



在线全文

血清钠、钾水平与孕中期抑郁症状风险的关联性研究

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【摘要】目的 探讨孕中期血清钠、钾水平与抑郁症状风险的关联。**方法** 基于2018–2020年在中国重庆市妇幼保健院建档孕妇组成的前瞻性出生队列数据,采用爱丁堡产后抑郁量表(Edinburgh Postnatal Depression Scale, EPDS)在孕中期评估抑郁症状,并从电子健康档案中提取血清钠、钾水平检测结果。使用logistic回归模型分析血清钠、钾水平与孕中期抑郁症状风险的相关性。**结果** 本研究共纳入1 429名参与者,孕中期抑郁症状的检出率为52.76%。Logistic回归模型结果显示,血清钾水平与抑郁症状风险呈负相关,而血清钠水平与抑郁症状风险无统计学关联。调整所有协变量后,与最低四分位数的血清钾水平相比(Q1),最高四分位数(Q4)有较低的抑郁症状风险[比值比(odds ratio, OR)=0.715, 95%置信区间(confidence interval, CI): 0.531 ~ 0.963]。**结论** 在正常生理范围内,孕中期较高的血清钾水平与较低的抑郁症状风险相关,而血清钠水平未见显著关联。

【关键词】 抑郁症状 孕中期 血清钠 血清钾

Association of Serum Sodium and Potassium Levels With the Risk of Depressive Symptoms During the Second Trimester of Pregnancy : A Cross-Sectional Study

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[Abstract] Objective To investigate the association between serum sodium and potassium levels and the risk of depressive symptoms during the second trimester of pregnancy. **Methods** This study was based on a prospective birth cohort of pregnant women who registered at Chongqing Maternal and Child Health Hospital, China, between 2018 and 2020. Depressive symptoms were assessed during the second trimester using the Edinburgh Postnatal Depression Scale (EPDS). Serum sodium and potassium levels were extracted from electronic health records. Logistic regression models were used to analyze the association between serum sodium and potassium levels and the risk of depressive symptoms. **Results** Among the 1 429 participants, the prevalence of depressive symptoms was 52.76%. A significant negative association was observed for serum potassium, while no significant association was found between serum sodium levels and the risk of depressive symptoms. In the fully adjusted model, the highest quartile (Q4) of serum potassium was associated with a lower risk of depressive symptoms compared to the lowest quartile (Q1) (odds ratio [OR] = 0.715, 95% CI: 0.531 to 0.963). **Conclusion** Within the normal physiological range, serum potassium levels were associated with the risk of depressive symptoms during the second trimester of pregnancy, whereas no significant association was found for serum sodium levels.

[Key words] Depression symptoms Second trimester of pregnancy Sodium Potassium

孕期抑郁是孕妇最常见的精神健康问题。在中国,孕中期抑郁症状检出率可达20%^[1]。抑郁症的诊断需要经过严格的临床评估,而抑郁症状的筛查可通过相对简单便捷的量表完成。有证据表明,无论临床上是否被确诊,孕期显著的抑郁症状会引起与孕期抑郁症相似的不良结局。例如,孕中期患抑郁症的女性,其胎儿生长受限的风

险增加70%~80%^[2],孕中期出现抑郁症状的,其胎儿在30~37周左右的生长速度相对缓慢^[3],孕期患抑郁或出现抑郁症状的孕妇的胎儿在出生后更易出现认知发展迟缓以及精神障碍等问题^[4-6]。孕中期抑郁症状在治疗中面临多重困难,可能存在药物威胁胎儿安全^[7],孕期生理变化降低药物疗效^[8],孕妇用药依从性较差等问题^[8-9]。同时,心理治疗等非药物干预在孕期的可及性也有限^[8]。因此,深入研究抑郁症状,探索低成本且可改变的生物学风险

