



Research Article

Early Detection of Miscarriage in Recurrent Pregnancy Loss Using a Novel Urinary Biomarker

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Abstract

Background: Recurrent pregnancy loss (RPL) is a complex reproductive disorder defined as the occurrence of two or more consecutive pregnancy losses before 20 weeks of gestation. There is an urgent need for noninvasive biomarkers that can facilitate early diagnosis and risk stratification. **Objective:** To assess the potential of HbA1c, TSH, antiphospholipid antibodies, urinary chemerin, and urinary adipsin as predictive biomarkers for recurrent pregnancy loss. **Methods:** This case-control study included 46 women with a history of two or more consecutive pregnancy losses before 20 weeks of gestation and 46 age-matched healthy controls. All participants were non-pregnant at enrollment, and the time since the last miscarriage was confirmed to be at least 3 months, based on medical records. We measured the metabolic parameters (HbA1c and TSH), immunological factors (antiphospholipid antibodies IgM and IgG), and urinary biomarkers (chemerin, adipsin, and cAMP). **Results:** The RPL group showed significantly higher TSH, HbA1c, aPLA (IgG, IgM), and urinary chemerin, adipsin, and cAMP compared with controls. Strong correlations with RPL were observed for HbA1c ($r=0.636, p<0.0001$) and urinary adipsin ($r=0.677, p<0.0001$), with moderate correlations for TSH ($r=0.514, p=0.0003$), chemerin ($r=0.598, p<0.0001$), cAMP ($r=0.474, p=0.001$), aPLA IgG ($r=0.460, p=0.0015$), and aPLA IgM ($r=0.578, p<0.0001$). **Conclusions:** TSH, HbA1c, IgG, IgM, chemerin, adipsin, and cAMP may serve as potential indicators for risk assessment in women with RPL. These markers offer opportunities for early detection and personalized clinical management of RPL.

Keywords: Adipsin, antiphospholipid antibody, chemerin, HbA1c, recurrent pregnancy loss, TSH.

التشخيص المبكر للإجهاض المتكرر باستخدام مؤشر حيوي بولي جديد

الخلاصة

الخلفية: الإجهاض المتكرر (RPL) هو اضطراب إنجابي متعدد العوامل يتميز بحدوث إجهاضين متتاليين أو أكثر قبل الأسبوع العشرين من الحمل. **الأهداف:** تقييم المؤشرات الحيوية الأيضية (HbA1c)، والهرمون المحفز للغدة الدرقية (TSH)، والمناعية (الأجسام المضادة للفسفوليبيد: IgM, IgG)، إضافة إلى المؤشرات البولية (الكيميرين والأديبينين)، لدى النساء المصابات بالإجهاض المتكرر، ودراسة إمكانيتها كعوامل تنبؤية لحدوث إجهاض لاحق. **الطرائق:** شاركت في هذه الدراسة 46 امرأة، 46 منهن تعرضن لفقدان الحمل مرتين أو أكثر قبل الأسبوع العشرين من الحمل و46 امرأة مجموعة ضابطة. تم جمع عينات دم وريدي لتقييم مستويات TSH و HbA1c و Hb و cAMP بالإضافة إلى ذلك، تم جمع عينات البول ومعالجتها لفحص تركيزات الكيميرين والأديبينين و cAMP. **النتائج:** أظهرت مجموعة RPL ارتفاعا ملحوظا من TSH و HbA1c و aPLA (IgG, IgM) و الكيميرين البولي والأديبينين و cAMP مقارنة بالمجموعة الضابطة. لوحظت ارتباطات قوية مع RPL ل HbA1c والأديبينين البولي، مع ارتباطات معتدلة ل TSH، كيميرين، cAMP، و aPLA IgG، و aPLA IgM. **الاستنتاجات:** قد تكون TSH و HbA1c و IgG و IgM و كيميرين و اديبينين و cAMP بمثابة مؤشرات محتملة لتقييم المخاطر لدى النساء المصابات ب RPL. توفر هذه العلامات فرصا للكشف المبكر والإدارة السريرية الشخصية ل RPL.

