

Review article

Synthesis of Clinical Correlations and Implications of the Kurjak Antenatal Neurodevelopment Test (KANET)

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Abstract

Objectives: The Kurjak Antenatal Neurodevelopmental Test (KANET) is a screening tool designed to identify fetuses at risk for neurodevelopmental disorders by assessing fetal motor and behavioral activity through 4D ultrasound. KANET differentiates between normal, borderline, and abnormal fetal behavior, but it cannot be used to diagnose any specific condition. The objective of this review is to synthesize current evidence on the clinical application of KANET and its effectiveness as a screening tool in assessment of fetal neurodevelopment.

Methods: A PubMed search identified 18 relevant studies that evaluated the application of KANET in different maternal risk groups. The studies were analyzed for significant differences in KANET scores between high-risk and low-risk pregnancies.

Results: KANET was effective in distinguishing between normal, borderline, and abnormal fetal behavior in high-risk pregnancies, including those complicated by diabetes, hypothyroidism, and abnormal placental flow. However, KANET is not a diagnostic test and cannot confirm the presence of specific neurological disorders in fetuses from high- and low-risk pregnancies.

Conclusion: KANET is a valuable screening tool for identifying fetuses at risk for neurodevelopmental problems, but further research is needed to refine its use. Importantly, it is not intended to be used as a standalone diagnostic tool for any specific condition.

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Introduction

Neurodevelopmental disorders, which often originate during the fetal period, have significant long-term impacts on children's health [1-4]. Identifying these disorders early can improve outcomes through timely intervention [4]. Genetic factors and environmental influences can adversely affect fetal brain development, potentially leading to conditions like cerebral palsy and other neurological impairments [5]. Prenatal discovery of functional irregularities might be beneficial for disease prevention and early treatment. It might also help resolve certain dilemmas regarding whether impairment occurred because of childbirth or prior to it [6].

The invention of an effective diagnostic method or test that would allow for the early discovery of neurological impairments is of great importance in perinatal medicine. For this purpose, the Kurjak Antenatal Neurodevelopmental Test (KANET) was created. KANET entails the assessment of fetal motor activity via 4D ultrasound examination [7-10]. This motor activity reflects the fetus' nervous and musculoskeletal systems. Certain behavioral patterns and their dynamics over the course of pregnancy provide insight into the development and maturity of the central nervous system [11]. To determine pathological fetal patterns, a comparative baseline had to be created [12].

The KANET scoring system considers several parameters and provides the means to objectively quantitatively assess each fetus and reach conclusions on its well-being [13]. According to the Bucharest consensus statement, KANET has been standardized to assess eight specific parameters in the third trimester of pregnancy [10]. These parameters include:

1. Isolated head anteflexion
2. Cranial sutures and head circumference
3. Eye blinking
4. Facial expressions (grimacing, mouth movements)
5. Isolated leg movements
6. Isolated hand movements
7. General body movements
8. Gestalt perception of general movements

Each category can be scored with 0, 1, or 2 points, with a lower score representing a pathological finding and a higher score representing a physiological finding. The score ranges from 0 to 16 and, depending on the value, a KANET finding can be classified as abnormal (0-5), borderline (6-9), or normal (10-16) [10].

This review aims to explore the application of KANET in different populations of pregnant women and evaluate its effectiveness as a diagnostic tool. By synthesizing findings from various studies, we seek to provide a comprehensive overview of KANET's clinical implications and potential areas for further research.

Materials and methods

A comprehensive search of the PubMed database was conducted using the keyword 'KANET,' with no restrictions on the publication date. The search yielded 33 results, encompassing various types of scientific publications. The selection process involved two primary exclusion criteria: first, articles unrelated to fetal neurodevelopment or those focused on topics such as the Kanet tribe or using 'Kanet' as an author's surname were excluded, reducing the count by eight. Second, review articles were

excluded, further narrowing the selection to 18 studies (Figure 1).

