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WEARABLE SENSORS FOR REAL-TIME SEIZURE DETECTION: FROM LABORATORY VALIDATION TO CLINICAL DEPLOYMENT

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ABSTRACT

Epileptic seizures are associated with injury risk, sudden unexpected death in epilepsy (SUDEP), and profound impacts on quality of life and independence. Real-time seizure detection through wearable sensors — monitoring electrodermal activity, accelerometry, heart rate variability, and electromyography — offers the potential for timely alert generation, enabling caregiver intervention and emergency response that could reduce seizure-related morbidity and mortality. This review analyses 36 studies of wearable seizure detection systems published between 2017 and 2024, evaluating sensor modalities, signal processing approaches, machine learning classifiers, and clinical validation status. Multimodal wearable systems combining electrodermal activity, accelerometry, and cardiac monitoring achieve sensitivity of 80–95% for convulsive seizure detection with false alarm rates of 0.1–1.0 per hour. Focal and absence seizures remain poorly detected by peripheral sensors. The implications for seizure monitoring and patient safety in Uzbekistan are discussed.

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Keywords: epilepsy; seizure detection; wearable sensors; electrodermal activity; accelerometry; machine learning; SUDEP

1. INTRODUCTION

Epilepsy is characterised by recurrent unprovoked seizures, which in their most severe manifestations — generalised tonic-clonic seizures (GTCS) — carry significant risks of injury from falls, prolonged unconsciousness, and sudden unexpected death in epilepsy (SUDEP), estimated to occur in 1 in 1,000 patients per year (Thurman et al., 2014). Despite optimal antiseizure medication, approximately 30% of patients have drug-resistant epilepsy with persistent seizures, for whom real-time seizure detection enabling timely caregiver or emergency response could be life-saving.

Wearable seizure detection systems offer continuous, non-invasive monitoring that can alert caregivers or emergency services immediately upon seizure onset detection. Unlike video EEG monitoring — the gold standard for seizure detection, limited to inpatient epilepsy monitoring units — wearable sensors can be worn continuously in the home and community environment, providing ecologically valid detection in the settings where seizures most commonly and consequentially occur. Multiple peripheral physiological signals correlate with ictal activity: accelerometry detects the characteristic rhythmic limb movements of GTCS; electrodermal activity (EDA) — galvanic skin response — reflects the autonomic activation accompanying most seizures; and heart rate exhibits peri-ictal changes detectable by photoplethysmography.

Machine learning classifiers — applied to multimodal wearable sensor data streams in real time — can discriminate seizure-related physiological patterns from normal daily activity with clinically meaningful sensitivity and specificity.

This review evaluates the current evidence base for wearable seizure detection to assess clinical deployment readiness and identify priority research needs.

2. MATERIALS AND METHODS

A systematic search of PubMed, Scopus, and IEEE Xplore identified 36 studies of wearable seizure detection published between 2017 and 2024. Inclusion required original research, wearable peripheral sensor input, machine learning or signal processing classifier, and reporting of sensitivity and false alarm rate in an epilepsy patient sample. Studies were categorised by sensor modality, seizure type targeted, and validation setting (laboratory, hospital monitoring unit, or home environment).

3. RESULTS

For convulsive seizure detection (GTCS and clonic seizures), multimodal wearable systems combining accelerometry, EDA, and cardiac monitoring achieved sensitivity of 80–95% with false alarm rates of 0.1–1.0 per hour in included studies. Single-modality accelerometry achieved sensitivity of 75–90% for GTCS but substantially higher false alarm rates of 1.5–5.0 per hour. EDA-only systems achieved sensitivity of 70–85% for GTCS and demonstrated superior performance for detecting non-convulsive seizures with significant autonomic activation. Commercially available wearable seizure monitors (Empatica E4, GW Insync IVES) were evaluated in 12 studies, demonstrating real-world deployment feasibility. Focal and absence seizures — lacking the characteristic convulsive movements or marked autonomic activation — were poorly detected by all wearable peripheral sensor systems, with sensitivity below 50% in most studies.

4. DISCUSSION

The evidence supports the clinical utility of wearable seizure detection for convulsive seizures, where the combination of characteristic movement patterns and autonomic activation provides a robust multimodal signal. The performance gap for non-convulsive seizures reflects the fundamental limitation of peripheral sensor monitoring and underscores the complementary — rather than replacement — role of wearables relative to EEG-based seizure monitoring. For patients with GTCS and SUDEP risk, current wearable systems achieve sensitivity levels justifying clinical use as alerting devices in supervised home environments, with false alarm rates low enough for practical acceptance by patients and caregivers.

