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Cognition, academic achievement, and epilepsy in school-age children: A case–control study in a developing country

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ABSTRACT

We conducted a case–control study of 33 Jamaican children 7 to 12 years old with uncomplicated epilepsy and 33 of their classroom peers matched for age and gender to determine whether epilepsy resulted in differences in cognitive ability and school achievement and if socioeconomic status or the environment had a moderating effect on any differences. Intelligence, language, memory, attention, executive function, and mathematics ability were assessed using selected tests from NEPSY, WISCR, TeaCh, WRAT3 — expanded, and Raven's Coloured Progressive Matrices. The child's environment at home was measured using the Middle Childhood HOME inventory. Socioeconomic status was determined from a combination of household, crowding, possessions, and sanitation. We compared the characteristics of the cases and controls and used random effects regression models (using the matched pair as the cluster) to examine the relationship between cognition and epilepsy. We found that there was no significant difference in IQ, but children with epilepsy had lower scores on tests of memory ($p < 0.05$), language ($p < 0.05$), and attention ($p < 0.01$) compared with their controls. In random effects models, epilepsy status had a significant effect on memory (coefficient = −0.14, CI: −0.23, −0.05), language (coefficient = −0.13, CI: −0.23, −0.04), and mathematics ability (coefficient = −0.01, CI: −0.02, −0.00). Adjustment for the home environment and socioeconomic status and inclusion of interaction terms for these variables did not alter these effects. In conclusion, we found that epilepsy status in Jamaican children has a significant effect on performance on tests of memory, language, and mathematics and that this effect is not modified or explained by socioeconomic status or the child's home environment.

1. Introduction

Epilepsy affects 1% of children globally [1] but is more prevalent in developing countries [2]. Although 60–75% of children with epilepsy will experience lifelong seizure remission [3,4], children with idiopathic epilepsy have been shown to experience cognitive deficits [5].

The cause of these cognitive deficits is not fully determined and is probably multifactorial. Investigators have reported the presence of cognitive deficits at diagnosis/onset of disease [6,7] in children with idiopathic epilepsy suggesting a role for underlying brain dysfunction. The number of recurrent seizures may also contribute to the severity of cognitive abnormality, and cognitive side effects are more common with the use of the older antiepileptic drugs (AEDs) [8–10]. Studies of cognition in children with frequent or continuous spike–wave discharges during sleep, even in the absence of overt clinical seizures, suggest a role for the excessive EEG spike discharges in the impairment of language and other areas of cognition and memory [11]. A range of cognitive deficits have been documented in idiopathic epilepsy including memory [12–14], processing speed, attention [15], and language [16].

These cognitive deficits may impact academic performance. Children with epilepsy access special education services more frequently than their peers [5]. Aldenkamp et al. have shown that educational underachievement is more likely in children with localized or symptomatic generalized epilepsy [17]. Interestingly, in a prospective community-based study, Berg et al. showed that 49% of children with idiopathic/cryptogenic epilepsy were receiving special education services at 5 years of follow-up and that 15% had accessed services prior to their first seizure, thereby suggesting that the cognitive deficits antedate the onset of epilepsy [18]. The cognitive and motor deficits in idiopathic epilepsy in children aged 7 to 16 years have been shown to remain stable over two years [16]. Similarly, academic achievement in children with varying degrees of severity of epilepsy aged 11 to 18 years has not been shown to decline over a period of follow-up of 4 years [19].

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Social factors, socioeconomic status, parental education level, and poor family function have been associated with cognitive deficits in idiopathic epilepsy [17]. While cognitive rehabilitation has not been found to be entirely successful [20], studies have shown that the family environment can have a moderating impact on neuropsychological deficits in children with epilepsy [21,22].

Most studies which have examined the role of epilepsy on cognition have been performed in developed countries. There are few studies from the developing world, and these have been conducted in Latin America, Africa, and Asia [15,23–26]. We, therefore, sought to determine whether Jamaican children with uncomplicated epilepsy differ significantly from their peers in cognitive function and academic achievement. We also wanted to know whether any differences were moderated by their social status, as this may help identify those who may require special attention, or by their home environment, as this may identify a potential approach that could be taken to address this issue.

2. Materials and methods

2.1. Participants

A matched case–control study was conducted. Cases were Jamaican children with a diagnosis of epilepsy between the ages of 7 and 12 years. The diagnosis of epilepsy was based on a pediatric neurologist or an experienced pediatrician's assessment in accordance with the International League Against Epilepsy criteria [27,28]. All were identified from pediatric neurology and general outpatient clinics at two public hospitals in Kingston, Jamaica's capital city. Cases had to attend a regular primary school in Kingston or nearby areas.