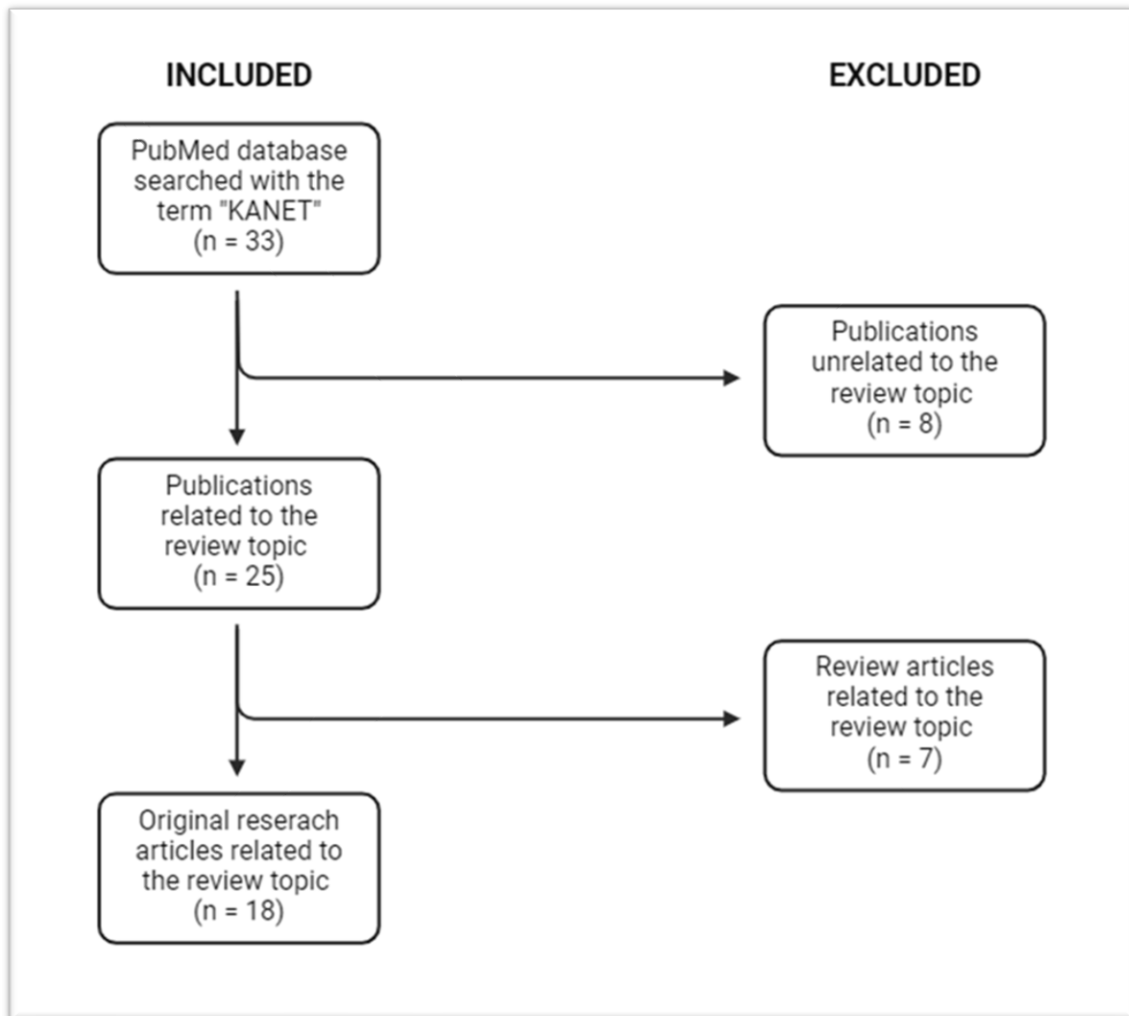


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart for publication selection (created with Biorender.com)

These studies were analyzed based on several factors, including the population studied, the timing of the examination, the statistical significance of the results, and which KANET parameters showed significance. A descriptive general analysis was conducted due to the variability of data across the studies.

Results

The PubMed search and subsequent selection process resulted in the inclusion of 18 studies relevant to the evaluation of KANET scores across different pregnancy populations (Table 1).

Qualitative analysis of the studies in question provided an overview of certain characteristics of the KANET test. Several general observations were made from qualitative parameters (Table 2).

The specific results and conclusions were discussed in depth in the Discussion section.

