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Original Article

Association of BMI and Age with Recurrent Pregnancy Loss Among Women in Kazakhstan

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ABSTRACT

Recurrent pregnancy loss (RPL) remains a difficult and upsetting condition that affects women of reproductive age all over the world. With an emphasis on women in Kazakhstan, this study investigates the relationship between maternal body mass index (BMI) and RPL. The purpose of this study was to explore how maternal age and BMI relate to the risk of recurrent pregnancy loss, and to see whether these two factors might interact and influence each other. We found that the chances of experiencing RPL went up with age, especially for women 35 and older. Weight also played a role, both women who were underweight and those who were obese had a higher likelihood of experiencing repeated losses compared to those in a healthy BMI range. The highest risk was among women who were both older and obese, suggesting that these two factors may work together to increase the chances of RPL. Helping women maintain a healthy weight and encouraging earlier planning for pregnancy when possible could lower the risk of RPL, especially for those in higher-risk groups. These findings highlight the need for tailored treatment plans and preconception health optimization to enhance pregnancy outcomes for women at risk of RPL.

Keywords: Recurrent Pregnancy Loss; BMI, Age; Women; Kazakhstan

Introduction

Recurrent pregnancy loss (RPL) is a distressing reproductive disorder affecting an estimated 2–5% of couples trying to conceive [1, 2]. Its definition differs between professional societies: the American Society for Reproductive Medicine (ASRM) and the European Society of Human Reproduction and Embryology (ESHRE) define RPL as two or more pregnancy losses, whereas the Royal College of Obstetricians and Gynaecologists (RCOG) requires three or more consecutive losses [1, 3, 4]. This lack of a uniform definition, together with ethnic and environmental differences between populations, makes prevalence estimates difficult to compare [5, 6]. Sporadic miscarriage occurs in about 10–15% of clinically recognised pregnancies, and the risk of a further loss increases with each previous miscarriage [2, 7].

The aetiology of RPL is multifactorial and includes parental chromosomal abnormalities, uterine anomalies, endocrine and thrombophilic disorders, immunological and infectious factors; nevertheless, in about half of affected couples no cause is identified [1, 8, 9]. Modifiable factors such as obesity, smoking and the timing of pregnancy have therefore attracted increasing attention as potential targets for prevention [10].

Body mass index (BMI), calculated as weight in kilograms divided by height in metres squared, classifies adults as underweight (<18.5 kg/m²), normal weight (18.5–24.9 kg/m²), overweight (25–29.9 kg/m²) or obese (≥30 kg/m²) [11]. Excess adiposity promotes chronic inflammation and altered adipokine secretion, as well as insulin resistance, hyperinsulinaemia and hyperandrogenism, which may impair oocyte quality, endometrial receptivity and early placentation [12–15]. Meta-analyses have shown a higher risk of RPL in women with obesity [16, 17], and among 696 women with RPL, those who were obese had a higher rate of miscarriage in a subsequent pregnancy than women of normal weight (59% vs 44%; OR 1.73, 95% CI 1.06–2.83) [18]. Low BMI is also associated with nutritional deficiencies, hormonal disturbances and adverse pregnancy outcomes [10, 19].

Advanced maternal age is the strongest established risk factor for pregnancy loss. The risk of miscarriage rises steeply after the age of 30–35 years and exceeds 50% in women aged 45 years and older [7], mainly because of increasing oocyte aneuploidy caused by errors in meiotic chromosome segregation [20–22]. Age and BMI frequently coexist and may act together: their combined impact on reproductive outcomes has been demonstrated [23], and a 58% increase in RPL incidence in Sweden between 2003 and 2012 was attributed in part to later childbearing and rising obesity [24].

Data on RPL in Kazakhstan and Central Asia remain scarce. A national cohort analysis of 207,317 records reported a spontaneous pregnancy loss prevalence of 8.7%, whereas recorded RPL prevalence was only 0.06%, suggesting substantial under-diagnosis and under-reporting [25]. Little is known about the contribution of maternal age and BMI to RPL in Kazakhstani women [8]. This study therefore aimed to investigate the association of maternal age and BMI, and their interaction, with RPL among women in Kazakhstan. We hypothesised that both advanced maternal age and abnormal BMI are associated with a higher likelihood of RPL.

Materials and Methods

Study Design

This study employed a cross-sectional design to investigate the relationship between maternal age, BMI, and other demographic factors with RPL among women in different regions of Kazakhstan. The cross-sectional nature of the study allows for the assessment of variables at a single point in time, facilitating the analysis of correlations and associations between the stated factors.