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INTRODUCTION

Recurrent pregnancy loss (RPL) is characterized by the occurrence of two or more consecutive pregnancy losses before 20 weeks of gestation, impacting about 1–2% of partners attempting to become pregnant [1]. It is a complex and multifactorial reproductive problem that has been associated with a variety of factors contributing to etiology, including autoimmune diseases, fetal chromosome

rearrangements, endocrine disturbances, maternal infections, antiphospholipid syndrome (APS), and inherited thrombophilic disorders [2]. Furthermore, lifestyle habits and obesity are associated with RPL [3]. Thyroid disorders are one of the most prevalent endocrine issues affecting women of reproductive age, and they are a significant contributing factor to RPL [4]. Thyroid hormones facilitate fetal brain development, placental function, and maternal metabolic adaptations, which are essential for

maintaining pregnancy [5]. Hypothyroidism is associated with placental insufficiency, implantation failure, and early pregnancy loss [6]. Conversely, hyperthyroidism is linked to increased risks of premature labor, restricted fetal growth, and miscarriage [7]. The poor glycemic control in diabetes mellitus, particularly when reflected by increased HbA1c levels, is associated with increased risk of miscarriage [8]. High HbA1c levels can impair endometrium receptivity, increase oxidative stress, interfere with embryo development, and impact pregnancy outcome [9]. Obesity is increasingly recognized as a modifiable risk factor for adverse female reproductive results, especially RPL [10]. Metabolic disorders, long-term inflammation, and hormonal imbalances are associated with obesity and have a negative effect on placentation, fetal development, and endometrial receptivity [11]. Higher BMI levels have been linked to a higher chance of early pregnancy loss, according to research, suggesting that obesity has a major impact on both the success of conception and the continuation of pregnancy [12]. APS is an autoimmune disorder characterized by the formation of blood clots within the vasculature, the production of specific antibodies, and complications during pregnancy. APS may manifest independently or in conjunction with other autoimmune diseases, particularly systemic lupus erythematosus (SLE) [13]. The primary pathophysiological mechanism appears to involve the development of an inadequate buffering system due to the failure of initial trophoblastic invasion, which either increases susceptibility to stressors or results in direct damage to the trophoblasts by antibodies [14, 15]. Adipokine chemerin is crucial for maintaining early pregnancy in addition to its critical role in modulating inflammation and the immune system [16]. The chemerin signaling system might be critically involved in pregnancy loss because of the differences in the expression of chemerin and its receptor CMKLR1 in the decidual tissue of women with early spontaneous abortions as compared with women with normal delivery [17]. Moreover, fetal growth limitation, recurrent implantation failure, recurrent miscarriage, and preeclampsia are among the pregnancy-related disorders that are associated with abnormal chemerin concentration [18]. Adipsin is an adipokine primarily secreted by adipose tissue, and it is involved in the activation of the alternative complement pathway [19]. Besides its immunological effects, adipsin has been reported to be involved in metabolic regulation and inflammatory response [20]. Obesity, insulin resistance, and systemic inflammation are associated with adipsin dysregulation, and the dysregulation of adipsin may affect reproductive outcomes [21]. Early recognition of the underlying causes is essential for preventing recurrence and improving pregnancy outcomes. Despite advances in diagnostics, nearly half of RPL cases remain unexplained, highlighting the need for reliable biomarkers to guide clinical assessments and management. The identification of metabolic, immunological, and urinary biomarkers

may help clinicians better stratify risk, personalize treatment plans, and enhance patient counseling in routine obstetric practices. Therefore, the aim of this study was to evaluate the levels of metabolic parameters (HbA1c and TSH), immunological factors (antiphospholipid antibodies, including isotypes of IgM and IgG), and urinary biomarkers (chemerin, adipsin, and cAMP) in women with recurrent miscarriage and assess their possible role as risk predictors in women with recurrent pregnancy loss.

METHODS

Study design and setting

This case-control study enrolled 92 women, including 46 women experiencing recurrent pregnancy loss and 46 healthy women who served as controls. Participants were recruited from private clinics and the Maternity and Obstetrics Teaching Hospital in Sulaimani City between October 2024 and May 2025. All underwent a comprehensive physical examination conducted by a registered physician.

Inclusion criteria

Women aged ≥ 18 years, matched for age with healthy controls, with a documented history of two or more pregnancy losses before the 20th week of gestation, and exhibiting regular menstrual cycles were included in the study. All participants were within the normal physiological weight range, without extreme obesity or underweight conditions that could influence metabolic parameters. At the time of enrollment, all the participants were confirmed to be non-pregnant. The interval since the last miscarriage was verified through medical records and clinical interviews, ensuring a minimum duration of three months before sample collection.