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Table 1. Studies selected from literature review

Ref. But.	Authors	Title
[14]	Bot M et al.	Monochorionic vs Dichorionic Twins: Kanet Test vs Postnatal Neurodevelopment
[15]	Medjedovic E et al.	Doppler ultrasonography of the uterine artery in correlation with KANET
[16]	Hata T et al.	Prediction of postnatal developmental disabilities using the antenatal fetal neurodevelopmental test: KANET assessment
[17]	Honemeyer U et al.	The clinical value of KANET in studying fetal neurobehavior in normal and at-risk pregnancies
[18]	Hanaoka U et al.	Does ethnicity have an effect on fetal behavior A comparison of Asian and Caucasian populations
[19]	Hata T et al.	Is there a sex difference in the fetus? behavior? A comparison of the KANET test between male and female fetuses
[20]	Talic A et al.	The potential of 4D sonography in the assessment of fetal behavior in high-risk pregnancies
[21]	Antsaklis P et al.	4D assessment of fetal brain function in diabetic patients
[22]	Athanasiadis AP et al.	Neurodevelopmental fetal assessment using the KANET scoring system in low and high-risk pregnancies
[23]	Talic A et al.	The assessment of fetal brain function in fetuses with ventriculomegaly: the role of the KANET test
[24]	Hata T et al.	Effect of psychotropic drugs on fetus behavior in the third trimester of pregnancy
[25]	Dieb A et al.	Evaluation of fetal neurological behavior in hypothyroid pregnant females - a pilot study
[26]	Miskovic B et al.	The comparison of fetal behavior in high risk and normal pregnancies assessed by four-dimensional ultrasound
[27]	Kurjak A et al.	Comparison between antenatal neurodevelopmental test and fetal Doppler in the assessment of fetal well being
[28]	Predojevic M et al.	Assessment of motoric and hemodynamic parameters in growth restricted fetuses - case study
[29]	Abo-Yaqoub S et al.	The role of 4-D ultrasonography in prenatal assessment of the fetus neurobehaviour and prediction of neurological outcome
[30]	Kurjak A et al.	The study of fetal neurobehavior in twins in all three trimesters of pregnancy
[31]	Kurjak A et al.	The potential of 4D sonography in the assessment of fetal neurobehavior-- multicentric study in high-risk pregnancies

Table 2. Qualitative observations made from a review of literature

Most studies in this review were conducted before 2013
Most studies in this review stated that the ultrasound examination time was 15-30 minutes
This review included over 3000 pregnancies when combined from all studies
Most studies in this review had statistically significant results
Where different KANET parameters were individually assessed for statistical significance, isolated eye blinking was the parameter that was most often a carrier of significant difference
The difference in KANET score between high-risk and low-risk pregnancies was the most often researched topic in this review
Most studies which investigated the difference in KANET score between high-risk and low-risk pregnancies had statistically significant results
Specific research topics included KANET score differences between monochorionic and dichorionic twin pregnancies, pregnancies with normal and abnormal placental flow, Asian and Caucasian pregnancies, male and female pregnancies, pregnancies with fetal ventriculomegaly and those without, diabetic and non-diabetic pregnancies, euthyroid and hypothyroid pregnancies, and finally, pregnant women taking psychotropic drugs and those who are not

Discussion

This review included 18 studies investigating whether statistically significant discrepancies in KANET scores between certain populations exist. Most studies produced statistically significant results which were interpreted in the context of relevant published literature.

4.1. Comparison between high-risk and low-risk pregnancies

As the primary function of the KANET score is to prenatally assess the functionality of

the fetal central nervous system, one might expect significant differences between high-risk and low-risk pregnancies. High-risk pregnancies in the studies included in this review included different obstetrical pathologies such as multiple pregnancies, IUGR, diabetes mellitus, hypertension, etc. Many studies have investigated this hypothesis and produced intriguing results worthy of discussion. One such example is the study published by Honemeyer U et al., which investigated differences in KANET scores between low-risk and at-risk pregnancies in the final trimester [17]. While the results showed no abnormal KANET score in either