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因素至关重要。

多项研究提示, 关键矿物质的失衡与情绪障碍的病理生理过程存在潜在关联, 包括人体最主要的电解质钠与钾。例如, 血清钾水平紊乱可能通过破坏神经递质功能或引发神经炎症, 影响情绪状态^[10]; 血清钠失衡可能通过影响血压增加抑郁风险^[11]。尽管已有线索提示电解质平衡与心理健康相关, 但目前暂无研究直接探讨血清钠、钾水平与孕中期抑郁症状风险的关联。基于前期证据, 本研究假设血清钠、钾失衡与孕中期抑郁症状风险相关, 并旨在通过前瞻性队列数据检验此假说, 以期为有效预防和缓解孕中期抑郁症状提供科学依据与实践指导。

1 资料与方法

1.1 研究对象

研究对象来源于2018–2020年在重庆市妇幼保健院进行建卡和分娩的孕产妇信息建立的前瞻性出生队列。研究数据通过两种途径获得: 一是通过队列问卷调查收集, 二是从该院的电子健康档案系统中提取。本研究根据母亲姓名、住院号及身份证号对这两种来源的数据

进行了精确匹配。纳入标准: ①孕中期(14周≤孕周≤28周)参加了抑郁量表调查; ②言语和理解能力正常; ③能够独立完成问卷填写。排除标准: ①怀孕前1年内被诊断为抑郁症、精神分裂症或其他精神疾病; ②从怀孕到完成建档期间被诊断为抑郁症、精神分裂症或其他精神疾病; ③无血清钠、钾检验数据; ④数据极端值或协变量数据缺失(家庭总收入除外)。筛选过程见图1。本项目已通过重庆市妇幼保健院医学伦理审查委员会审查, 批准号: (2018)伦审(科)020-02号。

1.2 调查内容

研究采用统一的问卷收集调查对象基本人口学特征(如年龄、民族、身高、体重和文化程度等)、疾病史及其治疗史(如精神疾病、内分泌系统疾病史及其治疗时长等)、健康行为(吸烟及饮酒习惯、身体活动和饮食习惯等)以及孕中期抑郁筛查等信息。

1.3 孕中期抑郁症状结局及测量

结局为出现抑郁症状, 采用爱丁堡产后抑郁量表(edinburgh postnatal depression scale, EPDS)在孕中期进行抑郁症筛查。EPDS是一种针对产后抑郁症的筛查量

