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Antenatal Risk Profiles and Distribution of Clinical and Obstetric Risk Factors Using the Modified Coopland Scoring System in Siaya County, Kenya

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Abstract

Purpose: Maternal mortality remains a major public health concern in low- and middle-income countries. Early identification of high-risk pregnancies is important for timely referral, follow-up, and appropriate care. The Modified Coopland Scoring System (MCSS) is a simple and low-cost antenatal risk stratification tool, but its use in routine antenatal care settings in western Kenya remains insufficiently described. This study described antenatal risk profiles among pregnant women attending level 4 health facilities in Siaya County, Kenya, using the MCSS.

Methodology: This was a secondary analysis of data from 175 pregnant women aged ≥30 weeks' gestation who were enrolled in the intervention arm of a parent randomized controlled trial. Participants were assessed using a digital MCSS antenatal risk stratification tool. The MCSS categorized women as low risk, moderate risk, or high risk based on demographic, medical, surgical, obstetric, and current pregnancy-related factors. Descriptive statistics and Fisher's exact tests were used to summarize and compare risk profiles across categories.

Findings: Most participants were classified as low risk (64.0%, n=112), while 25.6% (n=43) were moderate risk and 11.4% (n=20) were high risk. Maternal age and parity differed significantly across risk categories. The proportion of women aged >35 years increased from 6.3% in the low-risk group to 45.0% in the high-risk group. High parity was also more common among women classified as high risk. Malaria, moderate anemia, previous childbirth weight extremes, prolonged or difficult labor, previous caesarean section, hypertension, and multiple pregnancy were more frequently observed among women in higher risk categories.

Unique Contribution to Theory, Practice and Policy: The MCSS identified distinct antenatal risk profiles among pregnant women attending level 4 health facilities in Siaya County. Higher-risk classification was associated with older maternal age, higher parity, selected medical conditions, previous adverse obstetric history, and current pregnancy complications. These findings support the value of structured antenatal risk assessment to guide referral decisions and prioritize follow-up care in routine maternal health services.

Keywords: *Antenatal Risk Stratification, Modified Coopland Scoring System, High-Risk Pregnancy, Resource-Limited Settings, Western Kenya, Maternal Health*

JEL Codes: *I12, I18, O15*

INTRODUCTION

Maternal mortality remains a major public health concern globally, with a disproportionate burden in low- and middle-income countries (Ekwuazi et al., 2023). Globally, approximately 830 pregnant women die each day from preventable pregnancy- and childbirth-related complications(Olonade et al., 2019). Many of these deaths can be reduced through timely, quality care during antenatal care, childbirth, and the postpartum period. Early identification of women at increased risk is therefore important for timely monitoring, referral, and intervention (Sahare et al., 2025). A high-risk pregnancy is one that threatens the health or life of the mother or fetus (Biradar et al., 2024). Advanced maternal age is one factor commonly considered in antenatal risk assessment because it is associated with increased risk of maternal and perinatal complications (Correa-de-Araujo & Yoon, 2021).

In many resource-limited settings, health facilities face constraints in specialist care, diagnostic capacity, referral systems, and financial resources. These constraints may affect the timely identification and management of high-risk pregnancies. Simple, low-cost, and scalable risk stratification tools can therefore support triage, surveillance, referral, and follow-up. The Modified Coopland Scoring System (MCSS) is one such tool. It combines maternal, obstetric, medical, surgical, and current pregnancy-related risk factors into a single score that classifies antenatal women as low risk, moderate risk, or high risk (Al-Hindi et al., 2020; Biradar et al., 2024; Pillai & Mohan, 2021).

The MCSS may also support decision-making within the maternal referral pathway. The three-delays model identifies delays in deciding to seek care, reaching care, and receiving adequate care at the facility as major contributors to maternal mortality (Shah et al., 2020). By helping providers identify women who require closer monitoring or referral, MCSS can contribute to earlier recognition of risk and more structured referral decisions (Johnson et al., 2024; Souza et al., 2024). In primary and lower-level facilities, such tools may help providers determine which women can continue routine care locally and which require referral to higher-level facilities for further assessment or management (Narayanan et al., 2023).

Providing pregnant women with clear information about their risk status may also support care-seeking and adherence to referral advice. However, limited evidence exists on how MCSS-based antenatal risk categories are distributed in routine level 4 maternal health facilities in western Kenya, particularly when applied through a digital risk assessment approach. This study therefore aimed to describe maternal risk profiles stratified using the MCSS and associated maternal characteristics among women receiving antenatal care services in level 4 health facilities in Siaya County, Kenya.