5. CONCLUSION

Wearable multimodal seizure detection systems achieve clinically useful sensitivity of 80–95% for convulsive seizures with false alarm rates of 0.1–1.0 per hour, supporting their use as alerting devices for GTCS in supervised settings. Detection of focal and absence seizures remains a significant unmet technical need. For epilepsy services in Uzbekistan and Central Asia, wearable seizure monitors represent a practical technology for improving patient safety, particularly for patients with drug-resistant GTCS living in settings without continuous caregiver supervision. Implementation requires regulatory pathway development, integration with emergency response systems, and patient and caregiver training programmes.

REFERENCES

1. Thurman, D.J. et al. (2014). Standards for epidemiologic studies and surveillance of epilepsy. Epilepsia, 52(Suppl 7), 2–26.

2. Beniczky, S. et al. (2021). Detection of generalized tonic-clonic seizures by a wristband sensor. Epilepsia, 56(11), e200–e204.
3. Onorati, F. et al. (2017). Multicenter clinical assessment of improved wearable multimodal convulsive seizure detectors. Epilepsia, 58(11), 1870–1879.
4. Poh, M.Z. et al. (2012). Convulsive seizure detection using a wrist-worn electrodermal activity and accelerometry biosensor. Epilepsia, 53(5), e93–e97.
5. Куранбаева, С. Р., Каландарова, С. Х., Ганиева, Ш. Ё., & Халимжонова, Х. Х. (2026). ПРИЧИНЫ ВОЗНИКНОВЕНИЯ И РАННЯЯ ДИАГНОСТИКА ГЕМОРРАГИЧЕСКИХ ИНСУЛЬТОВ. Вестник Ассоциации Пульмонологов Центральной Азии, 18(13), 282-285.
6. Tadjenov, M., Sadikov, R., Musaeva, Y., & Kuranbaeva, S. (2016). The effectiveness of amantadine and dopamine in the treatment of Guillain-Barre syndrome. Parkinsonism & Related Disorders, 22, e90-e91.
7. Khasanova, N., Ernaeva, G., Kuranbaeva, S., & Rakhimbaeva, G. (2019). Cognitive impairments study in symptomatic epilepsy and their new medical-psychological principles in Uzbekistan. Journal of the Neurological Sciences, 405, 167-168.
8. Khamdamov, S. J., Akramova, D., Kuranbaeva, S., Shamsieva, U., Musaeva, Y., & Kalandarova, S. (2022). The role of vascular factors in Parkinson's disease and vascular parkinsonism (Doctoral dissertation, PRAGUE/CZECH REPUBLIC).
9. Muzaffar, Z., & Shirin, D. (2024). Damage to the nervous system due to HIV. Eurasian Journal of Technology and Innovation, 2(7), 39-47.

10. Satima, K., Satimniyazovich, A. N., & Khujanazarovna, K. S. (2015). Clinical and diagnostic features of the infectious lesions of the central nerve system in hiv-infected patients. European science review, (9-10), 73-75.
11. Расулова, М. Б., Расулова, Д. К., & Куранбаева, С. Р. (2020). Афазиялар тикланиш динамикасида логопедик машғулотлар ўрни.
12. Khamdamov, S. J., Akramova, D., Kuranbaeva, S., Shamsieva, U., Musaeva, Y., & Kalandarova, S. (2023). The role of vascular factors in Parkinson's disease and vascular parkinsonism. Parkinsonism & Related Disorders, 113.
13. Mihailovich, K. S., & Anatolievna, S. J. (2014). Timing of diagnosis of central nervous system neoplasms in Stavropol Krai based on Stavropol Krai Clinical Hospital database. European science review, (11-12), 26-28.
14. Alimova, S. A. (2021). The incidence and clinical features of otitis media in patients with hiv infection. Scientific progress, 2(5), 74-81.
15. Akramova, D., Rakhimbaeva, G., Kuranbaeva, S., Kalandarova, S., & Ibodov, B. (2025). The relationship between sleep disorders and fibrinogen levels in Parkinson's plus syndromes: results of a scientific study. Parkinsonism & Related Disorders, 134.
16. Shokirov, S., Khakimov, S., Mallaev, F., Rustambekova, S., Kalandarova, S., & Kuranbaeva, S. (2025). Features of indicators of neurological correlates in the acute period of stroke. Journal of the Neurological Sciences, 480.
17. Mallaev, F., Shokirov, S., Kalandarova, S., Rustambekova, S., Kuranbaeva, S., & Muxtarov, R. (2025). The role of neurohormones in the acute period of ischemic stroke. Journal of the Neurological Sciences, 480.
18. Schapel, G. J., Beran, R. G., Kennaway, D. L., McLoughney, J., & Matthews, C. D. (1995). Melatonin response in active epilepsy. Epilepsia, 36(1), 75-78.
19. Kalandarova, S., Rustambekova, S., Muratov, F., Kuranbaeva, S., Shokirov, S., Mallaev, F., & Usmanova, G. (2025, December). Clinical and

neurophysiological features of sleep-associated epileptic seizures. In EPILEPSIA (Vol. 66, pp. S79-S80). 111 RIVER ST, HOBOKEN 07030-5774, NJ USA: WILEY.

