RESEARCH PAPER

Comprehensive Clinical Profile, Risk Factors, and Seizure Patterns Across Different Age Groups: A Narrative Review

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ABSTRACT

Epilepsy is a heterogeneous neurological disorder characterized by a persistent predisposition to generate epileptic seizures, with clinical expression strongly influenced by age, brain maturation, comorbidity, etiology, and environmental or treatment-related precipitants. This narrative review synthesizes the clinical profile, major risk factors, seizure semiology, etiological patterns, diagnostic considerations, and management implications across four clinically useful age groups: neonates/infants, children/adolescents, adults, and older adults. Neonatal seizures frequently have acute symptomatic causes and may be electrographic-only, whereas childhood epilepsy includes genetic, developmental, structural, infectious, metabolic, and unknown etiologies and often presents with age-specific electroclinical syndromes. In adults, focal seizures and focal-to-bilateral tonic-clonic seizures are common, with structural lesions, cerebrovascular disease, tumors, trauma, infections, and metabolic disturbances representing important etiologies. In older adults, cerebrovascular disease, neurodegenerative disorders, tumors, and structural brain disease become increasingly prominent, while subtle focal impaired-consciousness seizures may be misdiagnosed as syncope, transient confusion, or behavioral change. Across the lifespan, careful history taking, witness/video information, seizure semiology, EEG, appropriate neuroimaging, laboratory assessment, etiological classification, and individualized antiseizure medication selection are central to accurate care. The review highlights the need for prospective, age-stratified observational studies using standardized definitions and outcomes to clarify differences in seizure patterns, risk factors, treatment response, and quality of life.

Keywords:epilepsy; seizures; seizure semiology; age groups; risk factors; EEG; neuroimaging; antiseizure medications; pediatric epilepsy; geriatric epilepsy.

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1. INTRODUCTION

Epilepsy affects people across the entire lifespan and represents an important cause of neurological morbidity, injury, disability, and psychosocial burden. The World Health Organization estimates that around 50 million people worldwide live with epilepsy and emphasizes that a substantial proportion could become seizure-free with appropriate diagnosis and treatment [1,2]. The disorder is not a single disease; rather, it encompasses multiple seizure types, epilepsy types, electroclinical syndromes, and etiologies. The International League Against Epilepsy (ILAE) classification therefore recommends a multilevel approach beginning with seizure type, followed by epilepsy type and syndrome, while considering etiology throughout the diagnostic process [3,4].

Age is a major determinant of epilepsy phenotype. Brain maturation in neonates and young children produces seizure manifestations that differ from those observed in adults. Childhood and adolescence are characterized by distinctive developmental and genetic epilepsies, while adult-onset epilepsy is increasingly associated with acquired structural and systemic disorders. In later life, cerebrovascular disease, neurodegeneration, tumors, and multimorbidity contribute substantially to seizure risk, and atypical or subtle manifestations may delay recognition [5–7].

A lifespan-oriented clinical framework is therefore valuable for both research and practice. The present review summarizes age-specific clinical features, seizure patterns, risk factors, diagnostic strategies, treatment considerations, and areas requiring further prospective investigation.

2. SCOPE AND REVIEW METHODOLOGY

This article was prepared as a narrative review using major guidance and peer-reviewed literature concerning epilepsy classification, epidemiology, seizure semiology, risk

factors, EEG, neuroimaging, drug-resistant epilepsy, and age-specific management. Priority was given to ILAE position papers, WHO guidance, systematic reviews, major epidemiological studies, and clinically relevant reviews. Literature was considered across neonatal, pediatric, adult, and older-adult populations. The synthesis is intended to provide a framework for designing a prospective observational study; it does not report original patient-level data and therefore should not be interpreted as a completed prospective clinical study.

3. EPILEPSY: DEFINITION AND CLASSIFICATION

The ILAE practical definition considers epilepsy to be present when there are at least two unprovoked seizures occurring more than 24 hours apart, one unprovoked seizure with a sufficiently high predicted recurrence risk, or an epilepsy syndrome [8]. Seizures are transient occurrences of signs and/or symptoms caused by abnormal excessive or synchronous neuronal activity. The 2017 ILAE framework classified seizures according to focal, generalized, or unknown onset, with expanded descriptors based on clinical manifestations [4].

