ORIGINAL ARTICLE

Association Between Indications for Induction of Labor and Mode of Delivery: A Cross-Sectional Study

Aisha Ahmed[1*], Mirza Sijeel Ahmad[2], Nidda Yaseen[3], Shoaib Ahmed Khan[2], Mohsin Saleem[4], Shabana Mirza[5]

ABSTRACT

Objective: This study aims to examine the relationship between indications for induction of labor and ultimate mode of delivery after labor induction.

Study Design: Cross-sectional study.

Place and Duration of Study: This study was conducted at the Department of Obstetrics and Gynecology, Combined Military Hospital (CMH), Okara, Pakistan, from 15th October 2023 to 15th March 2024.

Methods: A total of 300 females were included with a non-probability consecutive sampling method. Gravid patients aged 15-45 years, singleton gestations in cephalic presentation at term undergoing induction of labor after written informed consent and consultant's advice were included in the study. While females with multiple gestations, previous cesarean delivery, malpresentation at term, placenta accreta spectrum, and antepartum hemorrhage were excluded from the study.

At the time of labor induction, patients' demographic details, obstetric history, body mass index, gestational age, preinduction of labor bishop (IOL Bishop score), method of induction of labor, and indication of labor induction were noted. Data were stratified for age, gestational age at delivery, BMI, and indication of induction of labor. Chi-Square test was used to associate indications and maternal outcome in relation to mode of delivery in stratified groups by using Chi-Square test for each stratum. A *P*-value ≤ 0.05 was considered significant.

Results: The most common indication of induction of labor was fetal macrosomia (42.6%), followed by spontaneous rupture of membranes SROM (24%) and postdated pregnancy (22.6%). A notable majority, comprising 77.3% of cases, experienced spontaneous vaginal delivery. Conversely, lower segment cesarean section was employed in 22.7% of cases.

Conclusion: The study reported favorable maternal outcomes, with the majority of patients achieving spontaneous vaginal deliveries. The rate of Cesarean section was relatively low, indicating evidence-based and successful management of labor induction.

Keywords: *Cesarean Section, Fetal Macrosomia, Induction of Labor.*

How to cite this: *Ahmed A, Ahmed MS, Yaseen N, Khan SA, Saleem M, Mirza S. Association Between Indications for Induction of Labor and Mode of Delivery: A Cross-Sectional Study. Life and Science. 2026; 7(3): 404-410. doi: http://doi.org/10.37185/LnS.1.1.961*

[1]*Department of Obstetrics and Gynecology/Anesthesia*[2]
Combined Military Hospital (CMH), Okara, Pakistan
[3]*Department of Obstetrics and Gynecology/Anesthesia*[4]*/ Nursing*[5]
Combined Military Hospital (CMH), Hyderabad, Pakistan

Correspondence:
Dr. Aisha Ahmed
Department of Obstetrics and Gynecology
Combined Military Hospital (CMH), Okara, Pakistan
E-mail: aishaahmed669@hotmail.com

Received: Jun 21, 2025; 1st Revision Received: Dec 23, 2025
2nd Revision Received: Feb 19, 2026; 3rd Revision Received: Apr 27, 2026; Accepted: May 15, 2026

Introduction

Induction of labor is defined as the pharmacological stimulus of uterine contractions prior to the commencement of natural delivery as a choice when benefits of prompt delivery overshadow the hazards of ongoing pregnancy.[1] The goal of induction of labor is to attain normal delivery, and induction of labor may be specified for several settings that might undesirably disturb maternal or fetal health throughout gravidity.[2] The percentage of induction of labor in the U.S has increased from 9.6% in 1990 to

25.7% in 2018, with 31.7% of primary gravidas.[3]

When the advantages of ending a pregnancy for the mother or fetus surpass the dangers of waiting for labor to begin naturally, labor induction is considered. The American College of Obstetricians and Gynecologists (ACOG) identify several medical conditions that might justify inducing labor. Some instances where labor induction is appropriate include gestational or chronic hypertension, preeclampsia, eclampsia, diabetes, premature and spontaneous rupture of membranes, severe fetal growth restriction, and post-term pregnancy. Conversely, certain scenarios make labor induction unsuitable, e.g., transverse fetal lie, cord prolapse, active genital herpes, placenta previa, and prior myomectomy.[4] IOL increases the risk of cesarean section (CS).[5]