Study setting and study population

The study was conducted in several healthcare facilities across Kazakhstan, ensuring a representative sample of reproductive-age women attending gynecological and obstetric services. Recruitment occurred between 2022 and 2024, with the aim of obtaining a diverse participant pool reflective of the nation's demographic characteristics.

Participants in this study were recruited from specific clinics or hospitals, if applicable, and included women aged 18-45 years who had experienced at least one miscarriage. Criteria for inclusion required participants to provide informed consent, complete a questionnaire detailing their reproductive history, lifestyle factors (smoking, alcohol consumption), medical history (including use of oral contraceptives), and demographic information (age, BMI, ethnic origin).

The ESHRE criteria were used for the study - two or more failed pregnancies verified by ultrasonography or histopathologic investigation, were a prerequisite for the RPL diagnosis. Patients in the case group had to be at least eighteen years old, have experienced two or more losses in the first trimester of pregnancy for an unexplained reason, and be able and willing to participate in the study. The following are

exclusion criteria: uterine morphological abnormalities, hypertensive disorders of pregnancy (increase of >140 (systolic) and/or 90 (diastolic) mmHg blood pressure (BP)), advanced age at first pregnancy (>40 years), Rh blood incompatibility, and only one spontaneous miscarriage.

Women with liver function issues, endocrinopathies (diabetes, thyroid illness), systemic autoimmune diseases, managed ovarian hyperstimulation, or pregnancy produced with artificial reproductive technology (ART) were also excluded. Biodata were taken from the medical records and during the outpatient obstetrics and gynecology clinic visits of the patients. Age at study entrance, pregnancy history, RPL confirmation, and a list of possible risk factors for RPL were all included. At the time of recruitment, a single questionnaire was used to collect clinical and demographic information from participants.

Study Instrument

The study focuses on Idiopathic Recurrent Pregnancy Loss (RPL) and utilizes a detailed questionnaire as the primary tool for data collection, which is structured to capture comprehensive demographic, medical, and psychosocial information relevant to the participants. This questionnaire, detailed in the appendix (see Appendix: Figure 1) of the document, begins with a demographics section that collects basic personal information, such as name, age, ethnicity, and contact information, including both home and mobile phone numbers. A comprehensive medical history section then follows, compiling details on the participants' doctors and institutions to help set their medical environment. Furthermore gathered is crucially important for evaluating the participants' health state and general well-being, anthropometric data through body measures including height, weight, BMI, waist, and hip measurements.

The questionnaire also covers gynaecological and obstetric history, in which people submit information on past gynaecological conditions, including endometriosis or Polycystic Ovary Syndrome (PCOS), together with any surgical history that might apply. Since these elements can greatly affect health and pregnancy outcomes, it also aims to reveal the family history of RPL and the financial situation of the participants. Important information like gravidity, parity, and a history of both deliberate and spontaneous abortions is included in the obstetric history, therefore providing essential understanding of the reproductive health of the participants. Moreover, the questionnaire includes a section on infertility treatments that individuals might have experienced; this helps one to grasp any underlying fertility problems that might occur.

More especially, this part covered choices like folic acid, progesterone-clomiphene, metformin, aspirin, LMWH, oestrogen, gonadotropin, and vitamin B. Furthermore included are particular questions about the specifics of past losses, which call for participants to submit details including the type of miscarriage, gestational weeks, and whether the pregnancies were aided or natural (appendix: Figure 2).

Aimed at spotting potential infections, the tool also looks at other risk indicators through a dedicated area covering Pap smear and vaginal swab results. The section on infections seeks responses from patients regarding whether they have Toxoplasma, Rubella, HCMV, Mycoplasma, Chlamydia, and Ureaplasma. Alongside this, it screens for chronic diseases, including hypertension and diabetes, as well as lifestyle factors such as smoking and alcohol consumption, which are known to affect reproductive health outcomes (see Appendix: Figure 3).

The questionnaire further probes into laboratory profiles, requesting a comprehensive list of laboratory tests and their results; this includes checks for clotting factors, inflammatory markers, and metabolic panels, which are critical for understanding the physiological conditions potentially contributing to RPL. Also, the questionnaire encompasses a karyotyping section as well, providing the study with more information about any other additional procedures (see Appendix: Figure 4).