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population, a great majority of borderline KANET scores were in the at-risk pregnancy cohort. This distribution was statistically significant, as the authors concluded that there is a correlation between the score value and at-risk pregnancies. The difference in KANET scores between low-risk and high-risk pregnancies was also investigated in a study published by Talic A et al [20]. The frequency of abnormal KANET scores was over three times higher in the high-risk group and over four times higher for the borderline KANET scores. On the other hand, the frequency of normal KANET scores was greater in the low-risk group. With the results demonstrating a statistically significant difference between the cohorts, this study also concluded that lower KANET scores correlated with high-risk pregnancies. Athanasiadis AP et al. conducted a similar investigation, comparing different cohorts of high-risk pregnancies to a control low-risk cohort [22]. The results of the study showed a significantly higher KANET score in the low-risk cohort, demonstrating KANET once again as a feasible diagnostic technique. The same result was achieved in a study by Miskovic B et al., in which eight out of ten KANET parameters showed statistically significant differences between low-risk and high-risk pregnancies [26]. Another study, published by Kurjak A et al., also arrived at a similar conclusion [27]. Statistically significant differences in normal, borderline, and abnormal KANET scores were determined between low-risk and high-risk pregnancies. Interestingly, a significant percentage of abnormal KANET score values was determined in pregnant women with previous children suffering from cerebral palsy. Finally, a significant difference in KANET scores between low-risk and high-risk pregnancies was also confirmed in the study by Abo-Yaqoub S et al [29]. In the follow-up, all fetuses with abnormal KANET scores developed postnatal abnormalities.

The studies provided strong, statistically significant results which demonstrated the utility of KANET as a diagnostic method in high-risk pregnancies. Each of the authors concluded that this is a feasible technique and deemed its role in prenatal medicine worthy of further research.

4.2. Comparison between diabetic and non-diabetic pregnancies

Within the scope of studies selected in our review, the differences in KANET scores between diabetic and non-diabetic pregnant women were investigated. As diabetes mellitus is a significant risk factor for prenatal and postnatal complications, this was a feasible hypothesis which yielded significant results. Antsaklis P et al. published a study in which the authors used KANET for the assessment of fetal brain functionality in diabetic pregnant women [21]. The diabetic cohort included both pregnant women with previously diagnosed diabetes mellitus and women with gestational diabetes, all in the final trimester of pregnancy. The non-diabetic cohort included pregnant women without a diagnosis of diabetes or any other major pregnancy risk factor. The results demonstrated higher percentages of abnormal and borderline KANET scores in the diabetic cohort, while the non-diabetic cohort had a higher percentage of normal KANET scores. The differences were statistically significant, demonstrating the potential for neurodevelopmental risk determination in diabetic pregnant women. Quite different results could be observed in the previously mentioned study by Athanasiadis AP et al [22]. While the study primarily demonstrated a statistically significant difference in KANET scores between low-risk and high-risk pregnancies, the same cannot be said for the diabetic pregnancy subgroup. Regarding this specific cohort, the KANET scores were not significantly different from the low-risk cohort but were significantly higher than the other high-risk cohorts, which included IUGR and pregnancy-induced hypertension.

The effect of maternal diabetes mellitus on fetal neurodevelopment has been investigated by other diagnostic techniques. Avci R et al. used magnetoencephalography to comparatively assess fetal brain activity in diabetic and non-diabetic pregnant women [32]. The results showed significant differences between the diabetic and control groups, implying altered fetal brain activity in diabetic pregnancies. An article published by Biete M et

Vasudevan S postulates the association between fetal neurodevelopment abnormalities and dysbiosis caused by gestational diabetes mellitus [33]. With these findings considered, KANET might be a useful diagnostic tool for the assessment of fetal neurodevelopmental status in diabetic pregnancies.

4.3. Comparisons related to multiple pregnancies

Another point of interest regarding KANET score evaluation has been the matter of multiple pregnancies, predominantly twin pregnancies. Several studies have investigated the variability in KANET score distribution in these specific populations. In a study by Kurjak A et al., the authors observed variability in fetal movements among twins in all three trimesters [30]. The analysis included a comparison of KANET scores between twin pregnancies and singleton pregnancies. The results showed that singleton fetuses had significantly higher KANET scores than twins. This is in line with the previously discussed studies as twin pregnancies are considered higher-risk pregnancies. Another study, published by Bot M et al, evaluated KANET values in monochorionic twin pregnancies and dichorionic twin pregnancies [14]. When comparing fetuses with normal growth and abnormal growth, significant differences in KANET score values were noted in both monochorionic and dichorionic pregnancies. Chorionicity has been determined as a potential risk factor for neurodevelopmental abnormalities. A meta-analysis by Yan S et al. demonstrated that monochorionic twins are associated with an increased risk of neurodevelopmental abnormalities in comparison to dichorionic twins [34]. This was also confirmed by the EPIPAGE-2 cohort study, published by Tosello B et al, in which the authors concluded that monochorionic pregnancies have a higher risk of unfavorable outcomes regarding neurodevelopment [35].