Exclusion criteria

Women were excluded if they had parental chromosomal abnormalities, congenital or acquired uterine anomalies, or endocrine disorders such as diabetes mellitus or polycystic ovary syndrome (PCOS). Individuals with autoimmune disorders such as systemic lupus erythematosus (SLE), infertility, a history of adverse pregnancy outcomes such as molar or ectopic pregnancy, smoking habits, use of hormonal or antioxidant therapy within the previous three months, urinary tract infection, incomplete or missing medical records, or absence of a fertility plan were also excluded.

Outcome measurements

Overnight fasting blood and urine samples were collected from all participants for biochemical and hormonal assessment. For blood analysis, 5 mL of venous blood was drawn and allowed to clot at room temperature for 30 minutes. Samples were then centrifuged at 4,000 rpm for 10 minutes, and serum

was transferred into sterile tubes. Serum levels of antiphospholipid antibodies (aPLA) IgM and IgG and thyroid-stimulating hormone (TSH) were measured using the Roche Cobas 6000 analyzer. Additionally, 2 mL of venous blood was collected separately for the measurement of hemoglobin (Hb) and glycated hemoglobin (HbA1c). Participants were instructed to collect midstream morning urine samples following thorough perineal cleansing. They were advised to abstain from sexual intercourse, vaginal douching, and the use of intravaginal products for at least 48 hours prior to sample collection. For urinary analysis, samples were centrifuged at 3,000 rpm for 10 minutes at 4°C, and the supernatants were stored at -80°C to prevent repeated freeze-thaw cycles. Urinary chemerin, adipsin, and cyclic adenosine monophosphate (cAMP) levels were quantified using commercially available human ELISA kits according to the manufacturer's instructions: chemerin (Crystal Chem, catalog #80589), adipsin (Aviva Systems Biology, catalog #OKRC00130), and cAMP (Crystal Chem, catalog #90095).

Ethical considerations

This study was approved by the Ethics and Research Registration Committee of the College of Science, University of Sulaimani, and it was registered on August 24, 2024, with the registration number 9, and written informed consent was obtained from each participant prior to sample collection. The studies were conducted in accordance with the local legislation and institutional requirements, and all information was kept confidential.

Statistical analysis

All statistical analysis were conducted using SPSS version 22.0 and GraphPad Prism version 10.5.0 (GraphPad Software Inc., USA). Continuous variables are presented as mean \pm standard deviation (SD). Group comparisons were performed using the Mann-Whitney U test. Correlations between variables were evaluated using Spearman's rank correlation coefficient. All reported p-values were two-tailed, and values < 0.05 were considered statistically significant. Binary logistic regression analysis was performed using IBM SPSS version 22.0 (SPSS Inc., Chicago, IL) to investigate the relationships between the risk of RPL and metabolic (HbA1c, TSH), immunological (aPLA IgG, IgM), and urine biomarkers (chemerin, adipsin, cAMP). We estimated the crude and adjusted odds ratios (ORs) together with their related 95% CIs using binary logistic regression models. All graphical representations were generated using GraphPad Prism. Maternal age, body weight, TSH, HbA1c, aPLA IgG, aPLA IgM, urine chemerin, adipsin, and cAMP were all included as factors in the multivariable models. RPL >3 pregnancy losses (coded as 1) versus ≤ 3 losses (coded as 0) were established as the outcome variable. HbA1c, TSH,

chemerin, adipsin, and cAMP were all continuous predictors that were expressed as linear terms.

RESULTS

The study comprised 92 women, evenly distributed into two groups: 46 healthy controls and 46 women diagnosed with recurrent pregnancy loss (Table 1).

Table 1: Baseline characteristics of the control and RPL groups

Variables	Control (n=46)	RPL (n=46)	p-value
Maternal age (year)	26.69 \pm 4.66	29.78 \pm 5.35	0.017
Body weight (kg)	64.24 \pm 6.55	74.22 \pm 7.58	<0.0001
Hemoglobin (g/dl)	12.53 \pm 0.83	9.77 \pm 1.38	<0.0001

Values are presented as mean \pm SD. RPL: recurrent pregnancy loss. p-values calculated using Mann-Whitney U test; $p < 0.05$ was considered statistically significant.