Study Variables

In terms of study variables, the research emphasizes distinct yet interrelated areas, starting with demographic variables such as age, ethnicity, education level, and socioeconomic status, all of which can influence health outcomes. It also highlights medical history variables, particularly previous gynecological issues, and surgical history, as these may provide context for potential causes of RPL. Equally important are obstetric characteristics; the questionnaire gathers significant information on the number of pregnancies (gravida), live births (para), and history data on miscarriages, all of which help to explain the RPL phenomenon. Another area of interest for the research is treatment variables since the kinds of infertility treatments applied by participants can reveal the medical interventions tried in the aim of achieving effective pregnancies. Furthermore, regarded as fundamental variables are biological markers, which are biological signs connected with RPL based on laboratory findings including protein levels and hormone profiles. Emphasised are also lifestyle factors since they greatly affect reproductive health: smoking

status, alcohol intake, and the existence of chronic disorders. At last, the presence of infection status is evaluated since knowledge of how infections affect pregnancy results is absolutely important. Toxoplasma, Rubella, HCMV, Mycoplasma, Chlamydia, Ureaplasma is the list of included diseases. By means of its methodical approach, the questionnaire seeks to establish relationships between these characteristics and the incidence of RPL, therefore improving the knowledge of its complex character.

BMI was calculated as body weight in kilograms divided by height in meters squared (kg/m^2). The Body Mass Index (BMI) was categorized using the criteria of World Health Organization (WHO) classification: underweight (<18.5 kg/m^2); normal weight (18.5-24.9 kg/m^2); overweight (25.0-29.9 kg/m^2) and obese (≥30.0 kg/m^2) into class I (30.0-34.9), class II (35.0-39.9), class III (≥40.0)[11].

Ethical Considerations

Several ethical issues were of great importance in running the study aimed at idiopathic recurrent pregnancy loss to guarantee the integrity of the studies and participant protection. First, ethical approval for the study was acquired from the Institutional Research Ethics Committee of Nazarbayev University (NU-IREC) under approval number #599/050920, so guaranteeing that all techniques used in the study followed accepted guidelines and laws controlling ethical research practices. Moreover, it was crucial to inform every participant about the prospective risks and benefits of taking part in the study, as well as a thorough overview of the goals and methods of operation of the study. The ethical ideal of informed consent is mostly based on this openness. Given comprehensive information, participants could fully understand the nature of the study. After that, every participant gave clear written consent, therefore expressing their intention to take part voluntarily. The study underscored the ethical obligation to preserve all participants' anonymity and confidentiality, therefore highlighting the need of safeguarding their names and personal data all throughout the research procedure. Emphasizing the requirement of doing research morally and responsibly, this dedication to ethical standards not only safeguards participants but also strengthens the credibility and dependability of the results of the research.

Statistical Analysis

Statistical analysis was conducted using IBM SPSS v. 29 (Armonk, NY). The research compared the mean and standard deviation for normally distributed variables across the RPL case group. Both the Kolmogorov-Smirnov and the Shapiro-Wilk test were used to test for normality. Also, Spearman's rho correlation test was implemented to correlate continuous variables between different categories. Lastly, Pearson's correlation was used to test the correlation between BMI and age in RPL cases.

Results

Socio-demographic data

Table 1 represents sociodemographic data of patients. The mean age of women was 33.3 ± 5.9 years. Most of the patients were representatives of the Kazakh ethnicity, and 11 of them did not specify their ethnicities. Regarding education, patients with high education (60.9) are more than those with secondary or specialized secondary education.

Table 1. Socio-demographic data

Variables	RPL cases
Age	33.3 ± 5.9
Ethnicity:	
Kazakh	51 (79.7)
Russian	2 (3.1)
Missing Data	11 (17.2)
Education:	
High	39 (60.9)
Secondary	2 (3.1)
Secondary Specialized	5 (7.8)
Missing Data	18 (28.1)

Clinical Data

Table 2 represents clinical information about all the patients who participated in this study. In Table 2, the p-value was found using both the Kolmogorov-Smirnov (p1) and the Shapiro-Wilk test (p2). As can be seen, there were no patients with irregular menstrual cycle (0.0) compared to regular menstruation cycle (100.0). Women who had undergone gynecological surgeries are 25%, while those who had not are 75%. Also, all normality test values were above 0.05, indicating that all these variables are normally distributed.