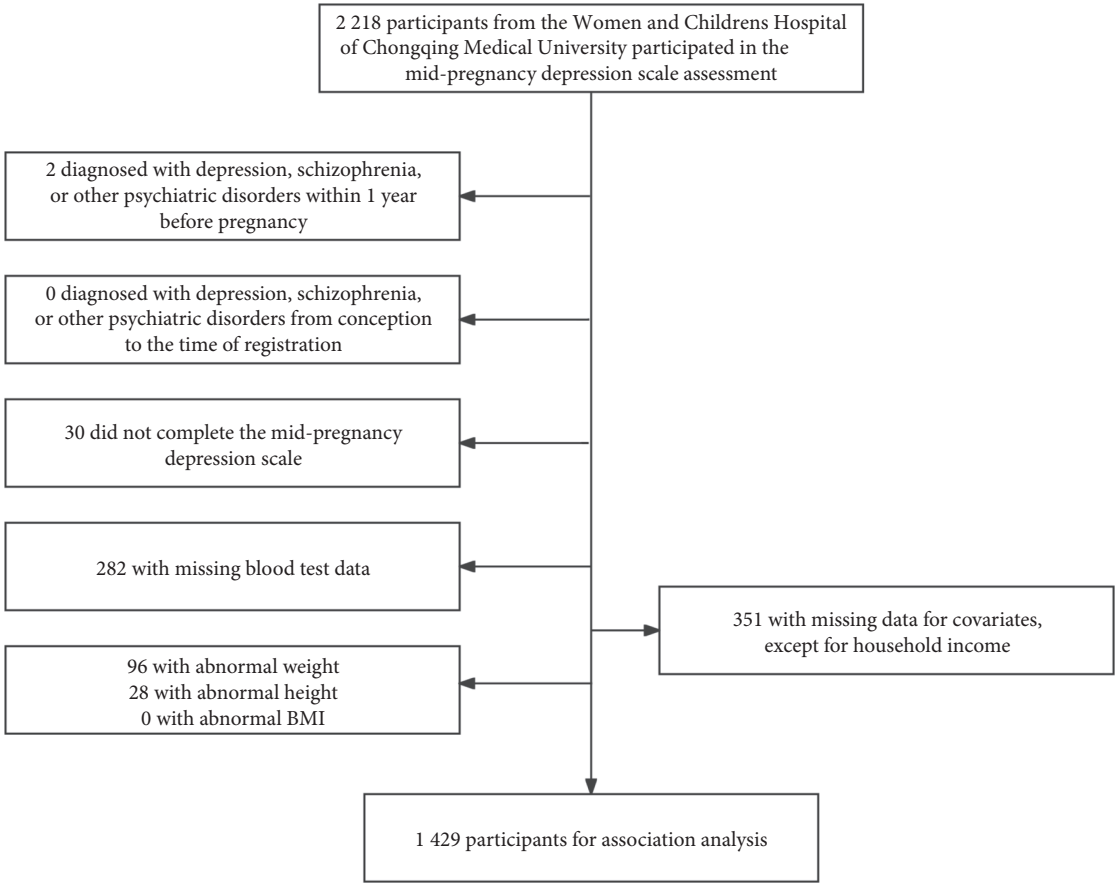


图 1 参与者的筛选流程图

Fig 1 Flow diagram for participant selection

表,但也广泛应用于孕期抑郁症筛查,此量表中文版在国内既往研究中已被证实具有较好的信度、效度^[12]。EPDS 包含 10 个条目,每个条目均采用 4 级李克特量表评分(Likert-scale),得分范围从 0 到 3 分,总分范围为 0 到 30 分。EPDS 总分 12 分及以上定义为有抑郁症状。

1.4 暴露因素及测量

血清中钠、钾水平由重庆市妇幼保健院进行血液检验,单位为 mmol/L。血液检验在孕中期至孕晚期完成。虽然血液检测时间与抑郁症筛查量表完成时间存在一定时间差,但该时间不会对结果产生显著影响。其依据在于,血清钠、钾水平受到机体稳态机制的严格调控,在无病理性失调或临床干预(如摄入钠、钾补充剂治疗)的情况下,通常维持在相对稳定的狭窄范围内。同时,在常规产前、孕期保健中,除非被临床确诊为低钠血症或低钾血症,孕妇一般不会自行补充钠、钾。因此,可以合理假设在该时间段内,被纳入研究孕妇的血清钠、钾水平保持稳定。

1.5 协变量

基于既往文献^[13-15],本研究采用以下协变量:年龄、孕前体质量指数(body mass index, BMI)、教育程度(初中及以下、高中或中专、大专、本科、硕士及以上)、家庭总收入(<12 000 元, 12 000 ~ 19 999 元, 20 000 ~ 59 999 元, 60 000 ~ 99 999 元, 100 000 ~ 199 999 元, >200 000 元)、孕前工作情况(曾有工作、从未工作)、吸烟情况(从未吸烟、吸烟、戒烟)、饮酒情况(从未饮酒、饮酒、戒酒)及身体活动(是否散步或体育活动)。其中,若参与者经常吸烟但明确表示已停止吸烟,则判定为戒烟;若未明确表示已停止吸烟,则判定为吸烟。戒酒及饮酒的判定标准类似。若孕妇报告散步或参与除散步外的体育活动,则判定为有身体活动。此外,因缺失家庭总收入数据的人群较多(占 14.89%),大量排除此类人群可能导致选择偏倚,故采用多重插补法插补缺失数据。本研究原计划调整孕中期高血压、糖尿病、子痫、子痫前期等妊娠期并发症,然而无相关数据。通过核查孕晚期数据,发现研究对象中仅 3 人在孕晚期报告被诊断患高血压,36 人报告被诊断患糖尿病,无人报告被诊断患子痫前期、子痫,患病人数仅占 2.72%。为确保模型稳定性,故不调整妊娠期并发症,将上述患病孕妇排除后做敏感性分析。

