>

In general population samples, adolescents who report hallucinatory experiences perform more poorly on tasks assessing language, motor skills, speed of processing, and executive function<sup>39</sup>—deficits that have also been shown in individuals with seizures.<sup>40,41</sup> In a community-based sample of intellectually normal children with a recent seizure, 27% had neuropsychological deficits at seizure onset (including deficits in language, processing speed, verbal memory and learning, and executive functioning).<sup>42</sup> Deficits in executive function and processing speed may contribute to the shared risk for suicidal behavior.

## 5 | STRENGTHS AND LIMITATIONS

The APMS provided data from a representative, population-based sample. The consistent methods used across the 2007 and 2014 data sets enabled the combination of data in order to increase power.

A limitation is that the data were cross-sectional; future research should seek to establish the longitudinal relationship. Although our sample size was large, the prevalence of seizures, at just over 1%, is low; therefore, replication of our analyses in other data sets will be valuable. Assessment of seizures was self-reported, which is subject to recall bias and generally less reliable than extracting data from medical records, although the prevalence of seizures was in line with other epidemiological research, in which medically recognized but self-reported rates of lifetime seizure prevalence has been estimated at 1.8%.<sup>43</sup> We could not differentiate between types of seizure, including epileptic vs psychogenic nonepileptic seizures, or the timing of hallucinations with regard to seizure activity, issues that future research should

further examine. We also could not look at the effect of seizure treatments (vs the seizures themselves). Nonetheless, these limitations do not take away from the value of understanding the relationship between hallucinations and mental health outcomes in individuals with a history of seizures.

Hallucinations occur at an elevated prevalence in individuals with seizures. They should not be regarded simply as a reflection of abnormal electrical activity in the brain but as markers of high risk for mental ill health. This includes a strong relationship with suicidal behaviour. Given these findings, we recommend that clinicians working with individuals with seizures should routinely ask about the occurrence of hallucinatory experiences and that positive responses should prompt a careful mental state examination and appropriate psychosocial follow-up.

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### CONFLICT OF INTEREST

None of the authors has any conflict of interest to disclose. We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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