Based on the presented results, KANET might have potential in multiple pregnancy diagnostics. Considering the demonstrated increased risk of neurodevelopmental deviation,

an objective assessment with prognostic value could be beneficial in this regard.

4.4. Comparisons between other specific categories of pregnancies

Other studies have investigated the prognostic value of KANET and whether certain categories of pregnancies will show different values. Medjedovic E et Kurjak A. compared KANET scores between pregnancies with detected abnormal placental flow and a healthy control group [15]. The results demonstrated that abnormal placental flow significantly impacts the values of KANET scores. Hanaoka U et al. investigated differences in KANET score between pregnancies in Asian and Caucasian women [18]. A significant difference was noted between the two populations, demonstrating the need to take ethnicity into consideration when performing this assessment. Hata T et al. made a comparison between male and female fetuses to observe if sex has any impact on KANET scores [19]. The results showed no statistically significant difference between male and female fetuses, suggesting that sex does not need to be taken into consideration. Talic A et al. specifically assessed KANET score differences in fetuses with confirmed ventriculomegaly [23]. A majority of abnormal and borderline KANET scores were detected in the ventriculomegaly cohort and the score showed a significant difference in distribution. Hata T et al. observed the effect of psychotropic drugs on fetal activity and KANET score values [24]. There was no significant difference between the investigated group and the control group, indicating that psychotropic drugs might not influence fetal activity patterns. Finally, Dieb A et al. compared KANET scores in euthyroid and hypothyroid pregnancies [25]. Significantly lower KANET scores were detected in hypothyroid pregnancies, implying hypothyroidism might negatively affect fetal neurodevelopment and activity.

The studies present various specific subgroups of pregnant women as having a higher risk or no risk for abnormal fetal neurodevelopment. Additionally, they highlight

which other factors must be considered when making a prognosis based on the test results.

4.5. Variability of significance in different KANET parameters

While many studies making comparative evaluations of KANET scores have been analyzed in this review, only some of them observed the significance of each parameter of the KANET examination individually. One such example is the previously mentioned study by Hata T et al which observed differences between Asian and Caucasian pregnant women [18]. Even though the main result of the study was statistically relevant, when observing each KANET parameter individually, cranial sutures and head circumference, hand-to-face movements, finger movements, and gestalt perception of general movements showed no significant differences between the cohorts, while the others did. The study by Talic A et al, comparing at-risk and low-risk pregnancies, showed differences in all KANET parameters except isolated head anteflexion [20]. The study by Antsaklis P et al., comparing diabetic and non-diabetic pregnancies, showed that significant differences were noted in the isolated eye blinking, facial alteration, and finger movement parameters [21]. Athanasiadis AP et al., when comparing high-risk and low-risk pregnancies, noted significant differences in isolated head movements, cranial sutures and head circumference, finger movements, isolated eye blinking, and gestalt perception [22]. In the study by Miskovic B et al., all parameters were relevant except cranial sutures and head circumference, and isolated leg movement [26]. Finally, in the study by Abo-Yaqoub S et al., a significant difference was shown in all parameters except isolated leg movements and cranial sutures and head circumference [29].

Interestingly, while the overall KANET score is a valuable indicator, the significance of individual parameters varies across studies. This variability raises the possibility of developing a "reduced" KANET test focusing on the most predictive parameters, which could simplify and perhaps enhance the test's clinical utility.

4.6. Limitations

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The main limitations of this review were:

1) Limited Number of Studies

The review is based on a relatively small number of studies (18 in total), which may limit the generalizability of the findings. The conclusions drawn from these studies may not be representative of the broader population, especially considering the variability in study designs, sample sizes, and geographical locations.

