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Prevalence and Risk Factors of Postpartum Hemorrhage in Cesarean Section: A Retrospective Cohort Study

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ABSTRACT

Background & Objective: Globally, postpartum hemorrhage (PPH) remains a leading cause of maternal deaths. However, in many low and middle-income countries, information on the magnitude of and risk factors for PPH is scarce. Understanding the relative contributions of different risk factors for PPH is important. We assessed the incidence of and risk factors for postpartum hemorrhage among women who had a cesarean section in Iran.

Materials & Methods: Between March 2021 and March 2022, a prospective cohort study was conducted at a university-affiliated general hospital for women who had a cesarean section in Iran. We used Spearman's correlation for the variables associated with PPH.

Results: Among the 300 women, the overall incidence of postpartum hemorrhage was 15.7%. Risk factors for postpartum hemorrhage among deliveries by cesarean section were: body-mass index, previous PPH, preoperative anemia, and preoperative hypofibrinogenemia.

Conclusion: The incidence of postpartum hemorrhage in the cesarean section was high. Extra vigilance in all women with cesarean section could address the risk factors identified.

Keywords: Cesarean section, Cohort Studies, Postpartum hemorrhage, Risk factors

Introduction

In most countries throughout the world, obstetric hemorrhage is the most common and lethal side effect of pregnancy (1, 2). Postpartum hemorrhage used to be defined as a blood loss of more than 500 mL estimated with a vaginal birth or more than 1000 mL estimated with a cesarean delivery (PPH) (1). Some important secondary consequences of bleeding include shock, adult respiratory distress syndrome, disseminated intravascular coagulation, acute renal failure, loss of fertility, and pituitary necrosis (1). About 27.1% of all maternal deaths worldwide and 43.7% of all maternal deaths in Iran are caused by postpartum hemorrhage (3, 4).

Atonicity of the uterus is the most common cause of PPH. When the placenta separates, inadequate contraction and retraction of the uterine musculature prevent the ruptured uterine sinuses from being sufficiently squeezed, which results in ongoing bleeding (5).

Primary postpartum hemorrhage can occur in any pregnant woman without any risk factors (6, 7), but numerous studies have identified factors that may help predict it. These include prepartum anemia (8), prolonged labor (9, 10), induction of labor (11), delivery by Cesarean section (11, 12) history of severe PPH (13), multiple pregnancies (10, 12, 13), preeclampsia (9, 13), mothers with older ages (8, 12), fetal macrosomia (8, 12), and multiparity (10).

The implementation of measures to lower the risk of maternal morbidity and mortality requires PPH prediction. This study's main goal was to determine the prevalence and causes of PPH (using the new definition) among mothers who gave birth in general hospitals that provided tertiary care. Nongovernmental organizations, people in charge of developing programs, and decision-makers can therefore assist the scientific community.

Methods

In a general hospital in Tehran, Iran, 300 mothers participated in this study between March 21, 2021, and March 21 of the following year. All women who underwent cesarean sections at the hospital during the research period made up the source population. The study excluded mothers who were under the age of 18, had gestational age less than 37 weeks or expressed dissatisfaction with the research.

Hospital records of 300 pregnant women who underwent elective Cesarean sections were reviewed after receiving approval from the Iran National Committee for Ethics in Biomedical Research (Code of Ethics: IR.SBMU.RETECH.REC.1402.032). The name of patients was left off of the written questionnaire out of respect for privacy.

At the time of admission to the operating theater before surgery, the following parameters were measured: prothrombin time (PT), partial thromboplastin time (PTT), platelets, plasma fibrinogen levels, and hemoglobin (Hb). Under the direction of a specialist, the same group of senior gynecology residents carried out the procedures. By counting surgical gases, measuring the amount of blood collected at suction, and checking the patient's drape after surgery, the amount of bleeding that occurred during the procedure was determined. The same measurements were made once more in the recovery room and 24 hours following surgery.

The final sample size was 278 using an online sample size **(14)** with the following assumptions: ratio of the case to control 35%, type I error rate 0.05, and power 0.8. Up until the target sample size was obtained, participants were chosen using a sequential sampling approach. The research questionnaire aimed to collect data from the hospital records of the mothers for the amount of bleeding, hospitalization complications, sociodemographic factors, obstetric-related characteristics, and fetal factors. For the quantitative data, Spearman's test was used to evaluate the characteristics of the patients. Version 17 of the SPSS software was used to enter and analyze the data.