The mean ages of the participants in the control groups were 26.69 ± 4.66 and in the RPL group 29.78 ± 5.35 years ($p = 0.017$). The mean body weight was 64.24 ± 6.55 kg among the controls and 74.22 ± 7.58 kg ($p < 0.001$) in women with RPL. The mean hemoglobin levels were 12.53 ± 0.83 g/dL in the control group compared to 9.77 ± 1.38 g/dL ($p < 0.0001$) in the RPL group. Metabolic indicators in women with RPL showed significantly higher serum TSH levels ($p < 0.0001$) and HbA1c levels ($p < 0.0001$) compared to the healthy control group (Figure 1).

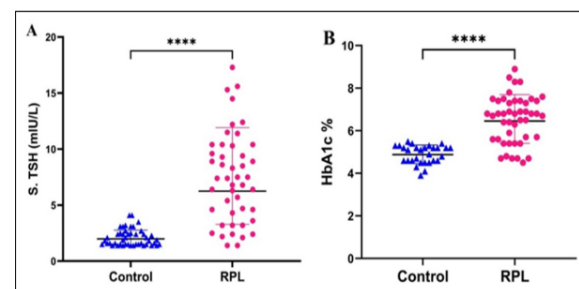


Figure 1: Variation in metabolic parameters between healthy controls and women with RPL; **A)** TSH: thyroid-stimulating hormone, and **B)** HbA1c: glycated hemoglobin levels. Statistical differences were assessed using the non-parametric Mann-Whitney U test. **** p -value < 0.0001 .

Antiphospholipid antibodies IgG and IgM are predominant immunological biomarkers associated with RPL. Figure 2 reveals that APLA IgG ($p < 0.0001$) and IgM ($p < 0.0001$) levels were significantly elevated in women with RPL compared to the healthy control group.

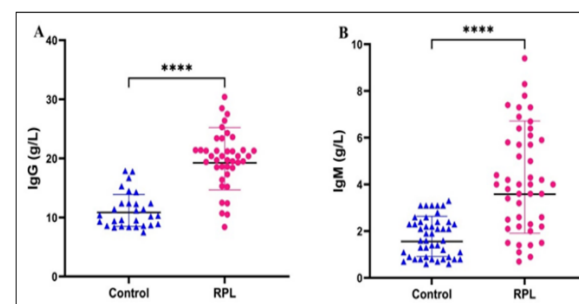


Figure 2: Comparison of antiphospholipid antibodies IgG and IgM between healthy controls and women with RPL; **A)** IgG and **B)** IgM. Statistical differences were assessed using the non-parametric Mann-Whitney U test. **** p -value < 0.0001 .

Figure 3 illustrates that the urinary biochemical markers chemerin, adipsin, and cAMP were significantly elevated in women experiencing RPL compared to healthy controls, with all differences achieving statistical significance ($p < 0.0001$).

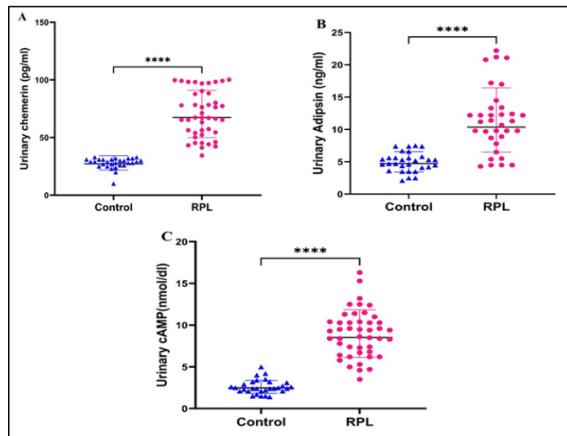


Figure 3: Comparison of urinary biochemical markers between healthy controls and women with RPL; **A)** urinary chemerin, **B)** urinary adipsin, and **C)** urinary cyclic adenosine monophosphate (cAMP) levels. Statistical differences were assessed using the non-parametric Mann–Whitney U test. **** $p < 0.0001$.

Table 2 summarizes Spearman's rank correlation analysis assessing the association between RPL and maternal demographic, biochemical, and urinary biomarker variables. Significant strong positive correlations were identified between RPL and HbA1c ($r = 0.636$, $p = 0.004$) and between RPL and urinary adipsin ($r = 0.677$, $p < 0.0001$). Moderate positive correlations with RPL were observed for urinary cAMP ($r = 0.474$, $p = 0.001$), urinary chemerin ($r = 0.598$, $p < 0.0001$), serum TSH ($r = 0.514$, $p = 0.0003$), aPLA IgG ($r = 0.460$, $p = 0.0015$), and aPLA IgM ($r = 0.578$, $p < 0.0001$).