Importantly, the ILAE published an updated seizure classification in 2025. The updated framework retains four principal classes—focal, generalized, unknown whether focal or generalized, and unclassified—and emphasizes classifiers and descriptive features, consciousness, observable manifestations, and the chronological sequence of seizure manifestations [9]. Neonatal seizures are addressed separately because their electroclinical characteristics differ substantially from those of older children and adults [10].

4. AGE-SPECIFIC CLINICAL PROFILE AND SEIZURE PATTERNS

4.1 Neonates and Infants (0–2 years)

Neonatal seizures are neurologically distinctive and frequently arise from acute brain injury or metabolic disturbance rather than established epilepsy. Important causes include hypoxic-ischemic encephalopathy, intracranial hemorrhage, ischemic stroke, central nervous system infection, congenital brain abnormalities, and metabolic abnormalities. Seizures may be subtle, focal, sequential, autonomic, tonic, clonic, myoclonic, or epileptic spasms, and many neonatal seizures have an electrographic component without an obvious clinical correlate [10].

In infants, epileptic spasms and early developmental epileptic encephalopathies become important diagnostic considerations. Abnormal development, regression, abnormal tone, recurrent stereotyped events, and clusters of brief movements warrant careful assessment. Video-EEG is particularly important when clinical manifestations are subtle or when nonepileptic movements are possible. Etiological investigation may include neuroimaging, metabolic testing, infectious evaluation, and genetic assessment according to clinical presentation.

4.2 Children and Adolescents (3–18 years)

Childhood and adolescence encompass a wide spectrum of epilepsy syndromes. Absence seizures may present as brief staring episodes with rapid recovery, while focal seizures may include sensory, autonomic, cognitive, emotional, or motor manifestations. Generalized tonic-clonic and myoclonic seizures are also encountered. Developmental and epileptic encephalopathies may present with seizures accompanied by developmental slowing, intellectual disability, behavioral abnormalities, or regression [11].

Etiologies include genetic factors, developmental malformations, structural brain lesions, previous central nervous system infection or injury, metabolic disorders, and unknown causes. Age at onset, seizure type, EEG pattern, neurological examination, developmental status, and family history should be integrated rather than interpreted in isolation. Adolescence also introduces practical risk factors such as sleep restriction, missed medication, psychosocial stress, alcohol or recreational substance exposure, and changing routines.

4.3 Adults (19–64 years)

Adult epilepsy displays marked etiological diversity. Focal seizures are common and may produce motor, sensory, autonomic, emotional, cognitive, or behavioral manifestations; focal seizures may progress to bilateral tonic-clonic seizures. Structural causes include traumatic brain injury, brain tumors, cortical malformations, vascular lesions, and sequelae of infection. Metabolic disturbances, autoimmune disorders, genetic epilepsies, and unknown etiologies also contribute.

Adult patients should be assessed for seizure precipitants and potentially reversible factors, including medication nonadherence, sleep deprivation, alcohol exposure, acute illness, metabolic abnormalities, and interacting medications. However, reported precipitants should be distinguished from established etiological risk factors because a trigger may precipitate a seizure without being the underlying cause of epilepsy [12–14].

4.4 Older Adults (≥65 years)

Epilepsy in older adults is increasingly important as populations age. The epidemiology differs from younger adults, with cerebrovascular disease becoming a leading acquired cause and neurodegenerative disease, brain tumors, head injury, and other structural lesions contributing substantially [5,6]. Focal seizures, particularly focal impaired-consciousness seizures, are common and may manifest as brief confusion, behavioral arrest, speech disturbance, wandering, or unexplained falls rather than dramatic convulsions.

Diagnosis may be challenging because seizure manifestations overlap with syncope, transient ischemic events, delirium, movement disorders, and cognitive fluctuations. Treatment is further complicated by polypharmacy, renal or hepatic impairment, drug interactions, frailty, fall risk, cognitive vulnerability, and comorbid disease. Individualized therapy, low starting

doses, cautious titration, interaction review, and attention to tolerability are particularly important [15,16].