Relying on induction of labor (IOL) for reasons lacking robust evidence might contribute to an increase in cesarean section (CS) rates**.** This trend has implications beyond immediate maternal health and subsequent pregnancies, also leading to economic repercussions.[6] Having a cesarean delivery following induction of labor (IOL) has been linked to macrosomia (57.2%), hypertension (52.8%), diabetes mellitus (46.3%), advanced age & short stature (39.4%). Nulliparous females exhibit a greater propensity for labor induction, and consequently, a higher risk of cesarean section following induction, in comparison to multiparous females (37.6%).[6] Obstetrical factors are associated with an elevated risk of cesarean delivery. These include the initial findings from a pelvic exam at the start of labor induction, particularly an "unfavorable" Bishop score (which is often defined as less than 6). Furthermore, labor inductions performed for fetal indications or for post-term pregnancies (comprising 40% of such indications) have also been linked to an increased risk of cesarean delivery.[2,4,6]

A cesarean delivery poses nearly three times the maternal health risks and mortality rates found in vaginal births.[6] The considerable variation in cesarean section rates, which span from 14% to 52% across 31 European nations, highlights ongoing concerns about current medical practices.[7] When making decisions about labor induction, clinicians should always consider the available evidence and discuss it thoroughly with their patients.[5] Among the patients undergoing induction of labor, the frequency of spontaneous rupture of membranes was 16%, postdates 19.5%, macrosomia 5%, suspected fetal compromise 9%, diabetes in pregnancy 13.2%, and hypertension 13%.[6]

The rationale of this research is to define the incidence of IOLs performed in a tertiary care setting for various indications and to find out the effect of various indications of IOL on the outcome in terms of mode of delivery. So we need to do this research to implement evidence-based decision-making to use IOL for recommended indications only. It will help to reduce the cesarean section rate after failed inductions, which will reduce maternal morbidity and mortality in current and future pregnancies. This, in turn, will have economic benefits for the patient and the country's health care system.

Methods

This study was conducted at the Department of Obstetrics and Gynecology, Combined Military Hospital (CMH), Okara, Pakistan from 15th October 2023 to 15th March, 2024, after taking approval from the Ethical Review Committee of the hospital, vide letter no: IRB/CMH/44/23, dated: 03th October 2023. A sample of 300 females was considered with a 95% confidence level, a 2.5% margin of error, and an estimated frequency of macrosomia of 5%. A non-probability consecutive sampling method was used in this study. Gravid patients of age 15-45 years, singleton gestations in cephalic presentation at term undergoing induction of labor after written informed consent and consultant's advice were included in the study. While females with multiple gestations, previous cesarean delivery, malpresentation at term, placenta accreta spectrum, and antepartum hemorrhage were excluded from the study.

Three hundred females who met the selection criteria were included in this research through the labor room of Obstetrics & Gynecology. Written Informed consent was taken, and information like name, age, gestational age, obstetric history, and any comorbidities were noted. At the time of IOL, pre-IOL Bishop score and indication for IOL were noted. The patient was observed till delivery and the outcome in terms of mode of delivery, whether vaginal delivery or cesarean section, was noted (instrumental vaginal deliveries were recorded as vaginal deliveries). The

data were entered and analyzed using SPSS version 21. Quantitative variables like age, pre-IOL Bishop score, gestational age at delivery, and BMI were described as mean and standard deviation. Qualitative variables such as parity, comorbidities, indication of IOL, method of IOL used, and mode of delivery were presented as frequencies and percentages. Maternal outcomes, in terms of mode of delivery, were compared among females according to the indication for IOL using the Chi-Square test. A *P*-value ≤ 0.05 was considered significant. Data were stratified for age, gestational age at delivery, BMI, and indication of IOL. Chi-Square test was used to associate indications and maternal outcome in relation to mode of delivery in stratified groups by using Chi-Square test for each stratum. A *P*-value ≤ 0.05 was considered significant.

Results

The average age of the patients in the research was 29.11 years, with a standard deviation of 4.058, indicating that the ages were relatively clustered around the mean with moderate variability. Regarding gestational age, the mean was 37.88 weeks, with a standard deviation of 1.707, suggesting that most subjects were close to full term and that gestational age varied relatively little among them. The mean BMI of the participants was 26.345 kg/m^2, with a standard deviation of 1.5180, indicating a moderate level of variability in body mass index among the sample population.