METHODOLOGY

Study Setting and Design

This study was conducted in Siaya County, Kenya, between June and October 2025. Siaya County has seven sub-counties: Alego Usonga, Bondo, Ugenya, Ugunja, Gem, and Rarieda. The county has 220 health facilities, including 11 level 4 sub-county referral and teaching hospitals, 50 level 3 health centres, and 159 level 2 dispensaries. Level 4 facilities provide comprehensive emergency obstetric and newborn care and serve as referral hubs for lower-level facilities. The parent study was a randomized controlled trial in which 350 pregnant women were randomized in a 1:1 ratio to either an intervention group or a standard-of-care group. Women in the intervention group were assessed using a digital antenatal risk stratification tool to support referral decision-making, while women in the standard-of-care

group received routine provider-guided referral assessment. The present study was a secondary analysis of the 175 women allocated to the intervention arm. Details of the parent study sample size calculation have been reported elsewhere (Christabel Wesonga et al., 2026).

Problem Statement

Maternal mortality and morbidity remain major public health challenges in Kenya and other low- and middle-income countries despite improvements in antenatal and delivery care services. Many maternal and neonatal complications are preventable when high-risk pregnancies are identified early and managed appropriately through timely referral, monitoring, and specialized care. However, in many resource-constrained settings, including western Kenya, antenatal risk assessment is often inconsistent and largely dependent on provider judgment, which may result in delayed recognition of high-risk pregnancies and missed opportunities for early intervention.

Structured antenatal risk stratification tools such as the Modified Coopland Scoring System (MCSS) have been shown to support identification of women at increased risk of adverse pregnancy outcomes. Although MCSS has been applied in other settings, limited evidence exists regarding the distribution of antenatal risk profiles and associated clinical and obstetric risk factors among pregnant women attending routine antenatal care services in western Kenya. In addition, few studies have described the application of digital MCSS-based risk assessment approaches within level 4 health facilities in resource-limited settings.

Therefore, this study sought to describe antenatal risk profiles and the distribution of clinical and obstetric risk factors among pregnant women attending level 4 health facilities in Siaya County, Kenya, using the Modified Coopland Scoring System. The findings may contribute to strengthening structured antenatal risk assessment, referral decision-making, and prioritization of maternal health services for women at increased risk of pregnancy complications.

Population and Sampling

Eligible participants were adult pregnant women who were at least 30 weeks' gestation and residents of Siaya County. Women with life-threatening obstetric complications or those too ill to provide informed consent were excluded. The parent study (Christabel Wesonga et al., 2026) used a two-stage sampling process. First, 4 of the 11 level 4 hospitals were randomly selected using a lottery method in collaboration with sub-county health management teams. Second, eligible women within the selected facilities were randomly allocated to either the intervention or standard-of-care arm using a ballot method. Antenatal clinic registers served as the sampling frame, and the number of participants recruited from each hospital was proportional to its average monthly antenatal clinic attendance.

Data Collection Tool

Risk assessment was conducted using a digital platform, which standardized data capture and classification. The Modified Coopland Scoring System was used to assess antenatal risk among women in the intervention arm. The tool captured three broad domains: maternal age and obstetric status; pre-existing medical or surgical conditions, such as chronic hypertension, heart disease, and previous gynecological surgery; and complications in the current pregnancy, such as antepartum bleeding, malpresentation, pre-eclampsia, and gestational diabetes mellitus. Total scores were used to classify women as low risk, moderate risk, or high risk. Data were collected electronically by trained nurses using password-protected tablets and uploaded to a secure cloud-based server. Data collectors ensured that no study data remained on the tablets

after daily upload. Sociodemographic characteristics of the intervention group, including age, marital status, occupation, education level, and household income, have been described elsewhere (Christabel Wesonga et al., 2026).

Statistical analysis

Descriptive statistics were used to summarize participant characteristics and MCSS risk categories. Categorical variables were summarized using frequencies and percentages. Continuous variables were assessed for distribution and summarized using medians and interquartile ranges where appropriate. Fisher's exact test was used to compare categorical variables across risk categories because of small cell counts in some categories. Statistical significance was set at a two-sided p-value of <0.05. Analyses were conducted using RStudio version 4.5.1.