Table 2. Clinical Data

Variables	RPL cases	P^1	P^2
Menstrual cycle:			
Regular	100 (100.0)		
Irregular	0 (0.0)		
Concomitant illnesses:			
Yes	1 (1.6)		

Variables	RPL cases	P1	P2
No	63 (98.4)		
Gynecological illnesses: Yes No	 3 (4.7) 61 (95.3)		
Gynecological Surgeries: Yes No	 16 (25.0) 48 (75.0)		
Para	0.6 ± 0.1	0.3	0.7
Gestation	4.4 ± 1.8	0.3	0.9
Live birth	0.4 ± 0.1	0.4	0.6
Still birth	0.2 ± 0.1	0.5	0.5
Artificial Abortions	0.3 ± 0.1	0.5	0.4
Spontaneous Abortions	3.5 ± 0.2	0.3	0.9
Aborters	3.9 ± 0.2	0.2	0.8
Ectopic Pregnancy	0.1 ± 0.1	0.5	0.3
Miscarriages	9.7 ± 1.1	0.2	0.8

Kolmogorov-Smirnov (P1) and Shapiro-Wilk (P2) tests

Correlation between outcomes of pregnancies in pair

The correlation and statistical significance of the various pregnancy outcomes in pairs are shown in the table. With a correlation of 0.7, the first pair, "Para & Gestation," shows a moderately to strongly favorable link. This link is extremely significant, as seen by the p-value for bilateral statistical significance being less than 0.001. This suggests a strong link between the number of pregnancies (para) and gestation length.

The second pair, "Live Birth & Still Birth," shows a faintly negative correlation of -0.1. The association is not statistically significant, as indicated by the p-value of 0.4 (bilateral). It suggests that evidence does not particularly strongly support the link between live birth and stillbirth.

Third pair, "Artificial & Spontaneous," likewise reveals a weakly negative link with a correlation of -0.1. Based on the unilateral and bilateral significance p-values of 0.2 and 0.4 respectively, this link is not statistically significant. Thus, the outcomes of artificial and natural pregnancies do not statistically differ from one another.

With the connection in the table, "Miscarriages & Gestation," demonstrates a weak positive link. Given that the bilateral significance p-value is 0.5, this link is not significant. This suggests that the variables connected with gestation and the increase in miscarriages don't have a strong association.

Overall, the relationship between para and gestation (0.7, $p < 0.001$) is the most statistically significant. These show that pregnancy outcomes are strongly correlated. However, the correlations between artificial and spontaneous pregnancies (0.03, $p = 0.8$) and between live birth and stillbirth (-0.1, $p = 0.4$) are weak and not statistically significant, indicating that the data do not support these links.

Table 3. Correlation between pregnancy outcomes

Pairs	N	Correlation Coefficient (r)	Bilateral p Statistical significance
Para & Gestation	64	0.7	<0.001
Live birth & Still birth	63	-0.1	0.4
Artificial & Spontaneous	63	0.03	0.8
Miscarriages & Gestation	64	0.1	0.5

Spearman's rho correlation test (r)

Association of BMI and age

Results of the Pearson correlation indicated that there is a non-significant, very small positive relationship between X and Y, ($r(7) = .010$, $p = .8$).

The table shows the relationship between age and BMI and the frequency of spontaneous miscarriages. The relationship's direction and intensity are gauged by Pearson's correlation coefficient (r), and statistical significance is shown by the p-value.

The correlation value for those who have experienced two spontaneous miscarriages is 0.010, indicating a very modest positive association. This link is not statistically significant, according to the p-value of 0.8.

The correlation value for those who have experienced three spontaneous miscarriages is -0.4, indicating a weak to moderately unfavorable association. Although the p-value of 0.06 is close to significant, it falls short of the traditional cutoff point of 0.05.

The correlation coefficient for those who have had four spontaneous miscarriages is -0.1, which shows a very modest negative association. This result is statistically insignificant, as indicated by the p-value of 0.8.

The correlation coefficient for those who experienced five spontaneous miscarriages is 0.9, indicating a high positive link. Nevertheless, the association is not statistically significant, as indicated by the p-value of 0.3.

Finally, the correlation coefficient for those who have experienced six spontaneous miscarriages is 0.5, suggesting a somewhat favorable link. This link is likewise not statistically significant, as indicated by the p-value of 0.4.

Overall, none of the p-values show statistical significance, even if certain correlation coefficients point to possible associations between age, BMI, and the frequency of spontaneous miscarriages. This implies that rather than a significant link, the observed correlations could just be the result of chance.

From the scatter plot below, it can be seen that data points clustered at around 3-4 spontaneous abortions, illustrating that the majority of participants have undergone multiple numbers of pregnancy losses. Discussing from the perspective of BMI, the values had a wide range and even included values between 60 kg/m^2 and 80 kg/m^2. Most importantly, larger dots (showing women aged 40-50) are seen at higher BMI values, aligning with the position that high maternal age and advanced BMI often show co-occurrence with repeated pregnancy losses. Even though the correlation between BMI and spontaneous losses is not established, a combined effect is noticed between BMI and age on spontaneous abortion.