Results

Three hundred of the 440 women who underwent cesarean sections during the 12-month study period and completed the study's eligibility requirements participated. One-hundred forty were excluded because the data was insufficient. Forty-seven (15.7%) of them had PPH, according to their criteria. Three of them were moved to the intensive care unit, and 22 (7.3%) of them required blood transfusions. Without any complications, all the patients were discharged from the hospital.

The study involved pregnant women who were at least 18 years old, and the maximum age of the participants was 45. The age was 31 **(9)** years at the median (interquartile range). Even though PPH patients' average ages were lower than those of patients with normal bleeding, there was no association between the two according to Spearman's test (Table 1). Moreover, people were subdivided into age groups of less than 20, between 20 and less than 35, and over 35. The age range of the majority of cases (n=199, 66.3%) was 20 to 35. The Bonferroni test was used to demonstrate that there is no difference in the proportion of PPH cases and cases of normal bleeding in these age groups. The participant's mean weight, height, and BMI were 78 (IQR=15) kg, 164 (IQR=8) cm, and 28.69 (IQR=3.53) kg/m2, respectively, for weight, height, and BMI. The likelihood of PPH was not revealed to be significantly correlated with maternal height or weight, however, a significant association between BMI and the likelihood of PPH was found using Spearman's correlation test (Table 1). Only 35 (11.7%) of the patients in our study had a normal BMI, whereas 171 (57.0%) were overweight (BMI 25–29) and 94 (31.3%) were obese (BMI > 30). Only two (4.3%) of the cases in the PPH group had a normal BMI; the remainder were overweight or obese (n=23, 48.9%; n=22, 46.8%). Individuals with a BMI greater than 35 were excluded from this study.

We defined illiteracy as under-diploma education and most of the cases (193 cases, 64.4%) were not illiterate. There was no difference between education level and bleeding severity (Table 1). The bulk of the mothers in this study were housewives; none of the others had full-time jobs. The results of Spearman's test indicated that there was no correlation between mothers' employment and the intensity of their bleeding (Table 1). Iranian women formed the majority of participants in this study, with Afghan mothers making up the remaining participants. According to the results of Spearman's test, there was no connection between the ethnicity of the mothers and the amount of bleeding (Table 1).

The correlation between maternal parity and the incidence of PPH was examined using Spearman's test, as indicated in Table 1, and it was discovered that there was no relationship. The majority of patients (65.3%) had previously undergone a cesarean section, however, the method of birth (cesarean section vs. normal delivery) has no bearing on the likelihood of severe bleeding. Abortion history was present in 42.3% of patients. The most frequent type was a single abortion; the moms in our sample had never experienced more than three miscarriages. There was no discernible link between the number of prior abortions and the level of bleeding. Nineteen-three percent of patients had never had abdominal surgery before, and 41.0% of participants had only one procedure. The chance of having PPH did not significantly correlate with the number of prior abdominal procedures.

A little more than 15% of the patients had a PPH history. In this study, 43 (91.5%) of the participants had a history of PPH in a previous pregnancy, compared to just 11 (4.3%) of the people who did not develop PPH. It was believed that these two factors would be strongly correlated (Table 1).

Table 1. **Maternal characteristics**

Variables	Normal Bleeding Group	PPH Group	P-value (Spearman's Test)
Age, median (IQR), year	31 (9)	30 (7)	0.441
Height, median (IQR), centimeter	164.00 (8)	163.00 (10)	0.337
Weight, median (IQR), kg	78.00 (13)	79.00 (14)	0.171
BMI, median (IQR), kg/m2	28.3060 (3.85)	29.7578 (3.48)	0.003
Illiterates, number (%)	93 (36.8%)	14 (29.8%)	0.263
Housekeepers, number (%)	227 (89.7%)	40 (85.1%)	0.420
Iranian race, number (%)	234 (92.5)	45 (95.7%)	0.424
Parity, median (IQR), min	2 (2)	2 (5)	0.417
Abortion, median (IQR), number	0 (1)	0 (1)	0.489
Previous Surgery, median (IQR), number	1 (1)	1 (1)	0.144
Previous PPH, median (IQR)	0 (0)	1 (0)	<0.000
Gestational hypertension, number (%)	17 (5.7)	3 (1)	0.933
Gestational diabetes, number (%)	5 (1.7)	1 (0.3)	0.946

IQR: interquartile range; BMI: body mass index, PPH: post-partum hemorrhage

Twenty (6.7%) and six (2%) mothers, respectively, experienced gestational diabetes and gestational hypertension. There was no relationship between the incidence of PPH and gestational diabetes or hypertension in the current study (P=0.933 and P=0.946, respectively).