5. Major Risk Factors Across the Lifespan

Age group	Major risk factors / etiologies	Typical clinical clues	Key investigations
Neonates/infants	Perinatal hypoxia, prematurity, hemorrhage, stroke, infection, metabolic disease, congenital malformations, genetic disorders	Subtle motor/autonomic events, apnea, spasms, developmental concerns	Continuous/video EEG, MRI, metabolic/infectious/genetic testing as indicated
Children/adolescents	Genetic syndromes, developmental disorders, structural lesions, prior CNS injury/infection, metabolic disease	Absence, focal, myoclonic, generalized tonic-clonic seizures; school/developmental effects	EEG, MRI when indicated, developmental and genetic evaluation
Adults	Stroke/vascular disease, tumor, trauma, infection, structural lesions, metabolic disease, autoimmune/genetic causes	Focal seizures, focal-to-bilateral tonic-clonic seizures, postictal confusion	EEG, epilepsy-protocol MRI, laboratory and etiological work-up
Older adults	Cerebrovascular disease, neurodegeneration, tumors, structural lesions, trauma, metabolic factors, medications	Subtle focal impaired-consciousness events, confusion, falls, focal-to-bilateral tonic-clonic seizures	EEG, MRI/CT when appropriate, medication review, vascular/metabolic assessment

6. SEIZURE SEMIOLOGY AND CLINICAL PATTERN RECOGNITION

Seizure semiology is the structured description of the signs and symptoms occurring during an event. It includes motor manifestations, sensory symptoms, autonomic features, behavioral arrest, cognitive or emotional symptoms, awareness or consciousness changes, progression, duration, postictal manifestations, and recovery. The first observable manifestation may provide localization clues, but the complete temporal sequence is essential for modern classification [4,9].

Focal seizures can produce highly variable manifestations depending on the cortical networks involved. Temporal lobe seizures may include epigastric sensations, experiential phenomena, fear, behavioral arrest, or automatisms; frontal lobe seizures may be brief, hypermotor, and sometimes predominantly nocturnal; occipital or parietal seizures may produce visual or somatosensory symptoms. Generalized seizures may include absence, myoclonic, tonic, atonic, or tonic-clonic manifestations. In neonates, electrographic-only seizures and sequential patterns require special attention [9,10].

7. COMMON SEIZURE PRECIPITANTS AND MODIFIABLE FACTORS

Potential seizure precipitants include antiseizure medication nonadherence, sleep deprivation, psychological stress, fatigue, fever or infection, alcohol exposure, missed meals, and—in selected patients—hormonal or sensory triggers. A prospective case-crossover study found reduced sleep in the 24 hours preceding seizures, supporting sleep loss as an important precipitating factor [13]. An Indian clinic-based study also reported missed medication, emotional stress, sleep deprivation, and fatigue among commonly perceived triggers [14].

These factors should be recorded systematically in prospective studies. A useful case-record form should distinguish chronic risk factors (for example, prior stroke or structural lesion) from proximal precipitants (for example, missed dose or sleep deprivation). This distinction improves causal interpretation and avoids labeling a transient trigger as the underlying etiology.

8. Diagnostic Evaluation

Diagnosis begins with a detailed history obtained from the patient and witnesses. Key variables include age at first seizure, precipitating circumstances, aura or initial symptom, sequence of manifestations, duration, level of consciousness, motor features, autonomic signs, tongue injury, incontinence, injuries, postictal confusion, recovery time, family history, developmental history, previous neurological disease, medication exposure, and potential triggers. Home video recordings can be highly informative when available.

EEG supports seizure classification and identification of interictal epileptiform abnormalities, but a normal routine EEG does not exclude epilepsy. Prolonged or video-EEG monitoring is useful when events are frequent, the diagnosis is uncertain, or electroclinical correlation is required. Neuroimaging is central to etiological evaluation; the ILAE Neuroimaging Task Force recommends structural MRI as a key investigation in new-onset epilepsy and describes epilepsy-focused MRI protocols for lesion detection [17]. Laboratory testing should be guided by age and clinical context and may include glucose, electrolytes, calcium, renal and hepatic parameters, toxicology, infection studies, metabolic investigations, or autoimmune/genetic testing.

9. MANAGEMENT CONSIDERATIONS ACROSS AGE GROUPS

Management is individualized according to seizure type, epilepsy type or syndrome, etiology, age, comorbidity, reproductive considerations, drug interactions, adverse-effect profile, patient preference, and access to care. Antiseizure medication (ASM) therapy is the mainstay for many patients. WHO guidance supports selection according to seizure type and patient characteristics; for generalized-onset seizures, lamotrigine or levetiracetam are important first-line options in women and girls of childbearing potential, while valproate requires particular caution because of fetal risks [18].