1.6 统计学方法

连续变量使用 $\bar{x} \pm s$ 描述,分类变量用构成比描述,通过卡方检验或单因素方差分析(One-way ANOVA)比较组间差异。采用方差膨胀因子(variance inflation factor, VIF)评估协变量间的共线性。采用 logistic 回归模型探索

血清钠、钾水平与孕中期抑郁症状风险的关系。孕中期抑郁症状为二分类变量。血清钠、钾水平采用四分位数(Q1 ~ Q4)。为便于临床解释,本研究将上述指标以每升高 0.1 mmol/L 为单位进行分析。模型一仅调整年龄。模型二对所有协变量进行调整。为验证模型稳健性,进行如下敏感性分析:①采取 10 分为 EPDS 的筛查临界值;②采取 13 分为 EPDS 的筛查临界值;③将 EPDS 分数及血清钠、钾水平作为连续变量进行分析;④排除在孕晚期报告患妊娠期并发症的孕妇后进行分析。使用 R 语言软件(4.5.1 版本)进行统计学分析,采用双侧检验, $\alpha = 0.05$ 。

2 结果

2.1 基本情况

研究对象的血清钠水平、血清钾水平及基线特征结果详见网络资源附件的附表 1 和附表 2。共纳入 1 429 名孕妇,平均年龄 29.3 岁,筛查出有抑郁症状的孕妇 754 名,检出率达 52.76%。出现血清钠失衡(≤ 135 mmol/L 或 ≥ 145 mmol/L)的个体共 90 人,占 6.30%;出现血清钾失衡(≤ 3.5 mmol/L 或 ≥ 5.5 mmol/L)的个体共 1 人,占 0.07%。

2.2 血清钠、钾水平与孕中期抑郁症状患病风险的关联

所有模型的协变量 VIF 均 < 2 ,表明协变量间无明显共线性。当采用 12 分作为 EPDS 的筛查临界值时,1 429 人中筛查出 754 例抑郁症状。模型一与模型二最高血清钾水平(Q4)与抑郁症状风险均呈负相关[比值比(odds ratio, OR)=0.724, 95%置信区间(confidence interval, CI): 0.539 ~ 0.969, $P=0.030$; OR=0.715, 95%CI: 0.531 ~ 0.963, $P=0.027$]。模型一和二的血清钠水平均与抑郁症状风险无统计学关联。详见表 1。

2.3 敏感性分析

当采用 10 分作为 EPDS 的筛查临界值时,1 429 人中筛查出 1 097 例抑郁症状。血清钠、钾水平与孕中期抑郁症状风险均无统计学关联。详见图 2。

当采用 13 分作为 EPDS 的临界值时,1 429 人中筛查出 550 例抑郁症状。两个模型的最高血清钾水平(Q4)与抑郁症状风险的负关联均保持稳健(OR=0.729, 95%CI: 0.537 ~ 0.986, $P=0.041$; OR=0.714, 95%CI: 0.524 ~ 0.972, $P=0.032$)。两个模型的血清钠水平与抑郁症状风险无统计学关联保持稳健。详见图 2。

将 EPDS 分数及血清、钠水平作为连续变量进行分析时,模型一的血清钾水平与抑郁症状风险的负关联保持稳健,血清钾水平每上升 0.1 mmol/L, EPDS 得分减少 6.266 分($\beta=-6.266$, 95%CI: -12.455 ~ -0.045, $P=0.048$)。模型二的血清钾水平与抑郁症状风险呈边缘

表 1 Logistic回归模型分析血清钠、钾含量与孕中期抑郁症状风险的关联 (n=1429)