Ethical Considerations

Ethical approval was obtained from the Kenya Methodist University Ethics Review Committee (KeMU/NACOSTI/HSM/14/2025). A research permit was also obtained from the Kenya National Commission for Science, Technology and Innovation (NACOSTI/P/25/4173194). Additional approval was granted by the Siaya County Health Department (CGS/CHD/RESEARCH/141/VOL.11 (166)), and authorization was obtained from the management of participating health facilities. All participants provided written informed consent through signature or thumbprint before data collection. The study was conducted in accordance with the relevant ethical approvals and reported in line with the STROBE guidance for observational studies.

RESULTS

Maternal Age and Parity Distribution

Out of the 350 women enrolled in the parent trial (Christabel Wesonga et al., 2026), 175 in the intervention arm were included in this analysis. Most participants were classified as low risk (64.0%, n=112), followed by moderate risk (25.6%, n=43) and high risk (11.4%, n=20). Maternal age and parity differed significantly across MCSS risk categories. Women aged 18–35 years formed the largest proportion in all groups, but women aged >35 years were more frequent in the high-risk group than in the low-risk group. High parity was also more common among women classified as high risk (Table 1). These findings suggest that age and parity contributed meaningfully to MCSS risk classification in this cohort and should be considered in early antenatal risk assessment. The pattern indicates that MCSS classification captured established demographic and obstetric risk markers, particularly advanced maternal age and high parity, within a routine antenatal care population.

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Table 1: Maternal age and parity distribution by MCSS antenatal risk category

Characteristic	Risk Category n (%)				p-value[1]
	Low risk n = 112	Moderate risk n = 43	**High risk** n = 20	**Overall** n = 175	
Age in years					0.001
<18	7 (6.3)	2 (4.7)	1 (5.0)	10 (5.7)	
18-35	98 (87.5)	36 (83.7)	10 (50.0)	144 (82.3)	
>35	7 (6.3)	5 (11.6)	9 (45.0)	21 (12.0)	
Parity					0.002
< 1	44 (39.3)	11 (25.6)	4 (20.0)	59 (33.7)	
1-4	59 (52.7)	29 (67.4)	8 (40.0)	96 (54.9)	
≥5	9 (8.0)	3 (7.0)	8 (40.0)	20 (11.4)	

[1]Fisher's exact test

Medical and Surgical Conditions

Medical and surgical conditions varied across MCSS risk categories (Table 2). Malaria was the most frequently reported condition and was more common among women in the moderate- and high-risk groups than in the low-risk group. Tuberculosis was reported only among women classified as high risk, while chronic hypertension and previous gynecological surgery were also more frequent in higher risk categories. Asthma and pregestational diabetes were uncommon and did not show statistically significant differences ($p>0.05$) across risk groups. These findings suggest that MCSS classification reflected not only obstetric risk but also the contribution of infectious and chronic medical conditions to antenatal risk profiles in this setting.

Table 2: Medical and Surgical Conditions by MCSS antenatal risk category

Medical Condition	Risk Category n (%)				p-value[1]
	Low n = 112	**Moderate** n = 43	**High** n = 21	**Overall** n = 176	
Tuberculosis	–	–	6 (28.6)	6 (3.4)	0.001
Asthma	2 (1.8)	–	2 (9.5)	4 (2.3)	0.082
Malaria	22 (20.0)	20 (45.5)	16 (76.2)	58 (33.1)	0.001
Chronic Hypertension	1 (0.9)	5 (11.4)	4 (19.0)	10 (5.7)	0.001
Pregestational Diabetes	1 (0.9)	3 (6.8)	1 (4.8)	5 (2.9)	0.070
Previous Gynecological Surgery	–	1 (2.3)	3 (14.3)	4 (2.3)	0.002

[1]Fisher's exact test; Totals vary due to missing observations

Missing data were assessed during data cleaning and analysis. Because the proportion of missing observations was small, an available-case analysis approach was used. Percentages and statistical tests were calculated using the number of participants with complete observations for each specific variable. Cases with missing data were excluded only from the relevant variable analysis and were not removed entirely from the dataset. Therefore, denominators may differ slightly across variables and tables.

Previous Obstetric History

Past obstetric history differed across MCSS risk categories (Table 3). The clearest pattern was observed for previous childbirth weight extremes, which affected 33.1% of participants overall

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and increased from 22.7% in the low-risk group to 71.4% in the high-risk group. Prolonged or difficult labor, history of postpartum hemorrhage or manual removal of placenta, and previous caesarean section were also more common among women in higher risk categories. History of infertility was uncommon and was not significantly associated with risk category. These findings show that previous obstetric history was an important contributor to MCSS risk classification in this cohort.