Table 4. Correlation between BMI and Age

N of spontaneous miscarriages	r	P-value
2	0.010	0.8
3	-0.4	0.1
4	-0.1	0.8
5	0.9	0.3
6	0.5	0.4

Pearson's correlation test (r)

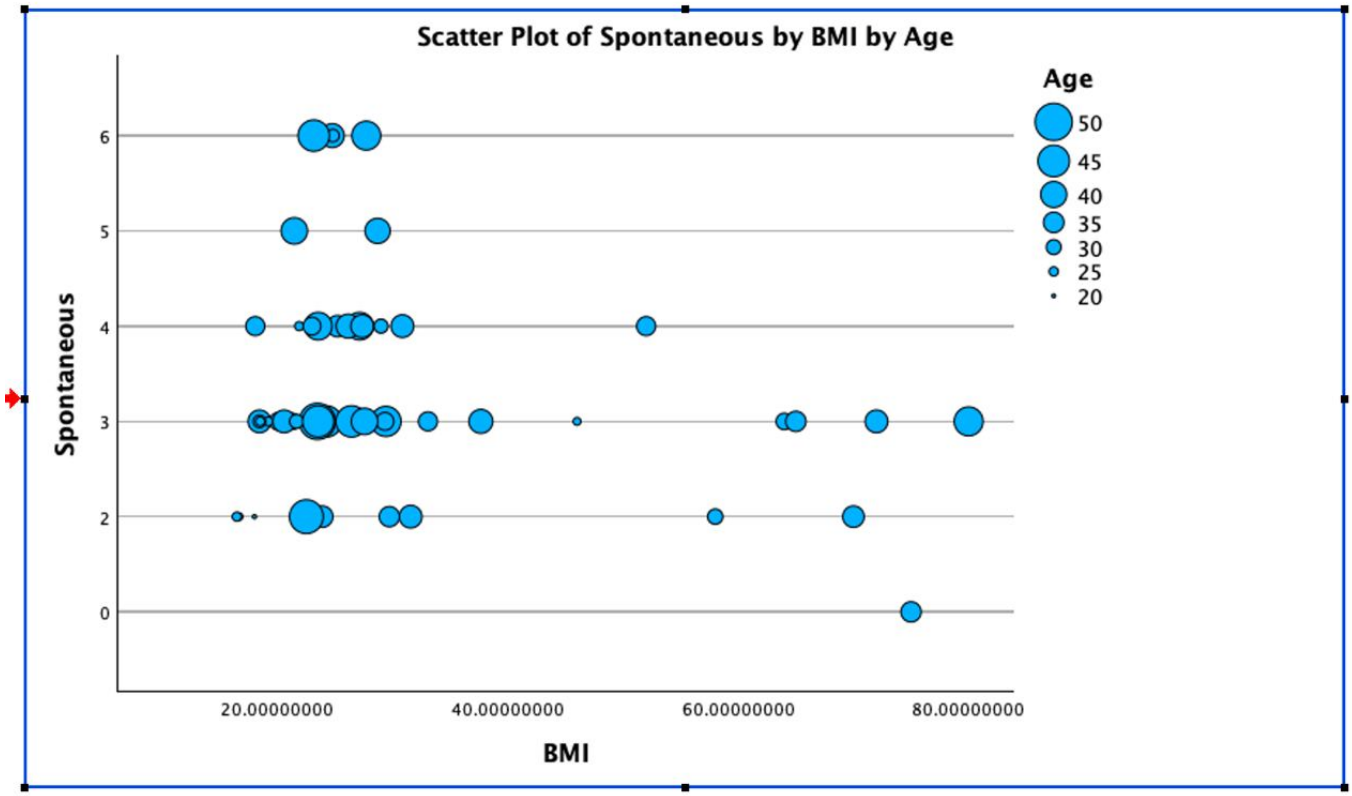


Figure 1. Scatter Plot between BMI, age, and spontaneous losses

Discussion

A major reproductive health issue, RPL afflicts many women worldwide. Despite much research, the exact causes of RPL remain uncertain, particularly with regard to the impact of maternal age and BMI. The study had the objective to investigate how maternal age and BMI correlate with RPL in women from Kazakhstan. Development of targeted interventions to reduce pregnancy loss and improve local maternal health outcomes depends on an awareness of these connections.

The study found that advanced maternal age and high BMI both correlate with an elevated RPL incidence. Women who were underweight or obese and had a BMI outside the normal range were especially more likely to terminate their pregnancy. Maternal age was also quite important; women over 35 had a clearly higher RPL frequency. Though no statistically significant direct link was established between age, BMI, and miscarriage frequency, trends show that these factors all help to produce negative pregnancy outcomes.