A little bit more than 13% of the participants had received general anesthesia. According to Spearman's test, there was no link between the severity of bleeding and the anesthetic method used (P=0.733).

The length of the operations was between 50 and 200 minutes, with a median of 75 (IQR=25) minutes. The likelihood of PPH was significantly correlated with the length of surgery (Table 2).

The newborns' median weight was 3100 (IQR: 500.00) grams. There was no link between neonatal weight and the occurrence of PPH, even though the median weight of neonates in PPH cases was slightly greater (Table 2).

As was already indicated, 47 cases (15.7%) of blood loss greater than 1000 mL with signs and symptoms of hypovolemia within 24 hours of the delivery process were noted. The bleeding volumes were 260, 2700, and 820 (IQR=522.50) mL at the minimum, maximum, and median, respectively. Table 2 displays the median blood loss in each group.

Before surgery, during recovery, and 24 hours following surgery, the median hemoglobin concentrations were 11.600 (IQR=2.3), 10.500 (IQR=1.9), and 10.700 (IQR=1.5), respectively. In the PPH group, each of these measured levels was significantly lower. Table 2's results demonstrate a significant association between preoperative anemia and the risk of PPH. The PPH group's hemoglobin levels were lower in the recovery room than those of the normal bleeding group, but not until 24 hours following surgery.

Before surgery, during recovery, and 24 hours following surgery, the median platelet counts were 202.00 (IQR=72), 192.00 (IQR=64), and 195.00 (IQR=70) 102/l, respectively. In the PPH group, all of these observed levels were lower. The likelihood of PPH did not correlate with the preoperative platelet count (P=0.066). The PPH group's platelet count was considerably lower after 24 hours (P=0.001).

The median prothrombin time (PT) was 12.000 (IQR=1.6), 12.000 (IQR=1.8), and 12.000 (IQR=1.7) seconds, respectively, before surgery, in the recovery room, and 24 hours following surgery. The probability of PPH did not correlate with the PT at any given period (P=0.310, P=0.364, and P=0.754, respectively). At the same time, the median international normalized ratio (INR) was 1.000 (IQR=0.2), 1.000 (IQR=0.1), and 1.000 (IQR=0.1) seconds. There was no connection between the INR at any given time and the chance of PPH, as shown in Table 2. The median partial thromboplastin time was 27.600 (IQR: 10.9), 27.300 (IQR: 9.2), and 27.400 (IQR: 8.9) seconds, respectively, at the same time. There was no relationship between the PTT at any given time and the risk of PPH, as demonstrated in Table 2.

Before surgery, during recovery, and 24 hours following surgery, the median plasma fibrinogen levels were 234.00 (IQR=99), 213.00 (IQR=97), and 228.00 (IQR=71), respectively. In both groups, fibrinogen levels dropped in the operating room and rose 24 hours later (Figure 1). The volume of bleeding and the probability of PPH at any given time were strongly correlated (Table 2). Seventy-nine instances (26.3%) were found to have low fibrinogen levels (less than 200 mg/dL) before surgery. PPH affected roughly 59% of mothers with low fibrinogen levels, while normal bleeding occurred in just 20% of these mothers. Low fibrinogen levels and the prevalence of PPH were strongly correlated (P<0.000).

According to Table 2, there was a significant association between the two groups transfusion requirements and the number of packed cells given. Also, there were notable differences in the number of blood units used for each patient between the two groups.