The distribution of participants across age groups reveals that the majority, comprising 76.0% of the total sample, were under 30 years old. Conversely, a smaller proportion, 24.0% of the total sample, was aged 30 years and above. Out of 300 pregnant females, 111 females were primigravida, comprising 37% of the total sample size, and 189 females were multigravida, making up 63% of the total population included in the study.

Among the sample of 300 participants, the most common indication for IOL was macrosomia, accounting for 42.7% of cases. Macrosomia, characterized by a fetus larger than average, emerged as the leading indication for labor induction. Following closely behind, post-dated pregnancy was identified as the reason for IOL in 22.7% of cases, indicating instances where pregnancies had extended beyond their expected duration. Spontaneous rupture of membranes (SROM) represented another significant indication, accounting for 24.0% of cases, suggesting instances where the amniotic sac had ruptured prior to the onset of labor. Additionally, suspected fetal compromise was cited as the reason for IOL in 10.7% of cases, underscoring situations where there were concerns regarding the health or well-being of the fetus.

Among the study population, preIOL bishop score was calculated to be <6 in 163 females, 6 to 8 in 85 pregnant females, and more than 8 in the remaining 52 females, which constitutes 54.3 % ,28.3 % and 17.4% of the total study population, respectively. Mean bishop score was 5.17 with a standard deviation of 2.46, suggesting an unfavorable bishop score in the majority of the females.

Among the 300 participants, mechanical methods were the most commonly used, accounting for 29.3% of cases. Following closely behind, ripening agents were utilized in 28.0% of cases. Oxytocin infusion use was another common method, employed in 22.7% of cases to induce labor. Additionally, membrane sweeping was utilized in 20.0% of cases.

A notable majority, comprising 77.3% of cases, experienced spontaneous vaginal delivery;

Table 1: Stratification of maternal outcome with age groups (N=300)

		Age Groups		Total	*Chi-Square* value	*P*-value
		≤ 30 Years	> 30 Years			
Maternal Outcome	Spontaneous vaginal selivery	172 75.4%	60 83.3%	232 77.3%	1.946	≤0.163
	Lower segment C section	56 24.6%	12 16.7%	68 22.7%		
Total		228 100.0%	72 100.0%	300 100.0%		

Table 2: Stratification of maternal outcome with parity (N = 300)

		Parity		Total	*Chi-Square* value	*P*-value
		Primipara	Multipara			
Maternal outcome	Spontaneous vaginal delivery	70	162	232	20.481	≤0.0001
		63%	85.7%	77.3%		
	lower segment C section	41	27	68		
		37%	14.3%	22.7%		
Total		111	189	300		
		100.0%	100.0%	100.0%		

Table 3: Stratification of maternal outcome with indication of induction of labor (N = 300)

		Indication of induction of labor (IOL)				Total	*Chi-Square* value	*P*-value
		SROM	Post dated pregnancy	Macrosomia	Suspected fetal compromise			
Maternal Outcome	Spontaneous Vaginal Delivery	48	56	104	24	232	6.870	≤0.076
		66.7%	82.4%	81.3%	75.0%	77.3%		
	Lower segment C section	24	12	24	8	68		
		33.3%	17.6%	18.8%	25.0%	22.7%		
Total		72	68	128	32	300		
		100.0%	100.0%	100.0%	100.0%	100.0%		

Table 4: Stratification of maternal outcome with bishop score (N = 300)

		Bishop score			Total	*Chi-Square* value	*P*-value
		<6	6 to 8	>8			
Maternal outcome	Spontaneous Vaginal delivery	114	69	49	232	14.261	≤0.002
		70%	81.2%	94.2%	77.3%		
	Lower segment C section	49	16	3	68		
		30%	18.8%	5.8%	22.7%		
Total		163	85	52	300		
		100.0%	100.0%	100%	100.0%		

Table 5: Stratification of maternal outcome with gestational age (N = 300)

		Gestational age		Total	*Chi-Square value*	*P*-value
		< 38 Weeks	>38 Weeks			
Maternal outcome	Spontaneous vaginal delivery	128	104	232	9.939	≤0.002
		71.1%	86.7%	77.3%		
	Lower segment C section	52	16	68		
		28.9%	13.3%	22.7%		
Total		180	120	300		
		100.0%	100.0%	100.0%		

conversely, lower segment cesarean section (C-section) was employed in 22.7% of cases, and Maternal Outcomes were stratified with age, indication of IOL, gestational age, and BMI in Tables 1 to 4, respectively.