Table 2: Correlation between RPL and maternal demographic, biochemical, and urinary biomarker parameters

Variables	r	95% CI	p-value
Maternal age (year)	0.299	-0.002-0.551	0.045
Body weight (kg)	0.399	0.119-0.620	0.006
Urinary chemerin	0.598	0.354-0.765	<0.0001
Urinary adipsin	0.677	0.472-0.813	<0.0001
Urinary cAMP	0.474	0.201-0.679	0.001
TSH	0.514	0.260-0.702	0.0003
HbA1c (%)	0.636	0.424-0.782	<0.0001
Hemoglobin (g/dl)	0.144	-0.164-0.427	0.345
aPLA IgG	0.460	0.193-0.664	0.0015
aPLA IgM	0.578	0.339-0.747	<0.0001

Spearman's rank correlation was used to assess associations between the number of recurrent pregnancy losses and metabolic, immunological, and urinary biomarkers. TSH, thyroid-stimulating hormone; cAMP, cyclic adenosine monophosphate; HbA1c, glycated hemoglobin; aPLA, antiphospholipid antibody. $P < 0.05$ considered statistically significant.

Additionally, weak significant positive correlations were noted with maternal age ($r = 0.299$, $p = 0.045$) and body weight ($r = 0.399$, $p = 0.006$). Elevated levels of these variables were associated with an increased number of pregnancy losses in the study. No significant correlations were found between RPL and Hb levels ($r = 0.144$, $p = 0.345$), aPLA IgG ($r = 0.12$, $p = 0.29$), aPLA IgM ($r = 0.06$, $p = 0.58$), or body weight ($r = 0.09$, $p = 0.40$). A summary of the correlation coefficients is provided in Table 2. As

shown in Table 3, maternal age, body weight, metabolic (TSH, HbA1c), immunological (IgG, IgM), and urinary biomarkers (chemerin, adipsin, cAMP) levels show significant association with risk of RPL. Advancing maternal age was associated with 1.6-fold higher odds of RPL (OR= 1.60; 95% CI: 1.12–2.38; $p = 0.010$). Women with elevated TSH levels showed a 2.5-fold increase in the odds of RPL (OR= 2.50; 95% CI: 1.32–4.64; $p = 0.005$), while those with higher HbA1c levels exhibited over four times the odds (OR= 4.20; 95% CI: 1.46–12.10; $p = 0.008$). Increased urinary adipsin (OR=1.40; 95% CI 1.16–1.77; $p = 0.001$) and chemerin (OR= 1.21; 95% CI 1.08–1.37; $p = 0.002$) levels were also linked to elevated risk of RPL. Similarly, higher serum aPLA IgG (OR= 1.41; 95% CI: 1.13–1.74; $p = 0.002$) and aPLA IgM (OR= 3.70; 95% CI: 1.55–8.87; $p = 0.003$) levels were significantly associated with increased risk of RPL. Conversely, urinary cAMP levels (OR= 1.20; 95% CI, 0.92–1.56; $p = 0.174$) and body weight (OR= 0.995; 95% CI, 0.88–1.13; $p = 0.938$) did not reveal significant associations in the model.

Table 3: Multivariable logistic regression analysis of risk factors for recurrent pregnancy loss

Variables	Odds Ratio (OR)	95% CI for OR	p-value
Maternal age	1.6	1.124-2.38	0.01
Body weight	0.995	0.876-1.13	0.938
TSH	2.5	1.323-4.643	0.005
HbA1c (%)	4.2	1.464-12.10	0.008
Urinary cAMP	1.2	0.923-1.560	0.174
Urinary Adipsin	1.4	1.159-1.774	0.001
Urinary Chemerin	1.21	1.076-1.367	0.002
aPLA IgG	1.41	1.13-1.739	0.002
aPLA IgM	3.7	1.55-8.87	0.003

$p < 0.05$ was considered significant; CI: confidence interval; Binary logistic regression.