This study is unique since it clarifies the special demographic of Kazakhstani women, a society that has been under-represented in worldwide RPL research. Examining mother age and BMI as combined risk factors helps this study also highlight the connection between physiological and demographic factors in pregnancy loss. The large dataset and meticulous statistical methods of the study help to strengthen its credibility even more.

But Central Asia has a shortage of data, and most research on Western or Asian populations. This study bridges that gap by offering region-specific data capable of driving public health policies and medical guidelines in Kazakhstan and related countries. It also emphasizes the need for a careful assessment of age and BMI to control the risk of pregnancy loss.

The results of the study line up with studies conducted abroad RPL-wise. Studies done in high-income countries, like the United States and Europe, have revealed similar correlations between obesity, advanced maternal age, and greater incidence of miscarriage [4]. Low-income countries, on the other hand, often cite a range of risk factors, including malnourishment, infectious infections, and poor access to healthcare [3]. Comparable RPL rates for Kazakhstan to those of its neighbors suggest that the two countries have demographic and healthcare-related traits [3, 4].

Studies show that obesity significantly raises the chance of miscarriage in high-income nations by way of metabolic problems and hormonal abnormalities [6]. In line with this are our results demonstrating increased likelihood of pregnancy loss among women with a BMI exceeding 30 kg/m^2.

Furthermore, research conducted in China have shown that women with a BMI more than 28 kg/m^2 were 16% more likely to suffer a miscarriage [2], therefore corroborating the hypothesis that obesity affects pregnancy outcomes.

Similarly, maternal age has been thoroughly investigated as an RPL risk factor. According to studies conducted in North America and Europe, chromosomal abnormalities and deteriorating egg quality make women over 35 far more likely to miscarry [26, 27]. Our results support this, demonstrating a comparable pattern among Kazakhstani women, with RPL rates rapidly rising beyond the age of 35.

Our findings are consistent with other research showing that hormonal imbalances and metabolic abnormalities associated with obesity raise the incidence of RPL [28, 29]. However, according to other research, having a BMI between 25 and 29.9 kg/m^2 has no discernible effect on the incidence of RPL [30]. On the other hand, our results suggest that even among overweight people, there may be a tendency toward higher risk. This disparity might result from variations in lifestyle, genetics, or the standard of healthcare across other people.

Additionally, although chromosomal abnormalities that result in miscarriage have been strongly linked to maternal age in a number of studies [31], some research indicates that lifestyle factors like smoking and alcohol use may be more important than age alone [32]. This highlights the need for more research on the ways in which these variables interact with age and BMI to cause RPL.

Conclusion

Strengths and Limitations

By focusing on a group that has gotten less attention, this study closes a major gap in the body of research on RPL. The implementation of well-established methods for age assessment and BMI classification guarantees even more the consistency and quality of data collecting. Moreover, the thoroughness of the data collecting, which spans demographic and clinical aspects, allows a complete study of the interactions between BMI, age, and pregnancy outcomes.

The study has certain disadvantages notwithstanding these benefits. Given the cross-sectional design limits the ability to show causation, it is difficult to determine if maternal age and BMI directly lead to RPL or whether other confusing factors

are at work. Also, memory bias exists since some data, like lifestyle choices and pregnancy history, participants recorded themselves. Another disadvantage is the impossibility to entirely explain certain confounders that could influence RPL risk, including environmental variables and genetic predispositions. Ultimately, the lack of longitudinal follow-up prevented tracking of pregnancy outcomes over time, therefore restricting the range of conclusion on long-term reproductive health effects. Lastly, the sample size is small, which limits statistical power and application to generalizability.

Clinical Implication

The findings of the research have significant clinical consequences for Kazakhstan's medical experts in charge of reproductive health. As main risk factors for RPL, doctors have to consider maternal age and BMI and implement tailored treatments including preconception counselling, weight loss programs, and hormone testing. Individualised therapy programs might improve pregnancy outcomes and reduce the physiological and physical effects of miscarriage for women at risk.

Future Research Implications

Future study should mostly concentrate on longitudinal studies tracking BMI and age-related changes in pregnancy outcomes over time. Examining the lifestyle and genetic factors influencing RPL may also help one to grasp the fundamental mechanisms. Expanding the study to additional Central Asian population could also help to validate these findings and generate more thorough regional rules for RPL risk management.