Table 6: Stratification of maternal outcome with body mass index (N = 300)

		Body Mass Index (BMI)		Total	*Chi-Square* value	*P- value*
		≤ 25 Kg/m^2	>25 Kg/m^2			
Maternal Outcome	Spontaneous Vaginal Delivery	40	192	232	1.370	≤0.242
		71.4%	78.7%	77.3%		
	Lower Segment C Section	16	52	68		
		28.6%	21.3%	22.7%		
Total		56	244	300		
		100.0%	100.0%	100.0%		

Discussion

The study conducted at the Department of Obstetrics and Gynaecology, CMH Okara, provides valuable insights into the demographics, indications for induction of labor (IOL), methods of IOL, and mode of delivery among a sample of 300 patients.

The mean age of 29.11 years aligns with previous studies indicating that women in their late twenties to early thirties are commonly found in obstetric populations. The mean gestational age of 37.88 weeks suggests that most participants were near full term, consistent with the usual timing for induction or delivery. The average BMI of 26.345 kg/m2 falls within the range of overweight, which may have implications for obstetric outcomes such as labor progression and mode of delivery.

The most common sign for IOL in this research was macrosomia, followed by post-dated pregnancy and spontaneous rupture of membranes (SROM). These findings are in line with previous research highlighting macrosomia and post-term gravidity as common signs for labor initiation.[8-10] However, the prevalence of suspected fetal compromise as an indication for IOL (10.7%) appears relatively lower compared to some studies, where it might be more prevalent due to increased monitoring for fetal well-being.[11-13]

The majority of the females included in the study were multigravida (63%) as compared to a smaller number of primigravida patients (27%), but the cesarean section rate was higher among primigravida patients (37%) as compared to multigravida females (14.3%). These findings are quite logical and in line with the results of past studies on the outcomes of failed induction.[9,13]

Pre-induction Bishop score was calculated to be <6 in the majority of patients (54.3%) as compared to 6 to 8 in (28.3%) and >8 in (17.4%) patients. But the results revealed that the rate of cesarean section dropped significantly as the Bishop score improved, i.e only 5.8% of females underwent cesarean delivery among females with a Bishop score of >8. It depicts that the success of induction of labor is closely linked to the pre-IOL Bishop score of the patient, and a favorable bishop score increases the chances of vaginal delivery (94.2%).[6,11,14]

Mechanical methods were the most commonly used technique for labor induction in this study, followed closely by ripening agents and oxytocin. These findings are consistent with standard obstetric practice, in which mechanical methods such as Foley catheters and cervical dilators are often used initially, followed by pharmacological agents if necessary.[14,15,16]

Spontaneous vaginal delivery was the predominant mode of delivery, occurring in 77.3% of cases, while lower segment cesarean section (C-section) was employed in 22.7% of cases. This distribution reflects a higher rate of vaginal deliveries compared to C-sections, which is consistent with the World Health Organization's recommendations for promoting vaginal birth whenever possible, provided it is safe for both the mother and the baby.

Stratification of maternal outcomes by age, parity, bishop score, indication of IOL, gestational age, and BMI provides a comprehensive understanding of how these factors may influence obstetric outcomes such as mode of delivery and maternal complications.[13,17,18] Further analysis and comparison with existing literature can elucidate any disparities or similarities in outcomes across different patient demographics and clinical scenarios.

In summary, the study's findings align with previous literature on obstetric outcomes and practices, highlighting common indications for labor induction, induction techniques, and modes of delivery.

However, further comparison and analysis are warranted to fully understand the implications of these findings and identify any potential areas for improvement in obstetric care practices.

The predominance of macrosomia as an indication for IOL aligns with some previous studies indicating fetal macrosomia as a common reason for labor induction, often due to concerns about maternal and fetal complications during delivery.[2,4,11]

The lower prevalence of suspected fetal compromise as an indication for IOL compared to some literature may reflect differences in patient populations, obstetric practices, or variations in clinical management protocols.[19,20]

The utilization of mechanical methods, such as Foley catheters and cervical dilators, as the most common technique for labor induction is consistent with established ACOG and NICE guidelines and reflects a preference for non-pharmacological methods as initial approaches.