Table 3: Previous obstetric history by MCSS antenatal risk category

Past Obstetric Condition	Risk Category n (%)				p-value[1]
	Low n = 112	Moderate n = 43	High n = 21	Overall n = 176	
Gestational hypertension/preeclampsia	–	2 (4.5)	4 (19.0)	6 (3.4)	0.001
Prolonged/difficult labor	6 (5.5)	17 (38.6)	10 (47.6)	33 (18.9)	0.001
History of ≥2 trimester abortions	3 (2.7)	5 (11.4)	5 (23.8)	13 (7.4)	0.002
History of < 2 trimester abortions	1 (0.9)	4 (9.1)	5 (23.8)	10 (5.7)	0.001
Previous childbirth weight <2.5kg or >4kg	25 (22.7)	18 (40.9)	15 (71.4)	58 (33.1)	0.001
History of PPH or manual removal of placenta	3 (2.7)	4 (9.1)	9 (42.9)	16 (9.1)	0.001
Previous still birth or neonatal death	–	1 (2.3)	3 (14.3)	4 (2.3)	0.002
History of infertility	–	1 (2.3)	1 (4.8)	2 (1.1)	0.074
Previous caesarean section	6 (5.5)	9 (20.5)	7 (33.3)	22 (12.6)	0.001

[1]Fisher's exact test; Totals vary due to missing observations

Current Pregnancy Conditions

Current pregnancy conditions differed across MCSS risk categories (Table). Moderate anemia was the most common condition, affecting 49.1% of participants overall and 81.0% of those classified as high risk. Multiple pregnancy, hypertension, bleeding before or after 20 weeks' gestation, and malpresentation at term were also more frequent among women in higher risk categories. Severe anemia and gestational diabetes were uncommon and were not significantly associated with MCSS risk category. These findings suggest that MCSS captured both common conditions, such as moderate anemia, and less frequent but clinically important pregnancy complications that may require closer antenatal monitoring.

Table 4: Current pregnancy conditions by MCSS antenatal risk category

Current pregnancy condition	Risk Category n (%)				p-value[1]
	Low n = 112	Moderate n = 43	High n = 21	Overall n = 176	
Severe anemia (Hb <6 g%)	1 (0.9)	3 (6.8)	–	4 (2.3)	0.120
Moderate anemia (Hb 6-10 g%)	48 (43.6)	21 (47.7)	17 (81.0)	86 (49.1)	0.007
Bleeding after 20 weeks' gestation	–	–	2 (9.5)	2 (1.1)	0.014
Bleeding before 20 weeks' gestation	1 (0.9)	2 (4.5)	3 (14.3)	6 (3.4)	0.011
Hypertension	1 (0.9)	6 (13.6)	3 (14.3)	10 (5.7)	0.001
Multiple pregnancy	1 (0.9)	2 (4.5)	10 (47.6)	13 (7.4)	0.001
Malpresentation at term	–	–	2 (9.5)	2 (1.1)	0.014
Gestational diabetes	–	1 (2.3)	1 (4.8)	2 (1.1)	0.074
Rh isoimmunization	1 (0.9)	4 (9.1)	–	5 (2.9)	0.030

[1]Fisher's exact test; Totals vary due to missing observations

Discussion

To our knowledge, this study provides context-specific evidence using MCSS-based antenatal risk profiles among pregnant women attending level 4 facilities in Siaya County. Most participants were classified as low risk, while a smaller proportion were categorized as moderate or high risk. The results show that higher MCSS risk classification was associated with a combination of demographic, medical, past obstetric, and current pregnancy-related factors. Advanced maternal age and high parity were more common among women classified as high risk. This finding is consistent with existing evidence showing that advanced maternal age is associated with increased risk of adverse pregnancy outcomes, including stillbirth, fetal growth restriction, and obstetric complications (Khalil et al., 2013; Lean et al., 2017; Correa-de-Araujo & Yoon, 2021). High parity was also more frequent in the high-risk group, which aligns with studies reporting that grand multiparity is associated with postpartum hemorrhage, malpresentation, and other maternal complications (Al-Shaikh et al., 2017; Dasa et al., 2022).