Table 1 Association between serum sodium/potassium levels and depression symptoms during the second trimester (n = 1429)

Item	Serum sodium level or serum potassium level						
	Q1	Q2		Q3		Q4	
	OR (95% CI)	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Serum sodium level							
Model 1	1 (Ref)	0.811 (0.611-1.076)	0.147	0.844 (0.636-1.120)	0.240	1.043 (0.783-1.391)	0.773
Model 2	1 (Ref)	0.905 (0.666-1.229)	0.521	0.827 (0.611-1.120)	0.218	1.069 (0.780-1.463)	0.679
Serum potassium level							
Model 1	1 (Ref)	0.865 (0.639-1.172)	0.350	0.815 (0.625-1.062)	0.129	0.724 (0.539-0.969)	0.030
Model 2	1 (Ref)	0.873 (0.642-1.187)	0.385	0.833 (0.637-1.089)	0.180	0.715 (0.531-0.963)	0.027

OR: odds ratio. Model 1 was adjusted for age. Model 2 was additionally adjusted for pre-pregnancy body mass index, education level, household income, employment status, smoking status, alcohol consumption, and physical activity.

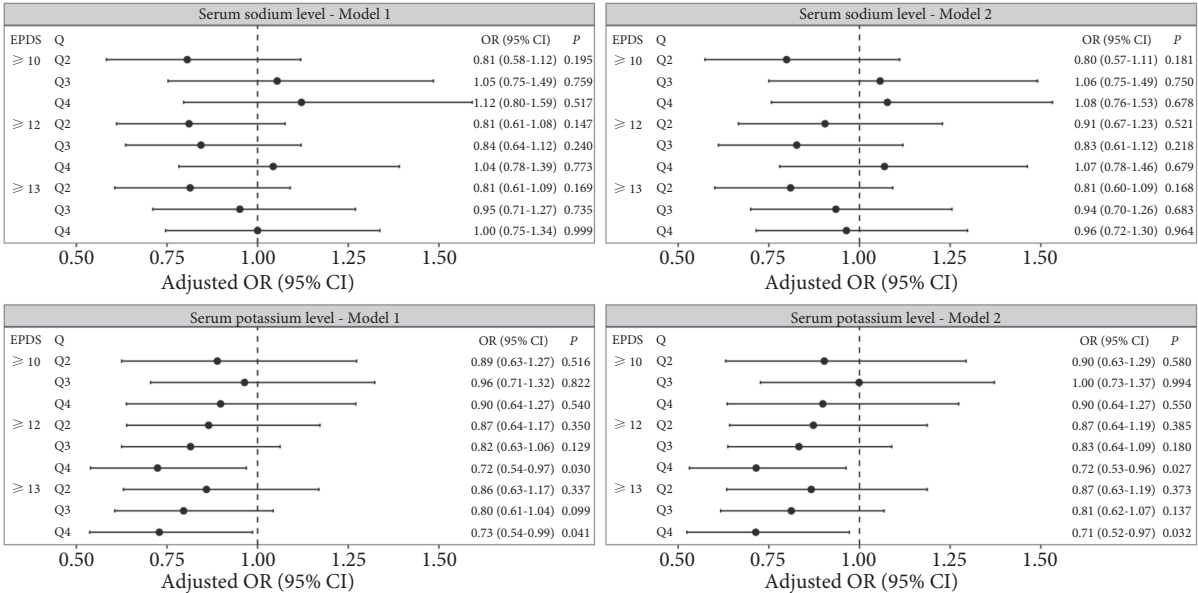


图 2 不同EPDS临界值下 (主分析≥12; 敏感性分析≥10及≥13) 血清钠、钾水平与孕中期抑郁症状风险的OR森林图

Fig 2 Forest plot of adjusted ORs for depressive symptoms associated with serum sodium/potassium quartiles across different EPDS cut-off points (primary analysis: score ≥12; sensitivity analysis: scores ≥10 and ≥13)

EPDS: Edinburgh Postnatal Depression Scale; OR: odds ratio. Reference group: Q1. Annotations for Model 1 and Model 2 are shown in Table 1.