The proportion of membrane sweeping (20.0%) observed in this study is relatively lower than in some literature, where it may be more frequently employed, suggesting potential variations in clinical practices or patient preferences.[17,19]

The predominance of spontaneous vaginal delivery and relatively lower rate of lower segment cesarean section (22.7%) in this study mirrors global efforts to promote vaginal birth whenever possible, reflecting adherence to evidence-based obstetric practices aimed at reducing unnecessary cesarean sections and promoting maternal-infant health.

Stratification of maternal outcomes by age, parity, Bishop score, indication of IOL, gestational age, and BMI allows for a comprehensive analysis of how these factors influence obstetric outcomes, aligning with the holistic approach advocated by many obstetric care providers to tailor management strategies based on individual patient characteristics.

Further comparison with existing literature may reveal disparities or similarities in maternal outcomes across different patient demographics and clinical scenarios, highlighting areas for potential improvement or intervention in obstetric care practices.

Overall, while the study's findings align with prior literature on obstetric outcomes and practices, further comparison and contrast can yield valuable insights into variations, trends, and factors influencing obstetric care delivery across settings and patient populations.

Reasons for cesarean section after IOL, e.g failed IOL, poor progress of labor, or fetal distress, were not included in the study. Moreover, outcome such as instrumental vaginal delivery were not recorded separately. Methods for recording the progress of labor were not mentioned. In future, these variables should be added to the study to better judge the outcome of the study.

Conclusion

The study reported favorable maternal outcomes, with the majority of patients achieving spontaneous vaginal deliveries. The rate of cesarean section was relatively low, indicating successful management of labor induction.

Acknowledgement: None

Conflict of Interest: The authors declare no conflict of interest

Grant Support and Financial Disclosure: None

REFERENCES

1. Lueth, GD, Kebede A, Medhanyie, AA. Prevalence, outcomes and associated factors of labor induction among women delivered at public hospitals of MEKELLE town-(a hospital based cross sectional study). BMC Pregnancy and Childbirth. 2020; 9: 203. doi: 10.1186/s12884-020-02862-7
2. Tolcher MC, Holbert MR, Weaver AL, McGree ME, Olson JE, El-Nashar SA, et al. Predicting cesarean delivery after induction of labor among nulliparous women at term. Obstetrics & Gynecology. 2015; 126: 1059-68. doi: 10.1097/AOG.0000000000001083
3. Declercq E, Belanoff C, Iverson, R. Maternal perceptions of the experience of attempted labor induction and medically elective inductions: analysis of survey results from listening to mothers in California. BMC Pregnancy Childbirth. 2020; 20: 458. doi: 10.1186/s12884-020-03137-x
4. Thakur S, Kadam K, Paliwal P, Singh S, Singh C, Gupta R, et al. Comprehensive post-mortem evaluation in Intrauterine deaths/still births in improving uptake of autopsy and future pregnancy outcomes. Authorea Preprints. 2024. doi: 10.22541/au.170665801.10097869/v1
5. Swarnamani K, Davies-Tuck M, Wallace E, Mol BW, Mockler J. A double-blind randomised placebo-controlled trial of melatonin as an adjuvant agent in induction of labour (MILO): A study protocol. BMJ open. 2020; 10: e032480. doi: 10.1136/bmjopen-2019-032480
6. Kumari J, Munir A, Milner M. Impact of Indication for Labour Induction on Caesarean Section Delivery. Obstetrics and Gynecology Research. 2021; 4: 101-7. doi: 10.26502/ogr059