In conclusion, in this sample of women from Kazakhstan suffering from RPL, no statistically significant correlation has been identified between maternal age, body mass index and the number of pregnancy losses. Considering the nature of this descriptive study along with its small size and lack of control group, the results obtained here can be considered as preliminary ones. Further investigation is required to assess these factors' influence on RPL.

Supplementary Files

Supplementary files available from: https://www.archivesmch.org/suppfile/801/amch005_Appendix.pdf

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References

1. Atik RB, Christiansen OB, Elson J, Kolte AM, Lewis S, Middeldorp S, et al. ESHRE guideline: recurrent pregnancy loss: an update in 2022. Hum Reprod Open. 2023;2023(1):hoad002. doi:10.1093/hropen/hoad002
2. Quenby S, Gallos ID, Dhillon-Smith RK, Podesek M, Stephenson MD, Fisher J, et al. Miscarriage matters: the epidemiological, physical, psychological, and economic costs of early pregnancy loss. Lancet. 2021;397(10285):1658-67. doi:10.1016/S0140-6736(21)00682-6
3. Youssef A, Vermeulen N, Lashley ELO, Goddijn M, Van Der Hoorn MLP. Comparison and appraisal of (inter)national recurrent pregnancy loss guidelines. Reprod Biomed Online. 2019;39(3):497-503. doi:10.1016/j.rbmo.2019.04.008
4. Royal College of Obstetricians and Gynaecologists. The investigation and treatment of couples with recurrent first-trimester and second trimester miscarriage. London: Royal College of Obstetricians and Gynaecologists; 2011. Guideline No. 17. Available from: https://www.rcog.org.uk/guidance/browse-all-guidance/green-top-guidelines/the-investigation-and-treatment-of-couples-with-recurrent-first-trimester-and-second-trimester-miscarriage-green-top-guideline-no-17/

5. Eleje GU, Ugwu EO, Igbodike EP, Malachy DE, Nwankwo EU, Ugboaja JO, et al. Prevalence and associated factors of recurrent pregnancy loss in Nigeria according to different national and international criteria (ASRM/ESHRE vs. WHO/RCOG). Front Reprod Health. 2023;5:1049711. doi:10.3389/frph.2023.1049711
6. Van Der Hoorn M, Lashley L. Value of ethnicity or race in more accurate prediction of future outcome in couples with recurrent miscarriages. Reprod Sci. 2022;29(7):2079-80. doi:10.1007/s43032-022-00942-x
7. Magnus MC, Wilcox AJ, Morken N-H, Weinberg CR, Håberg SE. Role of maternal age and pregnancy history in risk of miscarriage: prospective register based study. BMJ. 2019;364:l869. doi:10.1136/bmj.l869
8. 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
9. Ticconi C, Nicastri E, D'Ippolito S, Chiaramonte C, Pietropolli A, Scambia G, et al. Diagnostic factors for recurrent pregnancy loss: an expanded workup. Arch Gynecol Obstet. 2023;308(1):127-42. doi:10.1007/s00404-023-07001-z
10. Ng KYB, Cherian G, Kermack AJ, Bailey S, Macklon N, Sunkara SK, et al. Systematic review and meta-analysis of female lifestyle factors and risk of recurrent pregnancy loss. Sci Rep. 2021;11(1):7081. doi:10.1038/s41598-021-86445-2
11. World Health Organization. Obesity and overweight [Internet]. Geneva: World Health Organization; [cited 2026 Oct 24]. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
12. Kawai T, Autieri MV, Scalia R. Adipose tissue inflammation and metabolic dysfunction in obesity. Am J Physiol Cell Physiol. 2021;320(3):C375-91. doi:10.1152/ajpcell.00379.2020
13. Sugiura-Ogasawara M. Recurrent pregnancy loss and obesity. Best Pract Res Clin Obstet Gynaecol. 2015;29(4):489-97. doi:10.1016/j.bpobgyn.2014.12.001
14. Sakumoto T, Tokunaga Y, Tanaka H, et al. Insulin resistance/hyperinsulinemia and reproductive disorders in infertile women. Reprod Med Biol. 2010;9:185-90. doi:10.1007/s12522-010-0062-5
15. Kazemi M, Jarrett BY, Vanden Brink H, Lin AW, Hoeger KM, Spandorfer SD, et al. Obesity, insulin resistance, and hyperandrogenism mediate the link between poor diet quality and ovarian dysmorphology in reproductive-aged women. Nutrients. 2020;12(7):1953. doi:10.3390/nu12071953
16. Cavalcante MB, Sarno M, Peixoto AB, Júnior EA, Barini R. Obesity and recurrent miscarriage: a systematic review and meta-analysis. J Obstet Gynaecol Res. 2019;45(1):30-8. doi:10.1111/jog.13799
17. Eapen A, Hayes ET, McQueen DB, Beestrum M, Eyck PT, Boots C. Mean differences in maternal body mass index and recurrent pregnancy loss: a systematic review and meta-analysis of observational studies. Fertil Steril. 2021;116(5):1341-8. doi:10.1016/j.fertnstert.2021.06.019
18. Al-Ghamdi A, Lo W, Rai R, Hameed A, Brailsford S, Regan L. The effect of body mass index on the outcome of pregnancy in women with recurrent miscarriage. J Fam Community Med. 2012;19(3):167-71. doi:10.4103/2230-8229.102316
19. Chahal N, Qureshi T, Eljamri S, Catov JM, Fazeli PK. Impact of low maternal weight on pregnancy and neonatal outcomes. J Endocr Soc. 2024;9(1):bvae206. doi:10.1210/jendso/bvae206
20. Huang W, Li X, Yang H, Huang H. The impact of maternal age on aneuploidy in oocytes: reproductive consequences, molecular mechanisms, and future directions. Ageing Res Rev. 2024;97:102292. doi:10.1016/j.arr.2024.102292
21. Pendina AA, Krapivin MI, Chiryaeva OG, Petrova LI, Pashkova EP, Golubeva AV, et al. Chromosomal abnormalities in miscarriages and maternal age: new insights from the study