负相关, 血清钾水平每上升0.1 mmol/L, EPDS得分减少5.658分($\beta=-5.658$, 95%CI: $-11.855 \sim 0.538$, $P=0.073$)。两个模型的血清钠水平与抑郁症状风险均无统计学关联。详见图3。

将孕晚期报告被诊断患有并发症的孕妇排除后, 模型一、二的血清钾水平与抑郁症状风险的负关联保持稳健(OR=0.711, 95%CI: 0.529 ~ 0.956; $P=0.024$; OR=0.681, 95%CI: 0.505 ~ 0.920, $P=0.012$), 最高水平血清钠水平与抑郁症状风险均无统计学关联(OR=1.040, 95%CI: 0.777 ~ 1.394, $P=0.788$; OR=1.071, 95%CI: 0.778 ~ 1.474,

$P=0.674$)。

3 讨论

本研究利用前瞻性出生队列数据, 分析了血清钠、钾水平与孕中期抑郁症状风险的关联。结果显示, 血清钾水平与抑郁症状风险呈负相关, 血清钠水平未见统计学关联。值得注意的是, 纳入研究的孕妇中, 仅1名孕妇血清钾水平异常, 这提示所观察到的关联并非由极少数个体的病理值驱动, 而是反映在正常生理范围内, 血清钾水平可能是整合了抑郁症状病理生理过程的综合信号。此

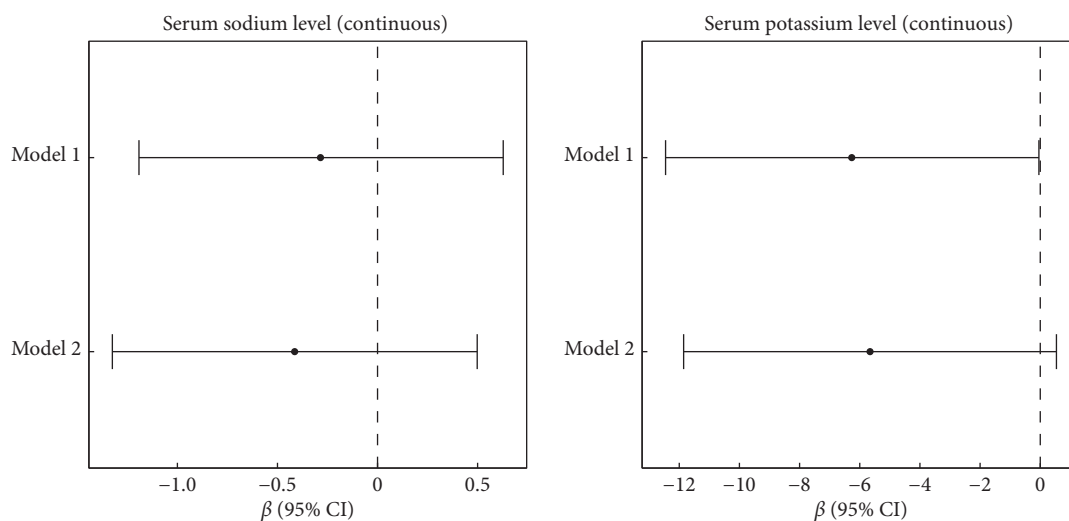


图3 血清钠、血清钾水平与孕中期EPDS分数的回归系数图

Fig 3 Coefficient plots for the association between EPDS scores and serum sodium/potassium levels (continuous)

β: partial regression coefficient. Annotations for Model 1 and Model 2 are shown in Table 1.