DISCUSSION

This study evaluated differences in metabolic markers, immune biomarkers, and urinary biochemical parameters to examine their correlations with RPL and to investigate whether these markers can predict early pregnancy loss. Our investigation found that elevated body weight is a risk factor for future pregnancy loss in RPL. Numerous studies have shown a correlation between pregnancy loss and obesity [22,23]. Obese women have a 25–37% higher likelihood of experiencing miscarriage or pregnancy loss before their first live-born child [24]. The current investigation demonstrated increased TSH and HbA1c levels in women with RPL. Bashiri et al. reported a positive correlation between elevated pre-pregnancy TSH levels and the risk of subsequent pregnancy loss in women with RPL. Their findings suggest that abnormal TSH levels may affect endometrial receptivity and glucose availability, potentially leading to impaired early embryo development and a higher risk of pregnancy loss [25]. Furthermore, Mu et al. revealed that elevated pre-pregnancy TSH and FT4 levels, along with reduced T3 levels, were associated with higher risk of subsequent pregnancy loss in women with RPL. These findings highlight the important role of thyroid hormones in implantation and the maintenance of

pregnancy, suggesting that thyroid dysfunction may contribute to pregnancy loss [26]. Similarly, Dimakou *et al.* found that elevated HbA1c levels were linked to an increased risk of miscarriage in women with RPL, indicating that impaired glucose metabolism may play a role in the pathogenesis of recurrent pregnancy loss [27]. The present investigation revealed that elevated levels of APLA, particularly IgG and IgM, were consistently associated with an increased risk of RPL. Al Samarrai *et al.* reported that Iraqi women with spontaneous abortion exhibited higher levels of anticardiolipin and antiphospholipid antibodies, in addition to elevated TSH and HbA1c levels, suggesting that both immune and metabolic factors may contribute to pregnancy loss [28]. Awad *et al.* reported that elevated APLA antibody levels in women with RPL can disrupt normal coagulation processes and impair placental development, contributing to pregnancy complications, including miscarriage, especially in women with a history of RPL [29]. These findings underscore the importance of screening for APLA in women with a history of RPL to identify those at a higher risk and to guide appropriate management strategies. To the best of our knowledge, this study represents the first investigation into the urinary concentrations of chemerin, adipsin, and cAMP in women experiencing RPL. These biomarkers have not been previously examined in this context, making our findings novel. The observed alterations may reflect underlying metabolic and immunological dysregulation, which is increasingly recognized as a contributing factor to pregnancy complications. Although urinary biomarkers have not been studied previously, evidence from serum analyses provides supportive insights. Several studies have reported that elevated serum chemerin levels are associated with RPL, suggesting that chemerin may be linked to inflammatory processes and impaired endometrial receptivity in RPL patients [30,31]. Specifically, chemerin levels are markedly elevated in women with RPL compared to those with successful pregnancies, underscoring its potential involvement in reproductive failure [32]. Additionally, adipsin, a component of the complement system and a regulator of metabolic pathways, has been reported to elevate in serum among women with preeclampsia, indicating its potential involvement in pregnancy complications [33]. These results support our findings and enhance the biological explanation for chemerin dysregulation's impact on RPL. The finding of these urinary biomarkers presents a novel perspective that could enable new approaches for the early diagnosis and risk assessment of RPL. Nonetheless, additional research with more substantial sample sizes with long-term follow-up is required to validate these findings and to investigate how metabolic, immunological, and urine parameters contribute to the pathogenesis of RPL.

Study limitations

This study possesses several limitations that need to be acknowledged. Firstly, the sample size is insufficient to effectively identify associations among various variables. Secondly, the majority of research on RPL has predominantly focused on factors related to women, with limited attention given to the male aspect, such as sperm DNA integrity and oxidative stress. Thirdly, the reliance on self-reported data may introduce recall bias, and the restricted availability of fetal tissue impedes comprehensive pathological analysis. Moreover, urinary biomarkers (cAMP, chemerin, and adipsin) are influenced by renal and metabolic factors and lack established diagnostic thresholds for RPL. Larger longitudinal studies are needed to validate these findings and clarify the biological relevance of these biomarkers.

Conclusion

This study demonstrated a correlation between elevated levels of TSH, HbA1c, antiphospholipid antibodies, and urine biomarkers such as chemerin, adipsin, and cAMP with a higher risk of RPL in women. These findings indicated that the pathophysiology of RPL may involve immunologic and metabolic disorders. In addition, urinary chemerin, adipsin, and cAMP levels are novel biomarkers that may be significant for early diagnosis and risk assessment.

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Conflict of interests

The authors declared no conflict of interest.

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Data sharing statement

Supplementary data can be shared with the corresponding author upon reasonable request.