Medical and surgical conditions also contributed to the risk profile. Malaria was the most frequently reported medical condition and was more common among women in higher risk categories. This finding is important in a malaria-endemic setting because malaria in pregnancy is associated with maternal anemia, low birth weight, preterm birth, stillbirth, and miscarriage (Zakama & Gaw, 2019). Chronic hypertension was also more common in higher risk categories. This is consistent with evidence that chronic hypertension in pregnancy is associated with adverse maternal and perinatal outcomes (Bramham et al., 2014; Cohen et al., 2024; Nukpezah et al., 2024; Su et al., 2025). Tuberculosis and previous gynecological surgery were uncommon but appeared more frequently among women classified as high risk; however, these findings should be interpreted cautiously because of the small number of affected participants.

Previous obstetric history was an important component of MCSS classification. Factors such as previous childbirth weight extremes, prolonged or difficult labor, previous cesarean section, postpartum hemorrhage, and manual removal of the placenta were more common among women in higher-risk categories (Heerwagen et al., 2010). This finding supports the clinical value of obtaining a detailed obstetric history during antenatal assessment. However, these results should not be interpreted as evidence of recurrence or prediction of outcomes, since participants were not followed prospectively to assess delivery or neonatal outcomes (Infante-Torres et al., 2020; Young et al., 2023).

Current pregnancy conditions also differentiated the MCSS risk categories. Moderate anemia was the most common current pregnancy condition and was especially frequent among women in the high-risk group. This finding is consistent with existing evidence showing that maternal anemia is associated with adverse maternal and perinatal outcomes (World Health Organization, 2021). However, the present study only describes its distribution across risk categories and does not establish its independent effect on outcomes.

Multiple pregnancy, hypertension, bleeding episodes, and malpresentation were also more frequent among women in higher-risk categories, suggesting that MCSS captured both common and clinically important pregnancy conditions requiring closer antenatal monitoring. The use of a digital risk assessment tool may enhance classification consistency, although this study did not directly compare digital assessment with routine assessment.

Taken together, the findings indicate that MCSS classification reflected a cumulative risk pattern rather than a single dominant factor. Higher risk categories were characterized by the clustering of demographic risk markers, medical conditions, previous adverse obstetric history, and current pregnancy complications. These findings highlight how structured risk stratification tools can support decision-making in referral systems within resource-constrained settings, where timely identification and triage remain key challenges. Future studies should validate MCSS categories against maternal and perinatal outcomes to determine how well the tool predicts clinical endpoints in this setting.

What this study adds

1. Demonstrates distribution of MCSS risk categories in routine level 4 facilities
2. Shows clustering of medical, obstetric, and current pregnancy risks
3. Highlight's role of structured risk stratification in referral-oriented systems

Strengths and Limitations

This study assessed antenatal risk using multiple domains of the Modified Coopland Scoring System, including demographic, medical, past obstetric, and current pregnancy-related factors. The use of a structured risk assessment tool provided a consistent basis for classifying women into antenatal risk categories. The study had some limitations. First, the sample size was modest, particularly in the high-risk category, which limited subgroup comparisons. Second, the study included only women from level 4 health facilities in Siaya County; therefore, the findings may not apply to lower-level facilities or other settings. Third, maternal and perinatal outcomes were not assessed, so the study could not validate MCSS risk categories against clinical outcomes. Finally, risk status was assessed at one point during pregnancy, and changes in risk later in pregnancy were not captured.

Implications for Clinical Practice and Future Research

The findings support the use of structured antenatal risk assessment to identify women who may require closer monitoring or referral. Detailed obstetric history-taking remains important because previous obstetric complications were more common among women in higher MCSS risk categories. Screening and management of common conditions such as anemia, malaria, and hypertension should also remain central to antenatal care in this setting. Future research should validate MCSS risk categories against maternal and perinatal outcomes. Longitudinal studies are also needed to assess how antenatal risk status changes as pregnancy progresses.

Conclusion

This study described antenatal risk profiles among pregnant women assessed using the Modified Coopland Scoring System in level 4 health facilities in Siaya County. Most women were classified as low risk, while about one-third were categorized as moderate or high risk. Higher-risk classification was characterized by advanced maternal age, high parity, selected medical conditions, previous obstetric complications, and current pregnancy conditions. Malaria, moderate anemia, hypertension, multiple pregnancy, and previous adverse obstetric history were prominent within the risk profiles. These findings show that structured antenatal risk assessment can help identify women who may require closer monitoring or referral during pregnancy. Future studies should validate MCSS categories against maternal and perinatal outcomes.

Competing interest

We declare no conflict of interest

Author's Contribution

CW and WT conceived the study and designed the methodology. CW drafted the initial version of the manuscript. WT and JM supervised all stages of the study. All authors critically reviewed and revised the manuscript, contributed to the final version, and approved the submitted manuscript.

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