In children, medication choice should account for syndrome specificity, developmental effects, behavioral adverse effects, and school functioning. In adults, comorbidity and occupational considerations are important. In older adults, treatment generally requires careful attention to pharmacokinetics, polypharmacy, renal function, falls, cognition, and tolerability; recent reviews emphasize individualized selection and cautious titration [15,16].

Drug-resistant epilepsy is traditionally defined by failure of adequate trials of two appropriately selected and tolerated ASM regimens to achieve sustained seizure freedom [19]. Such patients should be evaluated promptly for specialized epilepsy-center care, including video-EEG, advanced imaging, epilepsy surgery assessment, neuromodulation, and dietary or other adjunctive therapies when appropriate [20,21].

10. COMPLICATIONS AND QUALITY-OF-LIFE CONSIDERATIONS

Epilepsy affects more than seizure frequency. Recurrent seizures can cause falls, fractures, burns, aspiration, road and occupational injuries, cognitive difficulties, anxiety, depression, social restriction, educational disruption, employment problems, and stigma. The risk of premature death is increased, and sudden unexpected death in epilepsy (SUDEP) remains an important counseling and research issue [1,22]. Age modifies these outcomes: developmental and educational effects may be particularly important in children, occupational and reproductive concerns in adults, and falls, cognitive impairment, and medication interactions in older adults.

11. ROLE OF A PROSPECTIVE OBSERVATIONAL STUDY

For a prospective observational study using this review as its scientific background, consecutive or systematically sampled patients can be stratified into neonates/infants, children/adolescents, adults, and older adults. Baseline variables should include demographic characteristics, age at seizure onset, family history, developmental history, comorbidities, etiological factors, seizure type, frequency, duration, precipitating factors, EEG findings, neuroimaging, laboratory results, ASM regimen, adherence, adverse effects, hospitalization, and seizure outcomes.

Follow-up should use predefined intervals—for example, baseline, 3 months, 6 months, and 12 months—depending on the study objective. Primary outcomes may include seizure type distribution, seizure frequency, seizure freedom, and etiological category. Secondary outcomes may include emergency visits, injuries, medication adherence, adverse drug reactions, quality of life, cognitive or developmental measures, and treatment changes. Age-stratified analyses and multivariable models can identify independent predictors of seizure recurrence or poor control.

Standardized definitions are essential. The study protocol should specify how epilepsy is diagnosed, how seizure types are classified, how seizure frequency is recorded, what constitutes medication adherence, how drug resistance is defined, and how missing follow-up data are handled. Such standardization would improve comparability across age groups and strengthen the clinical relevance of the findings.

12. RESEARCH GAPS AND FUTURE DIRECTIONS

Several gaps remain. First, neonatal and geriatric epilepsy are often underrepresented in conventional epilepsy cohorts, despite distinct diagnostic and treatment challenges. Second, real-world prospective studies frequently use inconsistent definitions of seizure types, drug resistance, adherence, and treatment response. Third, the relationship between chronic etiological risk factors and short-term precipitants is not always clearly separated. Fourth, older adults with multimorbidity and polypharmacy require more age-specific comparative evidence for newer ASMs [15,16].

Future studies should incorporate standardized ILAE terminology, structured seizure diaries, caregiver or witness reports, video-EEG where clinically justified, epilepsy-protocol MRI, systematic medication-adherence assessment, and validated quality-of-life measures. Multicenter prospective cohorts would be particularly valuable for determining how age, etiology, seizure semiology, treatment exposure, and comorbidity interact to influence seizure control.

13. CONCLUSION

Clinical presentation, seizure semiology, etiological profile, and treatment priorities vary substantially across the

lifespan. Neonates commonly present with acute symptomatic and sometimes electrographic-only seizures; children and adolescents show a broad spectrum of genetic, developmental, structural, and syndrome-specific epilepsies; adults frequently demonstrate focal and focal-to-bilateral seizures associated with diverse structural and systemic causes; and older adults have a particularly high burden of acquired structural and vascular etiologies with subtle seizure manifestations and complex treatment considerations. A standardized age-stratified clinical framework combining history, semiology, EEG, neuroimaging, etiological evaluation, and individualized treatment can improve diagnostic accuracy and outcomes. Prospective observational research using harmonized definitions and longitudinal follow-up can further clarify age-dependent patterns, risk factors, treatment response, and quality-of-life outcomes.