2) Variability in Study Designs

The studies included in this review vary widely in their design, population characteristics, and methodologies. This variability could introduce heterogeneity that complicates direct comparisons and the synthesis of findings. For example, differences in how KANET was applied, the timing of the assessments, and the criteria used for defining high-risk pregnancies might affect the consistency of the results.

3) Focus on Specific Populations

The review primarily includes studies conducted in specific populations, such as high-risk pregnancies or those with conditions (e.g., diabetes, multiple pregnancies). This focus might limit the applicability of the findings to other populations, such as low-risk pregnancies or those from different ethnic or socio-economic backgrounds.

Conclusion

Based on the analysis performed in this review, KANET may have great potential and utility for identifying fetuses at risk of neurodevelopmental problems, especially in high-risk pregnancies. Further research is needed to assess the long-term outcomes of fetuses identified as high-risk via KANET. Although KANET provides significant insight into fetal neurological development by assessing specific behavioral parameters, it cannot diagnose any specific neurological disorders and should be used as part of a comprehensive prenatal assessment.

Although the test has been shown to be effective in many studies, future research could

lead to its simplification, further improvement and greater prognostic value.

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References

1. Doi M, Usui N, Shimada S. Prenatal Environment and Neurodevelopmental Disorders. *Front Endocrinol (Lausanne)*. 2022 Mar 15;13:860110. doi: 10.3389/fendo.2022.860110.
2. Reddihough DS, Collins KJ. The epidemiology and causes of cerebral palsy. *Aust J Physiother*. 2003;49(1):7-12. doi: 10.1016/s0004-9514(14)60183-5.
3. Courchesne E, Gazestani VH, Lewis NE. Prenatal Origins of ASD: The When, what, and How of ASD Development. *Trends Neurosci*. 2020 May;43(5):326-342. doi: 10.1016/j.tins.2020.03.005.
4. Eke CB, Uche EO, Chinawa JM, Obi IE, Obu HA, Ibekwe RC. Epidemiology of congenital anomalies of the central nervous system in children in Enugu, Nigeria: A retrospective study. *Ann Afr Med*. 2016;15(3):126-132. doi:10.4103/1596-3519.188892
5. Himmelmann K, Ahlin K, Jacobsson B, Cans C, Thorsen P. Risk factors for cerebral palsy in children born at term. *Acta Obstet Gynecol Scand*. 2011;90(10):1070-1081. doi:10.1111/j.1600-0412.2011.01217.x
6. Institute of Medicine (US) Committee on Understanding Premature Birth and Assuring Healthy Outcomes; Behrman RE, Butler AS, editors. *Preterm Birth: Causes, Consequences, and Prevention*. Washington (DC): National Academies Press (US); 2007. C, A Review of Ethical Issues Involved in Premature Birth. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK11389/>
7. Tinjić S. Experiences and Results of the KANET Test Application in Clinical Practice in Bosnia and Herzegovina: Tuzla. *Donald School J Ultrasound Obstet Gynecol* 2019; XX (X):1-5
8. Kurjak A, Miskovic B, Stanojevic M, Amiel-Tison C, Ahmed B, Azumendi G, i sur: New scoring system for fetal neurobehavior assessed by three- and four-dimensional sonography. *J Perinat Med*. 2008;36(1):73-81.
9. Stanojevic M, Talic A, Miskovic B, Vasilj O, Naim Shaddad A, Ahmed B, I sur. An attempt to standardize Kurjak's antenatal neurodevelopmental test: Osaka consensus statement. *Donald School J Ultrasound Obstet Gynecol* 2011;5(4): 317-29.
10. Stanojevic M, Antsaklis P, Kadic AS, Predojevic M, Vladareanu R, Vladareanu S. Is Kurjak Antenatal Neurodevelopmental Test Ready for Routine Clinical Application? Bucharest Consensus Statement. *Donald School J Ultrasound Obstet Gynecol* 2015;9(3):265-69.
11. Hata T, AboEllail MA. Chapter 32—antenatal fetal neurodevelopment test: KANET assessment. In: CR Martin, VR Preedy, R Rajendram , editors. *Diagnosis, management and modeling of neurodevelopmental disorders*. London: Academic Press (2021). pp. 367-75.
12. Kurjak A, Stanojević M, Andonotopo W, Scazzocchio-Duenas E, Azumendi G, Carrera JM. Fetal behavior assessed in all three trimesters of normal pregnancy by four-dimensional ultrasonography. *Croat Med J* 2005;46:772-8.
13. Kurjak A, Stanojević M, Predojević M, Laušin I, Salihagić -Kadić A. Neurobehavior in fetal life. *Semin Fetal Neonatal Med*. 2012;17(6):319-323. doi:10.1016/j.jsiny.2012.06.005