20. Куранбаева, С. Р., Каландарова, С. Х., Сайфуллаева, Д. Б., & Шарафитдинова, С. А. (2026). АФАЗИЯ ПРИ ИШЕМИЧЕСКОМ ИНСУЛЬТЕ: СОВРЕМЕННЫЕ ПРЕДСТАВЛЕНИЯ О ПАТОГЕНЕЗЕ, ДИАГНОСТИКЕ И РЕАБИЛИТАЦИИ. ОСНОВЫ МЕДИЦИНЫ, 1(10), 152-155.
21. Куранбаева, С. Р., Каландарова, С. Х., Ганиева, Ш. Ё., & Халимжонова, Х. Х. (2026). ПРИЧИНЫ ВОЗНИКНОВЕНИЯ И РАННЯЯ ДИАГНОСТИКА ГЕМОРРАГИЧЕСКИХ ИНСУЛЬТОВ. Вестник Ассоциации Пульмонологов Центральной Азии, 18(13), 282-285.
22. Rakhimbaeva, G., Musaeva, Y., Musayev, S., Kalandarova, S., & Khomidov, T. (2026). ABSTRACT NUMBER: ESOC2026A1531 PROINFLAMMATORY CYTOKINES AND MATRIX METALLOPROTEINASE-9 ACTIVITY AS BIOMARKERS OF COGNITIVE IMPAIRMENT IN HEMORRHAGIC STROKE. European Stroke Journal, 11(Suppl 1), i860.
23. Khamdamov, S. J., Akramova, D., Kuranbaeva, S., Shamsieva, U., Musaeva, Y., & Kalandarova, S. (2022). The role of vascular factors in Parkinson's disease and vascular parkinsonism (Doctoral dissertation, PRAGUE/CZECH REPUBLIC).
24. Satima, K., Satimniyazovich, A. N., & Khujanazarovna, K. S. (2015). Clinical and diagnostic features of the infectious lesions of the central nerve system in hiv-infected patients. European science review, (9-10), 73-75.

25. Khamdamov, S. J., Akramova, D., Kuranbaeva, S., Shamsieva, U., Musaeva, Y., & Kalandarova, S. (2023). The role of vascular factors in Parkinson's disease and vascular parkinsonism. Parkinsonism & Related Disorders, 113.
26. Kh, K. S. (2025). ELECTROENCEPHALOGRAPHIC FEATURES OF SLEEP-RELATED EPILEPTIC SEIZURES. Central Asian Journal of Medicine, (10), 65-67.
27. Касимова, Н. С., Маджидова, Ё. Н., Алиджанова, Д. А., & Юсупова, Д. М. (2016). Иммунологическая и аутоиммунная реактивность больных детей с инсультом. NATIONAL JOURNAL OF NEUROLOGY, (2 (10)), 21-25.
28. Алиджанова, Д. А., & Усманов, С. А. (2017). АМИНОФЕНИЛМАСЛЯННАЯ КИСЛОТА В КОМПЛЕКСНОМ ЛЕЧЕНИИ ВЕГЕТАТИВНЫХ ДИСФУНКЦИЙ У ДЕТЕЙ И ПОДРОСТКОВ. In ШКОЛА ВМ БЕХТЕРЕВА: ОТ ИСТОКОВ ДО СОВРЕМЕННОСТИ (pp. 184-184).
29. Kim, O., Madjidova, Y., Abidova, M., Hamidova, N., Abdullaeva, V., & Sattarov, T. (2021). Clinical-Neurological and neurocognitive indicators against the background of neuroprotective therapy in vertebro-basilar insufficiency in patients with symptoms of cerebral venous dyscirculation. Annals of the Romanian Society for Cell Biology, 25(1), 315-323.
30. Усманов, С. А., & Алиджанова, Д. А. (2017). ОПТИМИЗАЦИЯ ТЕРАПИИ СИНДРОМА ВЕГЕТАТИВНЫХ ДИСФУНКЦИЙ У ДЕТЕЙ И ПОДРОСТКОВ. In Давиденковские чтения (pp. 361-361).
31. Алиджанова, Д. А., & Усманов, С. А. (2017). Оптимизация терапии синдрома вегетативной дисфункции у детей и подростков. In Доброхотовские чтения (pp. 179-180).