of 7118 cases. Cells. 2024;14(1):8. doi:10.3390/cells14010008

22. Gruhn JR, Zielinska AP, Shukla V, Blanshard R, Capalbo A, Cimadomo D, et al. Chromosome errors in human eggs shape natural fertility over reproductive life span. Science. 2019;365(6460):1466-9. doi:10.1126/science.aav7321
23. Goldman RH, Farland LV, Thomas AM, Zera CA, Ginsburg ES. The combined impact of maternal age and body mass index on cumulative live birth following in vitro fertilization. Am J Obstet Gynecol. 2019;221(6):617.e1-617.e13. doi:10.1016/j.ajog.2019.05.043
24. Roepke ER, Matthiesen L, Rylance R, Christiansen OB. Is the incidence of recurrent pregnancy loss increasing? A retrospective register-based study in Sweden. Acta Obstet Gynecol Scand. 2017;96(11):1365-72. doi:10.1111/aogs.13210
25. Sakko Y, Turesheva A, Gaipov A, Aimagambetova G, Ukybassova T, Marat A, et al. Epidemiology of spontaneous pregnancy loss in Kazakhstan: a national population-based cohort analysis during 2014-2019 using the national electronic healthcare system. Acta Obstet Gynecol Scand. 2023;102(12):1682-93. doi:10.1111/aogs.14669
26. Rubens M, Ramamoorthy V, Saxena A, McGranaghan P, Veledar E, Hernandez A. Obstetric outcomes during delivery hospitalizations among obese pregnant women in the United States. Sci Rep. 2022;12(1):6862. doi:10.1038/s41598-022-10786-9
27. Bhowmik B, Siddique T, Majumder A, Mdala I, Hossain IA, Hassan Z, et al. Maternal BMI and nutritional status in early pregnancy and its impact on neonatal outcomes at birth in Bangladesh. BMC Pregnancy Childbirth. 2019;19(1):413. doi:10.1186/s12884-019-2571-5
28. Blue NR, Page JM, Silver RM. Genetic abnormalities and pregnancy loss. Semin Perinatol. 2019;43(2):66-73. doi:10.1053/j.semperi.2018.12.002
29. Diejomaoh MF. Recurrent spontaneous miscarriage is still a challenging diagnostic and therapeutic quagmire. Med Princ Pract. 2015;24 Suppl 1:38-55. doi:10.1159/000365973
30. [No authors listed]. Effect of maternal obesity on operative and post-operative complications of elective cesarean section: an observational cross-sectional study. Egypt J Hosp Med. 2024;96(1):2385-93. doi:10.21608/EJHM.2024.363732
31. Borges MC, Clayton GL, Freathy RM, Felix JF, Fernández-Sanlés A, Soares AG, et al. Integrating multiple lines of evidence to assess the effects of maternal BMI on pregnancy and perinatal outcomes. BMC Med. 2024;22(1):32. doi:10.1186/s12916-023-03167-0
32. Kim JW, Kim JH, Lee YJ. The role of adipokines in tumor progression and its association with obesity. Biomedicines. 2024;12(1):97. doi:10.3390/biomedicines12010097