Table 2. Association between the risk factors and postpartum hemorrhage

Variables	Normal Bleeding Group	PPH Group	P-value (Spearman's Test)
General anesthesia patients, number (%)	33 (82.5)	7 (17.5)	0.733
Duration of surgery, median (IQR), minutes	70.00 (20)	100.00 (60)	<0.000
Weight of the newborns, median (IQR), grams	3100 (500)	3200 (550)	0.789
Total bleeding, median (IQR), mL	765 (415.00)	1490 (795.00)	<0.000
Hb baseline, median (IQR), g/dL	11.800 (1.7)	9.70 (1.8)	<0.000
Hb recovery, median (IQR), g/dL	10.700 (1.55)	9.70 (3.5)	0.004
Hb 24 hours, median (IQR), g/dL	10.700 (1.3)	10.200 (2.3)	0.621
PLT baseline, median (IQR), /microliter	202.00 (77)	202.00 (59)	0.066
PLT recovery, median (IQR), /microliter	194.00 (63)	186.00 (51)	0.366
PLT 24 hours, median (IQR), /microliter	196.00 (71)	174.00 (50)	0.001
PT baseline, median (IQR), seconds	12.00 (1.7)	12.00 (1.4)	0.310
PT recovery, median (IQR), seconds	12.00 (1.7)	12.00 (1.8)	0.364
PT 24 hours, median (IQR), seconds	12.00 (1.7)	12.00 (2.2)	0.754
PTT baseline, median (IQR), seconds	27.600 (10.9)	29.000 (11.1)	0.451
PTT recovery, median (IQR), seconds	27.100 (9.5)	30.000 (8.2)	0.391
PTT 24 hours, median (IQR), seconds	27.300 (8.5)	31.000 (7.1)	0.064
INR baseline, median (IQR)	1.00 (0.2)	1.00 (0.2)	0.682
INR recovery, median (IQR)	1.00 (0.1)	1.00 (0.2)	0.737
INR 24 hours, median (IQR)	1.00 (0.1)	1.00 (0.1)	0.752
Fibrinogen baseline, median (IQR), mg/dL	239.00 (94)	187.00 (95)	<0.000
Fibrinogen recovery, median (IQR), mg/dL	224.00 (98)	165.00 (96)	<0.000
Fibrinogen 24 hours, median (IQR). mg/dL	231.00 (67)	185.00 (87)	<0.000
Cases of blood transfusions, median (IQR), numbers	0.00 (1.00)	1.00 (1.00)	0.004
Packed cell used for transfusion, median (IQR), numbers	0.00 (1.00)	1.00 (1.00)	0.007

IQR: interquartile range; HB: hemoglobin, PLT: platelet count; PT: prothrombin time; APTT: activated partial thromboplastin time; INR: international normalized ratio

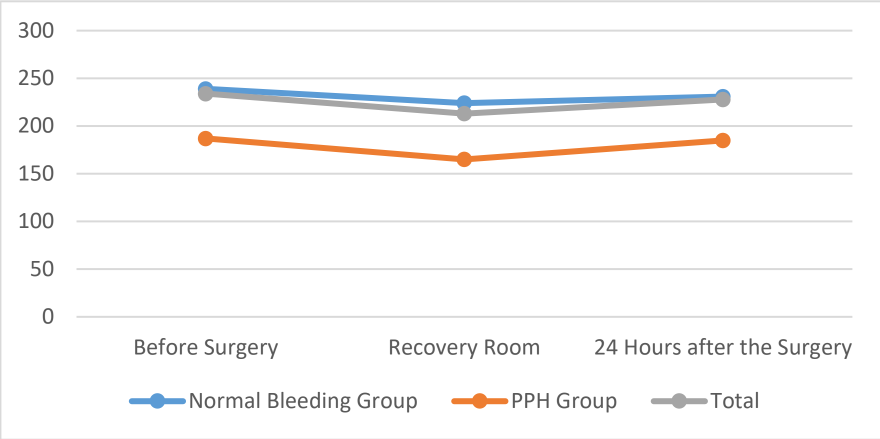

Figure 1.The course of changes in the serum level of fibrinogen (mg/dl)

Discussion

The prevalence of PPH has been estimated at 1.2% in the multicountry Survey on Maternal and Newborn Health **(15)** and is known to occur in more than 5-10% of cesarean sections **(16)**; in the current study, PPH was found in 47 of all cesarean sections or 15.7% of the total; this is consistent with previous reports. Several studies have revealed various prevalence rates for this condition **(17-21)**. Independent of the delivery mode, the current study defined PPH as cumulative blood loss greater than 1000 mL with signs and symptoms of hypovolemia within 24 hours of the birth process **(1)**. Although most studies used a standard definition of PPH that included blood loss over 500 ml within 24 hours of a vaginal delivery or blood loss exceeding 1000 ml after a cesarean section **(20, 22)**, their findings might not be comparable to ours.