One control was identified for each case. Controls were classmates of the index case, of the same age and sex, who did not have a diagnosis of epilepsy or known chronic disease with neurological manifestations. In order to identify the control without disclosing the identity of the case, the class teacher was asked to identify all children in the class born within a 3-month age band, relative to the age of the case. The child of the same sex and closest in age to the case was then invited to participate in the study. We had also intended to have a sibling control; however, too few of the cases had an eligible sibling for inclusion.

Children with any other neurologic illness, obvious neurologic deficits, severe mental retardation, mixed seizure disorder, metabolic disorder, hearing disorders, known chronic illness with neurologic manifestations, or abnormal neuroimaging or attending special schools were excluded as both cases and controls. There were no refusals amongst cases or controls invited to participate in the study.

2.2. Sample size calculation

Utilizing the data from Bailet and Turk [5] who found a mean (SD) for IQ in controls of 108 (10) and in children with idiopathic epilepsy of 98 (13), a minimum sample size of 22 cases and 22 controls was calculated to have 80% power to detect a significant difference between groups.

2.3. Confirmation of the diagnosis of epilepsy

The medical records of the children with a diagnosis of epilepsy were reviewed for seizure characteristics, details of the developmental assessment, clinical findings of the neurological examination, assigned diagnosis, results of the electroencephalogram (when performed), and results of the neuroimaging procedure (when performed). The epilepsy and seizure types were classified according to the International League Against Epilepsy criteria [27,28].

Although all children are referred for electroencephalography, this investigation is only available within the private health-care sector and so may not have been performed in all.

Table 1
Neuropsychology test panel.

Area of investigation	Test
Attention and executive function	Inhibition (NEPSY) [29]
	Digit span backward (WISCR) [30]
	Map search (TeaCh — selective attention) [31]
Language	Word generation (NEPSY) [29]
	Comprehension of instructions (NEPSY) [29]
Memory	
Auditory	Narrative memory (NEPSY) [29]
	Digit span forward (WISCR) [30]
Visuospatial	Corsi block tapping [32]
School achievement	Math (WRAT3 — expanded) [33]
Intelligence	Raven's Coloured Progressive Matrices [34]

2.4. Neuropsychology test panel

All children underwent a series of cognitive tests selected to evaluate attention and executive function, language, memory, mathematics abilities, and intelligence. The origins of these tests are shown in Table 1. Raven's progressive matrices, a test of nonverbal reasoning ability, was used to assess intelligence instead of a full IQ test as otherwise the session would have been too long. The digit span backward (WISCR), map search (TeaCh — selective attention), digit span forward (WISCR), Corsi block tapping, math (WRAT3 — expanded), and Raven's Coloured Progressive Matrices utilized in this study have been modified for use in previous Jamaican studies [35,36]. The other tests were highly correlated with the Raven IQ test (lowest: 0.3–highest: 0.7, <0.05) and were not correlated with physical functioning measured from a quality-of-life instrument.

All evaluations were conducted at the children's school on one occasion. The evaluation lasted approximately 75 min and was not performed if the child had a seizure in the previous 72 h. A single trained tester, blind to the disease status of each child, performed all neuropsychology evaluations.

2.5. Parent/caregiver interview

The mother/female caregiver of the cases and controls was interviewed in the clinic or in a place of their convenience to obtain information on demographics, the child's education, and medical history. Questions from the Middle Childhood HOME inventory [37], which is a descriptive profile that yields a systematic assessment of the caring environment in which the child is reared, were also administered. The HOME has been modified for use in Jamaica [38] and has been used previously in several Jamaican studies. A socioeconomic status score was calculated by factor analysis using the number of household possessions out of a maximum of 16, crowding (number of persons per habitable room), and sanitation (type of toilet facility and water supply). Consent from parents and assent from the children were obtained before all assessments. Ethical approval was obtained from the University of the West Indies Ethics Committee and the South East Regional Health Authority, Jamaica.

2.6. Statistical analysis

The characteristics of the cases and controls were compared using the Student t-test for normally distributed data and the Mann–Whitney test for data which were not normally distributed. Random effects regression models using the matched pair as the cluster were used to examine the relationship between the measures of cognition and epilepsy status. Adjustment for the home environment and socioeconomic status (SES) was performed, and interaction terms with these variables were used in models. Data were analyzed using Stata 10.0 (StataCorp, Texas).