REFERENCES

1. Ali A, Elfituri A, Doumouchtsis SK, Zini ME, Jan H, Ganapathy R, Divakar H, et al. Managing couples with recurrent miscarriage: A narrative review and practice recommendations. *Int J Gynaecol Obstet.* 2024;164(2):499-503. doi: 10.1002/ijgo.14971.
2. Turesheva A, Aimagambetova G, Ukybassova T, Marat A, Kanabekova P, Kaldygulova L, et al. Recurrent pregnancy loss etiology, risk factors, diagnosis, and management. Fresh look into a full box. *J Clin Med.* 2023;12(12):4074. doi: 10.3390/jcm12124074
3. Al-Fahham AA. Etiology of antisperm antibodies in the serum of virgins. *Open J Obstet Gynecol.* 2018;8(3):236-245. doi: 10.1016/S0015-0282(98)00302-1.
4. Sreelatha S, Nadagoudar S, Devi A. The study of maternal and fetal outcome in pregnant women with thyroid disorders. *Int J*

- Reprod Contracept Obstet Gynecol.* 2017;6(8):3507-3513. doi: 10.18203/2320-1770.ijrcog20173473.
5. Luccioni L, Ficara M, Cenciarelli V, Berardi A, Predieri B, Iughetti L. Long term outcomes of infants born by mothers with thyroid dysfunction during pregnancy. *Acta Bio Medica.* 2020;92(1):e2021010. doi: 10.23750/abm.v92i1.9696.
 6. Tańska K, Gietka-Czernel M, Glinicki P, Kozakowski J. Thyroid autoimmunity and its negative impact on female fertility and maternal pregnancy outcomes. *Front Endocrinol.* 2023;13:1049665. doi: 10.3389/fendo.2022.1049665.
 7. Quan X, Lan Y, Yang X. Thyroid autoimmunity and future pregnancy outcome in women of recurrent pregnancy loss: a meta-analysis. *J Assist Reprod Genet.* 2023;40(11):2523-2537. doi: 10.1007/s10815-023-02933-6.
 8. Biondi B, Kahaly GJ, Robertson RP. Thyroid dysfunction and diabetes mellitus: two closely associated disorders. *Endocr Rev.* 2019;40(3):789-824. doi: 10.1210/er.2018-00163.
 9. Li YH, Marren A. Recurrent pregnancy loss. *Australian J Gen Pract.* 2018;47(7):432-436. doi: 10.31128/AJGP-01-18-4459.
 10. Duman G, Bayram F. Obesity and pregnancy. *Turkish J Diabetes Obes.* 2018;2(3):101-105. doi: 10.25048/tjdo.2018.29.
 11. Sugiura-Ogasawara M. Recurrent pregnancy loss and obesity. *Best Pract Res Clin Obstet Gynaecol.* 2015;29(4):489-497. doi: 10.1016/j.bpobgyn.2014.12.001.
 12. Cavalcante MB, Sarno M, Peixoto AB, Araujo Junior E, Barini R. Obesity and recurrent miscarriage: A systematic review and meta-analysis. *J Obstet Gynaecol Res.* 2019;45(1):30-38. doi: 10.1111/jog.13799.
 13. Alijotas-Reig J, Esteve-Valverde E, Anunciación-Llunell A, Marques-Soares J, Pardos-Gea J, Miró-Mur F. Pathogenesis, diagnosis and management of obstetric antiphospholipid syndrome: a comprehensive review. *J Clin Med.* 2022;11(3):675. doi: 10.3390/jcm11030675.
 14. Chaturvedi S, McCrae KR. Diagnosis and management of the antiphospholipid syndrome. *Blood Rev.* 2017;31(6):406-417. doi: 10.1016/j.blre.2017.07.006.
 15. Schreiber K, Hunt BJ. Managing antiphospholipid syndrome in pregnancy. *Thrombosis Res.* 2019;181:S41-S46. doi: 10.1016/S0049-3848(19)30366-4.
 16. Yu M, Yang Y, Huang C, Ge L, Xue L, Xiao Z, et al. Chemerin: a functional adipokine in reproductive health and diseases. *Biomedicines.* 2022;10(8):1910. doi: 10.3390/biomedicines10081910.
 17. Yang X, Yao J, Wei Q, Ye J, Yin X, Quan X, et al. Role of chemerin/CMKLR1 in the maintenance of early pregnancy. *Front Med.* 2018;12(5):525-532. doi: 10.1007/s11684-017-0577-9.
 18. Yin Y, Xie S, Xu Q, Liao L, Chen H, Zhou R. Circulating chemerin levels in preeclampsia: a systematic review and meta-analysis. *Lipid Health Dis.* 2023;22(1):179. doi: 10.1186/s12944-023-01941-w.