The age of the mother did not predict PPH in this study. Although PPH patients' average ages were younger than those with normal bleeding, there was no association between the two. Its result differed from that of other studies **(5, 23-26)**. In comparison to women in the age range between 20 and 34 years old who had a vaginal delivery, women aged 35 and older were more likely to have experienced PPH, according to research by Kebede et al. **(5)** and Shahbazi Sighaldeh et al. **(18)**. However, Bazirete et al. and Onong et al. were unable to discover a relationship between age and bleeding **(12, 21)**, and their findings are consistent with those of the current investigation.

In the current study, postpartum hemorrhage incidence was not predicted by the mothers' height or weight. Postpartum hemorrhage has been proven to significantly correlate with body mass index, though. Others, like Bazirete et al. and Zandi et al., also demonstrated this connection **(21, 25, 27)**. Butwick et al., on the other hand, suggest that maternal obesity has, at most, a minimal impact on the risk of postpartum hemorrhage and that the direction of the relationship between hemorrhage and body mass index may vary depending on the method of delivery. They demonstrated that obese and overweight women had up to a 19% higher risk of hemorrhage following vaginal delivery, but cesarean deliveries had up to a 14% lower risk of serious hemorrhage for all fat women **(28)**. Wang et al. meta-analysis revealed that the mother's BMI had no bearing on the occurrence of PPH **(26)**.

Literacy levels between the two groups did not significantly differ. In this instance, there hasn't been a specific study done, and the studies that have been done haven't focused as much on it. The association between illiteracy and PPH was demonstrated in a study conducted in Egypt, however, the level of illiteracy at the time was higher **(29)**. Moreover, the incidence of PPH was unaffected by mothers' employment status. The mothers' employment position had no impact on the prevalence of PPH in the current investigation. The importance of work status has not been covered in studies.

According to the Ashouri study, Afghan women had a PPH incidence that was more than three times higher than Iranian mothers **(25)**. The incidence of PPH was shown to be greater among the black race and racial minorities in the study by Jardine et al. in England **(30)**. Okunlola et al. discovered in a comprehensive review that Native Americans had the highest risk of uterine atony whereas Caucasians had the lowest risk of PPH. The incidence of PPH was shown to be higher among Black Americans and those with African ancestry, although the risk of atonic PPH was found to be lower **(31)**. There was no difference in the amount of bleeding across the groups in this study.

Multiparity has been identified as a PPH risk **(3, 5, 18, 25, 28)**. However, although finding no correlation between parity and the amount of bleeding, Ononge et al. suggested that grand multi-parity may be tangentially related to PPH **(12)**, and some research showed that the majority of PPH cases were in mothers who were nulliparous **(25, 26)**. Similar to the Ononge study, the current investigation found no evidence of a substantial impact of parity on the occurrence of PPH.

Ambounda et al. in Gabon showed that past abortion history can predict PPH in upcoming deliveries **(32)**. The Yang et al. study produced the same outcome **(33)**.

The history of abortion was not a risk factor for postpartum hemorrhage in our study.

By forming intraabdominal adhesions, prior abdominal surgery other than a cesarean section may increase bleeding during the procedure. In general, there hasn't been much research done on the connection between prior abdominal surgery and the likelihood of postpartum hemorrhage. It has been demonstrated that prior cesarean sections or uterus surgeries may raise that risk **(13)**. Despite this, the incidence of postpartum hemorrhage and prior abdominal surgery were not related in the current study.

The current investigation likewise produced the same conclusion that previous PPH is a predicted risk factor for PPH **(5, 13, 21)**, but Onongе found no correlation **(12)**.

Twenty (6.75%) and 6 (2.0%) of the mothers experienced gestational hypertension and gestational diabetes, respectively. Although some research **(25, 26, 34)** hypothesized that hypertensive problems during pregnancy might cause PPH, others were unable to show this connection **(35)**. Similar controversy surrounds studies on how gestational diabetes affects postpartum hemorrhage **(25, 36, 37)**.

In several studies, the choice of anesthesia technique (general vs. spinal/epidural) has been effective in determining the likelihood of postpartum hemorrhage, with general anesthesia being more closely related to it **(38-41)**. Despite this, the current investigation did not identify any evidence of such a connection.