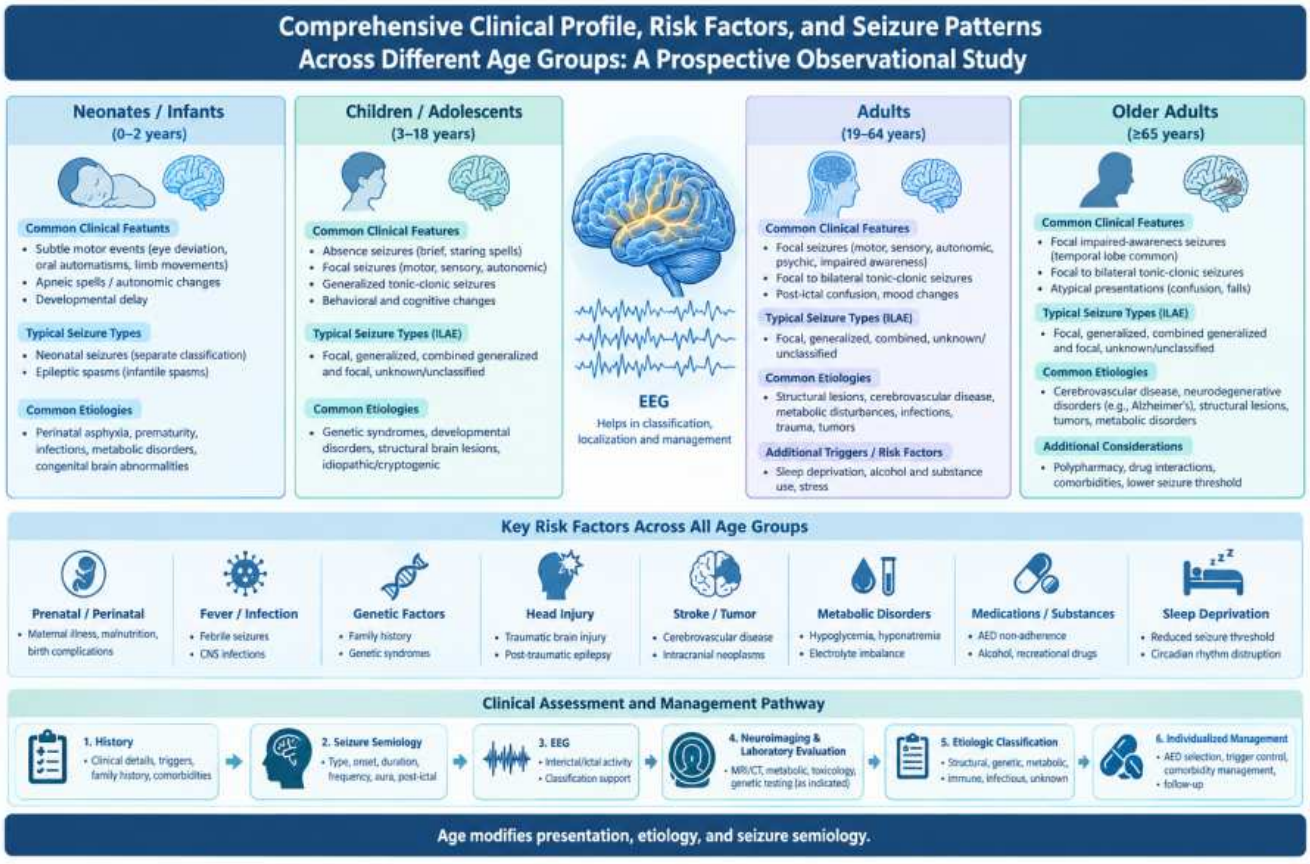


Figure 1. Age-stratified clinical profile, risk factors, seizure patterns, and clinical assessment pathway

Schematic overview of major age-specific clinical features, seizure patterns, etiologies, cross-cutting risk factors, and the diagnostic/management pathway.

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