 19. Xu Y, Ma M, Ippolito GC, Schroeder HW, Carroll MC, Volanakis JE. Complement activation in factor D-deficient mice. *Proc Natl Acad Sci.* 2001;98(25):14577-82. doi: 10.1073/pnas.261428398.
 20. Poveda NE, Garcés MF, Ruiz-Linares CE, Varón D, Valderrama S, Sanchez E, et al. Serum adipsin levels throughout normal pregnancy and preeclampsia. *Sci Rep.* 2016;6(1):20073. doi: 10.1038/srep20073.
 21. Kwon H, Pessin JE. Adipokines mediate inflammation and insulin resistance. *Front Endocrinol.* 2013;4:71. doi: 10.3389/fendo.2013.00071.
 22. Metwally M, Saravelos SH, Ledger WL, Li TC. Body mass index and risk of miscarriage in women with recurrent miscarriage. *Fertil Steril.* 2010;94(1):290-295. doi: 10.1016/j.fertnstert.2009.03.021.
 23. Wang RQ, Deng ZM, Chen GT, Dai FF, Xia LB. Obesity and recurrent spontaneous abortion: the crucial role of weight management in pregnancy. *Reprod Biol Endocrinol.* 2025;23(1):10. doi: 10.1186/s12958-024-01326-3.
 24. Malasevskaia I, Sultana S, Hassan A, Hafez AA, Onal F, Ilgun H, et al. A 21st century epidemic-obesity: and its impact on pregnancy loss. *Cureus.* 2021;13(1). doi: 10.7759/cureus.12417.
 25. Bashiri A, Galperin G, Zeadna A, Baumfeld Y, Wainstock T. Increased live birth rate with dydrogesterone among patients with recurrent pregnancy loss regardless of other treatments. *J Clin Med.* 2023;12(5):1967. doi: 10.3390/jcm12051967.
 26. Mu F, Huo H, Wang C, Hu N, Wang F. A new prognostic model for recurrent pregnancy loss: assessment of thyroid and thromboelastograph parameters. *Front Endocrinol.* 2024;15:1415786. doi: 10.3389/fendo.2024.1415786.
 27. Dimakou DB, Tamblyn J, Justin C, Coomarasamy A, Richter A. Diagnosis and management of idiopathic recurrent pregnancy loss (RPL): Current immune testing and immunomodulatory treatment practice in the United Kingdom. *J Reprod Immunol.* 2022;153:103662. doi: 10.1016/j.jri.2022.103662.
 28. Al-Samarrai AA, Hilmi FA, Al-Allawi NA, Murad AF. Antiphospholipid antibodies in Iraqi women with recurrent mid-trimester abortions. *J Lab Physicians.* 2012;4(02):078-82. doi: 10.4103/0974-2727.105586.
 29. Awad DD, Saeed IAHM, Jasim ME. The Association between antiphospholipid and coagulation in pregnant women with blood clotting. *Med J Babylon.* 2024;21(Suppl 2):S272-S275. doi: 10.4103/mjbl.mjbl.926.23.
 30. Ma Z, Chu L, Zhang Y, Lu F, Zhu Y, Wu F, et al. Is chemerin associated with gestational diabetes mellitus? a case-control study. *Diabetes Metab Syndr Obes.* 2023;2271-2281. doi: 10.2147/DMSO.S417632.
 31. Zhang Q, Xiao Z, Lee CL, Duan YG, Fan X, Yeung WS, et al. The regulatory roles of chemerin-chemokine-like receptor 1 axis in placental development and vascular remodeling during early pregnancy. *Front Cell Dev Biol.* 2022;10:883636. doi: 10.3389/fcell.2022.883636.
 32. Mukherji AB, Idowu V, Zhao L, Leung LL, Shen S, Palaniappan L, et al. Chemerin levels in individuals with type 2 diabetes and a normal weight versus individuals with type 2 diabetes and obesity: An observational, cross-sectional study. *Biomedicines.* 2024;12(5):983. doi: 10.3390/biomedicines12050983.
 33. Liu M, Luo X, Xu Q, Yu H, Gao L, Zhou R, et al. Adipsin of the alternative complement pathway is a potential predictor for preeclampsia in early pregnancy. *Front Immunol.* 2021;12:702385. doi: 10.3389/fimmu.2021.702385.