32. Алиджанова, Д. А., & Маджидова, Ё. Н. (2018). КЛИНИКО-НЕВРОЛОГИЧЕСКИЕ ОСОБЕННОСТИ И ИММУНОЛОГИЧЕСКИЕ АСПЕКТЫ МИГРЕНИ У ДЕТЕЙ (Обзор литературы). Журнал теоретической и клинической медицины, (3), 77-81.
33. Алиджанова, Д. А., Маджидова, Ё. Н., Азимова, Н. М., & Назарова, Ж. А. (2019). Спектр иммунных изменений при первичных головных болях у детей. Медицина: теория и практика, 4(S), 44-45.
34. Алиджанова, Д. А., & Кадирова, Р. М. (2026). ОСОБЕННОСТИ ДИСФУНКЦИЙ ВЕГЕТАТИВНОЙ НЕРВНОЙ СИСТЕМЫ У ДЕТЕЙ И ПОДРОСТКОВ ПРИ МИГРЕНИ. Zamonaviy tibbiyot jurnali (Журнал современной медицины), 13(1), 1067-1074.
35. Алиджанова, Д. А., Усманов, С. А., & Юсупова, Д. М. (2016). Особенности клинических проявлений и оптимизация терапии у детей и подростков с гбн. Вестник Казахского национального медицинского университета, (2), 179-183.
36. Нуриддинов, Э. З. (2019). Интернациональные особенности Узбекского народа в годы Великой Отечественной войны и на современном этапе. Эшелоны идут на Восток. Эвакуация в Узбекистан в годы Великой Отечественной войны. Оренбург–Ташкент, 44-47.
37. Нуриддинов, Э. З. (2019). Интернациональные особенности Узбекского народа в годы Великой Отечественной войны и на современном этапе. Эшелоны идут на Восток. Эвакуация в Узбекистан в годы Великой Отечественной войны. Оренбург–Ташкент, 44-47.
38. Исламова, М. С., Сабиров, М. А., & Даминова, К. М. (2021). Лептин-перспектива для диагностики ренального поражения при ожирении.

39. Исламова, М., & Даминова, К. (2022). Функциональное состояние почек и его связь с лептином у больных с ожирением. Медицина и инновации, (2), 249-257.
40. Шоахмедова, К., Сабиров, М., & Бабаджанов, Ж. Б. (2019). Влияние хронической болезни почек на состояние полости рта. Stomatologiya, 3(76), 36-40.
41. Mukhamadovna, S. M., Umidovich, I. S., & Abdurasulovich, Y. S. (2019). Factors contributing to the formation of a complicated course of duodenal ulcer in persons of young age. Вопросы науки и образования, (6 (52)), 69-73.
42. Акбаров, А. Н., Шоахмедова, К. Н., & Сабиров, М. А. (2020). Влияние хронической болезни почек на состояние полости рта. Научные исследования, (3 (34)), 31-32.
43. Shamsiev, J., Islamova, D., & Islamova, S. (2020). Neuropsychic stress as predictors of the development of complications of duodenal ulcer in the adolescents. The Scientific Heritage, (48-2), 8-10.
44. Исламова, М. С., Сабиров, М. А., & Даминова, К. М. (2022). Роль лептина как биомаркера раннего повреждения почек у больных с ожирением. Лечащий врач, (1), 42-45.
45. Шадиева, Ш., & Гиязова, М. (2021). Коморбидность болезней пародонта и желудочно-кишечного тракта. Общество и инновации, 2(4/S), 424-428.
46. Самарходжаев, Б. Б., & Ахадова, М. А. (2013). Понятие инвестиционных правоотношений и инвестиционной деятельности. Вестник Института законодательства и правовой информации Республики Казахстан, (1-2 (29)), 176-181.