7. MacFarlane AJ, Blondel B, Mohangoo AD, Cuttini M, Nijhuis J, Novak Z, et al. Wide differences in mode of delivery within Europe: risk-stratified analyses of aggregated routine data from the Euro-Peristat study. BJOG: An International Journal of Obstetrics & Gynaecology. 2016; 123: 559-68. doi: 10.1111/1471-0528.13284
8. Monari F, Pellegrini R, Menichini D, Spelta E, Tarozzi G, Grandi G, et al. Induction of Labor According to Medical Indications: A Critical Evaluation through a Prospective Study. Clinical and Experimental Obstetrics & Gynecology. 2022; 49: 171. doi: 10.31083/j.ceog4908171
9. Mebratu A, Assefa DG, Zeleke ED, Mengistu N, Woldesenbet TT, Aynalem A, et al. Failed induction of labor and associated factors among women delivered in Jigjiga University Sheik Hassan Yabare Referral Hospital: a cross-sectional study. Current Medical Research and Opinion. 2022; 38: 1655-62. doi: 10.1080/03007995.2022.2103959
10. Uma R, Bhavadharini B, Ranjani H, Mahalakshmi MM, Anjana RM, Unnikrishnan R, et al. Pregnancy outcome of gestational diabetes mellitus using a structured model of care: WINGS project (WINGS-10). Journal of Obstetrics and Gynaecology Research. 2017; 43: 468-75. doi: 10.1111/jog.13249
11. D'Souza R, Ashraf R, Foroutan F. Prediction models for determining the success of labour induction: A systematic review and critical analysis. Best Practice & Research Clinical Obstetrics & Gynaecology. 2022; 79: 42-54. doi: 10.1016/j.bpobgyn.2021.12.005
12. Tarvonen M, Markkanen J, Tuppurainen V, Jernman R, Stefanovic V, Andersson S. Intrapartum cardiotocography with simultaneous maternal heart rate registration improves neonatal outcome. American Journal of Obstetrics and Gynecology. 2024; 230: 379.e1-379.e12. doi: 10.1016/j.ajog.2024.01.011
13. Rabei NH, Taha MO, Etman MK, Naser O. Measurement of Cerebro-Placental Doppler Ratio and Amniotic Fluid Index as a Predictor of Perinatal Outcome in Prolonged Pregnancy. Evidence Based Women's Health Journal. 2020; 10: 298-307. doi: 10.21608/ebwhj.2020.20645.1064
14. Shahabuddin Y, Murphy DJ. Cervical ripening and labour induction: a critical review of the available methods. Best Practice & Research Clinical Obstetrics & Gynaecology. 2022; 79: 3-17. doi: 10.1016/j.bpobgyn.2021.11.008
15. Sium AF, Prager S, Wolderufael M, Abubeker FA, Tufa TH, Grentzer JM. Foley catheter for cervical preparation prior to second trimester dilation and evacuation: a supply-based alternative for surgical abortion: a case series. Contraception: 2022; 4: 100085. doi: 10.1016/j.conx.2022.100085
16. Idris IM, Menghisteab S. Cesarean section delivery rates, determinants, and indications: a retrospective study in Dekemhare Hospital. Global Reproductive Health. 2022; 7: e56. doi: 10.1097/GRH.0000000000000056
17. Claramonte Nieto M, Meler Barrabes E, Garcia Martínez S, Gutiérrez Prat M, Serra Zantop B. Impact of aging on obstetric outcomes: defining advanced maternal age in Barcelona. BMC pregnancy and childbirth. 2019; 19: 342. doi: 10.1186/s12884-019-2415-3
18. Vandekerckhove M, Guignard M, Civadier MS, Benachi A, Bouyer J. Impact of maternal age on obstetric and neonatal morbidity: a retrospective cohort study. BMC pregnancy and childbirth. 2021; 21: 732. doi: 10.1186/s12884-021-04177-7
19. Melamed N, Baschat A, Yinon Y, Athanasiadis A, Mecacci F, Figueras F, et al. FIGO (international Federation of Gynecology and obstetrics) initiative on fetal growth: best practice advice for screening, diagnosis, and management of fetal growth restriction. International Journal of Gynaecology and Obstetrics. 2021; 152: 3-57. doi: 10.1002/ijgo.13522
20. Fiolna M. Prediction of adverse perinatal outcomes following induction of labour. Canterbury Christ Church University (United Kingdom); 2021. Available at: https://www.proquest.com/openview/6734c0337001e5a1e80a0ad8f1b97fd6/1?pq-origsite=gscholar&cbl=2026366&diss=y

Author Contributions

AA: Conception, design of the work, and approval for final submission
MSA: Manuscript writing for methodology design, investigation, and approval for final submission
NY: Data acquisition, curation, statistical analysis, and approval for final submission
SAK: Validation of data, interpretation, write-up of results, and approval for final submission
MS: Revising, editing, supervising for intellectual content, and approval for final submission
SM: Writing the original draft, proofreading, and approval for final submission
AA is the nominated guarantor and takes full responsibility for the overall content and integrity of the work