外,敏感性分析显示,血清钾与抑郁症状的关联仅在使用更严格的EPDS临界值时保持稳健。这可能是由于13分的特异性较高,能更有效识别中重度抑郁症状,而10分则纳入较多症状较轻或亚临床个体^[12]。这提示,血清钾水平可能与临床意义较明确的抑郁症状相关。

目前,尚无直接证据表明血清钾水平与抑郁症状风险相关,但已有研究提供了潜在的生物学解释。血清钾水平的稳定对维持中枢神经系统内环境至关重要,血清钾水平紊乱可能破坏多种神经递质功能^[16-18],进而影响心理健康^[10, 19-21]。血清钾水平变化还可能引起血清神经丝轻链水平改变引发神经炎症^[22-24],进而引起抑郁症状^[25-27]。此外,血清钾水平的波动可能影响神经元的兴奋性^[28-29],进而增加氧化应激^[30]。而妊娠过程会进一步增加母体对氧化应激的敏感性^[31],有研究发现孕中期和孕晚期的氧化应激是引起抑郁症状的机制之一^[30-32]。因此,血清钾水平可能通过加剧氧化应激增加孕妇抑郁症状风险。

有关血清钠水平与抑郁症状风险的研究也十分有限。一项老年队列研究显示,即便是患有轻微低钠血症的老年人,也比正常血钠老年人有更高的抑郁量表评分^[33]。本研究与其结果不一致,可能由于年轻成年女性内分泌调节机制更为完善,从而将血清钠水平维持在狭窄范围内。有研究显示,普通成人低钠血症患病率仅约2%~8%,远低于老年人群的15%~30%^[34-35],而本研究人群出现血清钠水平失衡的个体仅占6.30%。更高的稳定性及较低异常率,可能导致本研究难以发现相关效应,从而未显现出相关性。

本研究具有以下优势。首先,血清钠、钾水平受多重

机制精密调控,维持在相对稳定的范围^[36-41],相较于反映短期摄入的膳食数据或尿液指标,血清钠、钾水平更能反映个体在一段时间内的生理状态,并提示神经系统功能状况。在相关研究十分有限的情况下,本研究为探索孕中期抑郁症状的生物学标志物提供了一定依据。其次,不同EPDS临界值具有不同特征,10分及13分是较常见的选择,10分具有更高敏感性,13分具有更高特异性^[12]。本研究采用不同临界值进行了敏感性分析,验证了核心结果的稳健性。此外,本研究还采用线性回归分析探索EPDS得分随血清钠、钾水平变化的总体趋势,以较大程度避免单一临界值选择带来的信息偏移以及极端值样本不足导致的统计效能降低。本研究也存在一定局限。第一,尽管已排除孕前一年内被诊断为精神疾病的个体,但无法排除更早期、未被记录或未治愈的患者,这可能导致真实关联被低估。第二,存在残余混杂,如无法调整所有妊娠期并发症,孕妇对非处方补充剂的使用等。但考虑到电解质失衡及自行使用补充剂的情况在孕妇人群中的发生概率较低,该影响有限。最后,研究人群主要为中国西南地区孕妇,由于各地饮食习惯不同,结果的外部有效性有待在其他地区人群中验证。

本研究显示孕中期血清钾水平与抑郁症状风险相关,而血清钠水平未见统计学关联,为孕期抑郁生物学机制提供了新的证据。该发现提示,长期充足的钾摄入和正常范围内相对较高的血清钾水平可能维护孕妇心理健康。由于血清钾检测是产检常规且低成本项目,本研究为孕中期抑郁症状临床风险分层提供了低成本的新思路。未来应开展大规模前瞻性研究或干预试验,以明确

血清钾水平对抑郁症状风险的预测价值。

* * *

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Author Contribution CAI Jiarui is responsible for conceptualization, data curation, formal analysis, methodology, visualization, and writing--original draft. DONG Ting is responsible for data curation, formal analysis, and validation. YU Chuan is responsible for project administration, supervision, validation, and writing--review and editing. All authors consented to the submission of the article to the Journal. All authors approved the final version to be published and agreed to take responsibility for all aspects of the work.

利益冲突 所有作者均声明不存在利益冲突

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