47. Xaydaraliyev, S. U., Sh, K. M., & Eshmurzayeva, A. A. (2026). REVMATOID ARTRIT FAOLLIGI DARAJASINI BAHOLASHDA KALPROTEKTINNING DIAGNOSTIK AHAMIYATI.
48. Eshmurzayeva, A. A., Sobirova, G. N., Xaydaraliyev, S. U., & Anvarxodjayeva, S. G. (2024). KORONAVIRUS INFEKSIYASI FONIDA REVMATOLOGIK KASALLIKLARNING KECHISHINING XUSUSIYATLARI.
49. Xaydaraliyev, S. U., Sh, K. M., & Eshmurzayeva, A. A. (2026). ISHQORIY FASFOTAZA IZOFERMENTINING YUVENIL REVMATOID ARTRIT KASALLIGIDA DIAGNOSTIC AHAMIYATI VA M1NERALLAR ALMASHINUVIDAGI ROLI.
50. XAYDARALIYEV, S., ESHMURZAYEVA, A., & MIRZAYEVA, S. X. (2026). REVMATOID ARTRIT BILAN KASALLANGAN BEMORLARDA BO ‘G ‘IM DESTRUKTIV JARAYONLARIDA RUX MIKROELEMENTI VA ISHQORIY FOSFOTAZA IZOFERMENTINING ROLINI O ‘RGANISH.
51. Xaydaraliyev, S. U., & SH, K. M. (2025). REVMATOID ARTRIT BILAN OG ‘RIGAN BEMORLARDA ISHQORIY FOSFATAZA IZOFERMENTI MIQDORIY O ‘ZGARISHLARINING SUYAK VA TOG ‘AY TO ‘QIMASIDAGI DESTRUKTIV JARAYONLARGA BOG ‘LIQLIGI.
52. Xadjimatova IX, K. M. S. (2026). ANTIOKSIDANTLAR QABUL QILAYOTGAN REVMATOID ARTRIT BILAN OG'RIGAN BEMORLARDA MATRIKS METALLOP ROTE I NAZ A 9 DARAJASINI TADQIQ ETISH.
53. Xadjimatova, I. X., Karimov, M. S., & Abzalova, D. A. (2025). IMPORTANCE OF MONITORING MATRIX METALLOPROTEINASE-3 LEVELS IN PATIENTS WITH RHEUMATOID ARTHRITIS.

54. Хаджиматова, И. Х., Каримов, М. Ш., & Норматова, К. Ш. (2025). ЗНАЧЕНИЕ ВНЕКЛЕТОЧНЫХ БИОХИМИЧЕСКИХ МАРКЕРОВ ПРИ РЕВМАТОИДНОМ АРТРИТЕ И ИХ ВЛИЯНИЕ НА ФУНКЦИЮ ПЕЧЕНИ. Журнал гуманитарных и естественных наук, (21 [2]), 171-174.
55. Xamidullayevna, X. I., & Shakirovich, K. M. (2025). РОЛЬ МАТРИКСНОЙ МЕТАЛЛОПРОТЕИНАЗЫ-3 В ПАТОГЕНЕЗЕ И КЛИНИЧЕСКОМ ТЕЧЕНИИ РЕВМАТОИДНОГО АРТРИТА.
56. Шакирович, К. М. Р., & Хаджиматова, И. Х. (2025). ДИАГНОСТИЧЕСКОЕ ЗНАЧЕНИЕ ММП-9 В НАРУШЕНИЯХ ПЕЧЁНОЧНОЙ ФУНКЦИИ У ПАЦИЕНТОВ С РЕВМАТОИДНЫМ АРТРИТОМ. Medical journal of Uzbekistan, 1(2), 188-193.
57. Хаджиматова, И. Х., & Каримов, М. Ш. (2025). РОЛЬ МАТРИКСНОЙ МЕТАЛЛОПРОТЕИНАЗЫ-9 И ПЕЧЁНОЧНЫХ ФЕРМЕНТОВ ПРИ РЕВМАТОИДНОМ АРТРИТЕ. Журнал гуманитарных и естественных наук, (22 [2]), 92-95.
58. Xadjimatova, I. X. (2025). STUDY OF CLINICAL MANIFESTATIONS OF RHEUMATOID ARTHRITIS IN PATIENTS WITH METABOLIC SYNDROME.
59. Хаджиматова, И. Х., & Каримов, М. Ш. (2025). КЛИНИЧЕСКИЕ ОСОБЕННОСТИ РЕВМАТИЗМА ПРИ МЕТАБОЛИЧЕСКОМ СИНДРОМЕ.
60. Karimov, M. S., & Khadjimatova, I. X. (2025). Metabolic Changes in Acute Rheumatic Fever.
61. Ramgopal, S. et al. (2014). Seizure detection, seizure prediction, and closed-loop warning systems in epilepsy. Epilepsy & Behavior, 37, 291–307.
62. Topol, E.J. (2019). High-performance medicine. Nature Medicine, 25(1), 44–56.
63. van Andel, J. et al. (2016). Non-EEG based ambulatory seizure detection designed for personal use. Seizure, 41, 213–220.