The length of the surgery varied significantly between the two groups. It should be remembered that if there is delivery bleeding, the procedure may take longer. Additionally, given that the senior residents are in charge of administering the procedure, it is reasonable to assume that when they change, the surgery's duration will be as well. Additionally, it is anticipated that as their level of experience grows throughout the trial, so will the pace of their surgeries. The length of the surgery and its impact on the quantity of bleeding are not specifically included in the trials that were undertaken.

In some investigations **(25, 34)**, large for gestational age was discovered to be a significant risk factor for severe PPH, but not in others **(35)**. The newborn's weight and the intensity of bleeding were not correlated in the current investigation.

The incidence of postpartum hemorrhage and moderate to severe anemia during pregnancy were not linked, according to research by Onong et al. and Butwick et al **(12, 28)**. However, a lot of other investigations came to different results **(5, 18, 21, 25, 35)**. In the current study, women with PPH had median hemoglobin levels that were less than 10 g/dl. This was in line with the findings of the majority of investigations.

Low platelet counts have been linked to postpartum hemorrhage in some studies **(25)**, although other researchers have not confirmed this link **(42, 43)**. There was no correlation between the preoperative platelet count and the extent of bleeding in the current investigation.

The association between coagulation tests like PT, aPTT, and INR and the frequency of postpartum hemorrhage has been examined in numerous research, and various findings have been reported **(42-45)**. There was no link between these tests and the incidence of postpartum hemorrhage since only women without coagulopathy were included in the current investigation.

Some researchers have shown the role of fibrinogen level as a predictor of postpartum hemorrhage **(43-47)**. Notwithstanding the contradictory findings in the Karlsson et al. study **(42)**, there was a significant correlation between it and the occurrence of postpartum hemorrhage in the current investigation.

In 2018, Alvarez et al. introduced the Australian severe PPH prognostic model. Maternal age, nulliparity, length of the first and second stages of labor, neonatal birth weight, and prenatal hemoglobin levels were among the variables in this model **(48)**. The history of prior PPH, obesity, anemia, and hypofibrinogenemia upon admission to labor was the most common risk variables in the current study for PPH. It should be recalled that Ende showed in a systemic review in 2021 that a significant percentage of postpartum hemorrhage occurs without known risk factors **(35)**.

The gathering of reliable data and the reduction of missing data were made possible by the study of medical records in maternity units and structured interviews with participants throughout the hospital stay. Healthcare professionals measured blood loss visually, and it's possible that they under- or overestimated it, which may have resulted in missing some PPH cases. To reduce this risk, we educated research assistants to recognize PPH cases based on clinical characteristics and visual estimation of blood loss.

Conclusion

Primary PPH is a common complication after cesarean sections and in the present study, it was recorded in 15.7% of cases. The most common antepartum risk factors for PPH were preoperative BMI, a history of prior PPH, anemia, and hypofibrinogenemia at the time of labor admission. To lower the high risks of maternal mortality and morbidity linked to PPH, policymakers, health managers, and service providers should prioritize enhancing the quality of proactive prevention. Further extensive research into suspected PPH risk factors is required.

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Ethics committee approval code:

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https://ethics.research.ac.ir/ProposalCertificateEn.php?id=328963&Print=true&NoPrintHeader=true&NoPrintFooter=true&NoPrintPageBorder=true&LetterPrint=true

Authors' contribution:

Dariush Abtahi has conducted the design, execution, and management of the project, including writing and final approval of the manuscript; Maral Hosseinzadeh contributed to writing the paper and translation to English and has analyzed and interpreted the data; Ebtehaj Heshmatkhah cooperated in writing the manuscript.

Declarations:

We declare by signing the following letter:

1. The manuscript is the original work of the authors. All data, tables, figures, etc. used in the manuscript are prepared originally by the authors.

2. The manuscript has not been and will not be published elsewhere or submitted elsewhere for publication.

3. Authors mention that there is no conflict of interest in this study.

4. The final version of the paper I enclose is not substantially the same as any that I/we have already published elsewhere.

5. No more changes in the authors or main results are accepted from my side after submitting them to the journal.

Availability of data and materials:

All data, tables, figures, etc. used in the manuscript are prepared originally by the authors and are available (by the corresponding author) if needed.

Conflict of Interest

The authors declare that they have no known financial or interpersonal conflicts that would have seemed to have an impact on the research presented in this study.

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