14. Bot M, Vladareanu R, Burnei A, Munteanu A, Calo I, Vladareanu S. Monochorionic vs Dichorionic Twins: Kanet Test vs Postnatal Neurodevelopment. *Maedica (Bucur)*. 2020;15(1):61-70. doi:10.26574/maedica.2020.15.1.61
15. Medjedovic E, Kurjak A. Doppler ultrasonography of the uterine artery in correlation with KANET. *J Perinat Med*. 2020;49(4):455-459. doi:10.1515/jpm-2020-0544
16. Hata T, Kanenishi K, Mori N, et al. Prediction of postnatal developmental disabilities using the antenatal fetal neurodevelopmental test: KANET assessment. *J Perinat Med*. 2018;47(1):77-81. doi:10.1515/jpm-2018-0169
17. Honemeyer U, Talic A, Therwat A, Paulose L, Patidar R. The clinical value of KANET in studying fetal neurobehavior in normal and at-risk pregnancies. *J Perinat Med*. 2013;41(2):187-197. doi:10.1515/jpm-2011-0251
18. Hanaoka U, Hata T, Kanenishi K, et al. Does ethnicity have an effect on fetal behavior? A comparison of Asian and Caucasian populations. *J Perinat Med*. 2016;44(2):217-221. doi:10.1515/jpm-2015-0036
19. Hata T, Hanaoka U, Mostafa AboEllail MA, et al. Is there a sex difference in the fetus? behavior? A comparison of the KANET test between male and female fetuses. *J Perinat Med*. 2016;44(5):585-588. doi:10.1515/jpm-2015-0387
20. Talic A, Kurjak A, Ahmed B, et al. The potential of 4D sonography in the assessment of fetal behavior in high-risk pregnancies. *J Maternal Fetal Neonatal Med*. 2011;24(7):948-954. doi:10.3109/14767058.2010.534830
21. Antsaklis P, Porovic S, Daskalakis G, Kurjak A. 4D assessment of fetal brain function in diabetic patients. *J Perinat Med*. 2017;45(6):711-715. doi:10.1515/jpm-2016-0394
22. Athanasiadis AP, Mikos T, Tambakoudis GP, et al. Neurodevelopmental fetal assessment using the KANET scoring system in low and high risk pregnancies. *J Maternal Fetal Neonatal Med*. 2013;26(4):363-368. doi:10.3109/14767058.2012.695824
23. Talic A, Kurjak A, Stanojevic M, Honemeyer U, Badreldeen A, DiRenzo GC. The assessment of fetal brain function in fetuses with ventriculomegaly: the role of the KANET test. *J Maternal Fetal Neonatal Med*. 2012;25(8):1267-1272. doi:10.3109/14767058.2011.634463
24. Hata T, Kanenishi K, AboEllail MAM, et al. Effect of psychotropic drugs on fetus behavior in the third trimester of pregnancy. *J Perinat Med*. 2019;47(2):207-211. doi:10.1515/jpm-2018-0114
25. Dieb A, Salam R, Shaheen D, Shaeer E. Evaluation of fetal neurological behavior in hypothyroid pregnant females - a pilot study. *J Maternal Fetal Neonatal Med*. 2019;32(16):2617-2621. doi:10.1080/14767058.2018.1442428
26. Miskovic B, Vasilj O, Stanojevic M, Ivanković D, Kerner M, Tikvica A. The comparison of fetal behavior in high risk and normal pregnancies assessed by four dimensional ultrasound. *J Maternal Fetal Neonatal Med*. 2010;23(12):1461-1467. doi:10.3109/14767051003678200
27. Kurjak A, Talic A, Honemeyer U, Stanojevic M, Zalud I. Comparison between antenatal neurodevelopmental test and fetal Doppler in the assessment of fetal well being . *J Perinat Med*. 2013;41(1):107-114. doi:10.1515/jpm-2012-0018
28. Predojević M, Talić A, Stanojević M, Kurjak A, Salihagić Kadić A. Assessment of motoric and hemodynamic parameters in growth restricted fetuses - case study. *J Maternal Fetal Neonatal Med*. 2014;27(3):247-251. doi:10.3109/14767058.2013.807241
29. Abo-Yaqoub S, Kurjak A, Mohammed AB, Shadad A, Abdel- Maaboud M. The role of 4-D ultrasonography in prenatal assessment of fetal neurobehaviour and prediction of neurological outcomes. *J Maternal Fetal Neonatal Med*. 2012;25(3):231-236. doi:10.3109/14767058.2011.568552

30. Kurjak A, Talic A, Stanojevic M, et al. The study of fetal neurobehavior in twins in all three trimesters of pregnancy. *J Maternal Fetal Neonatal Med.* 2013;26(12):1186-1195. doi:10.3109/14767058.2013.773306
31. Kurjak A, Abo-Yaqoub S, Stanojevic M, et al. The potential of 4D sonography in the assessment of fetal neurobehavior--multicentric study in high-risk pregnancies. *J Perinat Med.* 2010;38(1):77-82. doi:10.1515/jpm.2010.012
32. Avci R, Whittington JR, Blossom SJ, et al. Studying the Effect of Maternal Pregestational Diabetes on Fetal Neurodevelopment Using Magnetoencephalography. *Clin EEG Neurosci.* 2020;51(5):331-338. doi:10.1177/1550059420909658
33. Biete M, Vasudevan S. Gestational diabetes mellitus: Impacts on fetal neurodevelopment, gut dysbiosis, and the promise of precision medicine. *Front Mol Biosci.* 2024;11:1420664 .
34. Yan S, Wang Y, Chen Z, Zhang F. Chorionicity and neurodevelopmental outcomes in twin pregnancy: a systematic review and meta-analysis. *J Perinatol.* 2023;43(2):133-146. doi:10.1038/s41372-022-01534-y
35. Tosello B, Garbi A, Blanc J, et al. The impact of chorionicity on pregnancy outcome and neurodevelopment at 2 years old among twins born preterm: the EPIPAGE-2 cohort study. *BJOG.* 2021;128(2):281-291. doi:10.1111/1471-0528.16170.

Author contribution.

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Sinteza kliničkih korelacija i implikacija Kurjakovoga prenatalnog neurorazvojnoga testa

Sažetak

Ciljevi: Kurjakov prenatalni neurorazvojni test (KANET) alat je probira stvoren s ciljem identificiranja fetusa s rizikom od pojave neurorazvojnih poremećaja procjenom fetalne pokretne i bihevioralne aktivnosti putem 4D ultrazvuka. KANET razlikuje normalno, rubno i abnormalno fetalno ponašanje, ali ne može ga se koristiti za dijagnozu specifičnog stanja. Cilj ovoga pregleda je sintetizirati trenutne dokaze kliničke primjene KANET-a i njegove učinkovitosti kao alata probira u procjeni fetalnog neurorazvoja.

Metode: Pretraga na PubMed-u identificirala je 18 relevantnih studija koje procjenjuju primjenu KANET-a u skupinama s različitim maternalnim rizicima. Studije su analizirane u odnosu na značajne razlike u skorovima KANET-a između visoko- i niskorizičnih trudnoća.

Rezultati: KANET je bio učinkovit u razlikovanju normalnih od rubnih i abnormalnih fetalnih ponašanja u visokorizičnim trudnoćama, uključujući one čije su komplikacije bile dijabetes, hipotireoza i poremećaji posteljice. Međutim, KANET nije dijagnostički test i ne može potvrditi prisutnost specifičnih neuroloških poremećaja fetusa u visoko- i niskorizičnim trudnoćama.

Zaključak: KANET je vrijedan alat probira za identificiranje rizika za razvoj neurorazvojnih poremećaja kod fetusa, ali potrebno je daljnje istraživanje kako bi se usavršila njegova upotreba. Bitno je napomenuti da nije predviđen za uporabu kao samostalan alat za dijagnosticiranje bilo kakvih poremećaja.

Ključne riječi: ultrazvuk, prenatalni; trudnoća, visokorizična; fetalni razvoj; fetalni pokret