Adolescent pregnancies: a retrospective study on maternal and neonatal outcomes at Ndala Hospital, Tanzania

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Abstract

Background: Globally, over 21 million adolescent pregnancies occur annually among women aged 10-19 years. Giving birth before adulthood is common in low- and middle-income countries and is associated with increased risks of (pre)eclampsia, prolonged labour, and haemorrhage. Compared to adult pregnancies, neonates born to adolescent mothers are at higher risk of low birth weight, prematurity, low APGAR scores, stillbirth, and neonatal death. This study aimed to compare maternal and neonatal outcomes between adolescents and adults at a rural hospital in Tanzania.

Methods: A retrospective observational study was conducted at Ndala Hospital, including all mothers who gave birth during the year 2025. Adolescents were defined as mothers aged 10-20 years, while adults were 21 years or older. Data from multiple sources was collected, digitized, and analysed statistically.

Results: A total of 1559 mothers gave birth during the study period, of whom 555 were adolescents. Adolescents had a fourfold higher risk of eclampsia and 81% lower odds of antepartum haemorrhage. Assisted vaginal deliveries were more common among adolescents, whereas caesarean sections were more frequent among adults. Small perineal tears were observed more among young mothers., who also had a fourfold higher risk of episiotomy. Neonates of adolescents had more low APGAR scores and required more frequently admission to the intensive care unit, while stillbirths were more common among adults.

Conclusion: Current findings highlight the urgent need for targeted interventions to improve maternal and neonatal outcomes among adolescent mothers in rural Tanzania.

Keywords: adolescent pregnancy; obstetric outcomes; maternal outcomes; neonatal outcomes; Tanzania

Introduction

Adolescent pregnancies, occurring in young women aged 10-19 years, are highly prevalent in low- and middle-income countries (LMICs) (1). These pregnancies can be categorized into two groups: early adolescence (10-14 years) and late adolescence (15-19 years) (2). Most research on adolescent pregnancies focuses on women aged 15-19 years, but data on early adolescent pregnancies is gradually increasing (1). In 2019, 21 million adolescent pregnancies (aged 15-19 years) occurred in LMICs, approximately half of which were unintended (1). Of these pregnancies, more than 12 million resulted in childbirth (3), nearly 6 million ended in abortions and the remaining cases can be attributed to miscarriages and underreporting (1). According to 2022 data, the global adolescent fertility rate is 39 births per 1000 women aged 15-19, compared to 9 births per 1000 in high-income countries (HICs) (4).

Global

Studies from various countries (e.g., Ethiopia, Indonesia, Poland, Turkey) indicate that giving birth before adulthood is associated with increased health risks, including (pre)eclampsia (1,5-7), infections (1,5,7), and haemorrhage (5,7). In contrast, caesarean sections are significantly less common among adolescents (6-8). Data on adolescent maternal mortality is scarce, and therefore maternal mortality rate (MMR) is typically reported for the overall population rather than disaggregated by age. One study with global age-specific data on maternal mortality showed a J-shaped curve, with the lowest MMR of approximately 160 deaths per 100,000 live births observed among women aged 15-29 years (9). In 2020, the total global MMR was 223 per 100,000, while HICs had a significantly lower MMR of 13 per 100,000 (10,11). Although the overall maternal mortality declined between 1990 and 2015, the reductions among adolescents were smaller than those across all age groups combined (9). Similarly, data on neonatal mortality specific to adolescents is limited. As a result, neonatal mortality rate (NMR) is generally reported at the population level. Globally, neonatal mortality remains a major public health concern (12), with an estimated NMR of 17.3 deaths per 1000 live births in 2023, compared with less than five deaths per 1000 in HICs (13). Neonates born to adolescent mothers are at an increased risk of low birth weight (LBW) and preterm births (1,5,7,8). These risks are among the leading global causes of neonatal mortality (12,14). Adverse perinatal outcomes are significantly higher among women attending less than four antenatal care (ANC) visits (15), and the World Health Organization (WHO) advises a minimum of eight visits (16).

Africa

A scoping review of adolescent pregnancies in Africa found similar associations compared to worldwide data. Among adolescents, there were higher incidences of (pre)eclampsia, and obstructed and prolonged labour, while adults had higher rates of caesarean sections. Assisted vaginal deliveries were equally common in adolescents and adults (17). Adverse outcomes in newborns were also reviewed: LBW, preterm birth, stillbirth, neonatal death, low APGAR scores, and respiratory distress were all found to be more prevalent among adolescent mothers (17). MMR in sub-Saharan countries varies from 127 up to 1223 deaths per 100,000 live births (10). NMR varies from 11 up to 39 deaths per 1000 births (13).

Tanzania

In Tanzania, there were over 200,000 pregnant adolescents aged 15-19 years in 2022 (18,19). The adolescent fertility rate is 114.3 births per 1000 women aged 15-19 years, ranking the country among the top fourteen with the highest fertility rates (4). According to the Tanzania Demographic and Health

Survey and Malaria Indicator Survey (TDHS-MIS) 2022, 22% of women aged 15-19 have ever been pregnant and 16.1% had a live birth (20). Of all adolescent pregnancies, most resulted in living babies, 8% were miscarriages and 2% were stillbirths (20). Tanzanian adolescents have significantly higher chances on prolonged labour and premature rupture of membranes (PROM) compared to adults (21). Consistent with global data, caesarean sections are seen significantly less in adolescents. Significant more newborns have a low birth weight (22) or are born preterm (21). The nationwide NMR is 20 deaths per 1000 births (13), adolescents have a significantly higher NMR compared with women aged 20-39 (22). The average MMR across all age groups is 238 deaths per 100,000 live births (10). Although the total number of deaths caused by maternal conditions is lowest among adolescents compared to women aged 20-49 years (22 versus 44-61 deaths per 100,000 population), these maternal deaths account for 27% of all mortalities in women aged 15-19 years (14). During their last pregnancy, 65.1% of all women had four or more ANC visits (18).

Hospital

Ndala Hospital is a mission-based health facility located in Nzega District, Tabora Region, Tanzania. Recently, the hospital received a government-provided ambulance for patient transport, highlighting its role as a referral centre not only for Nzega District, but also for the neighbouring districts of Uyui and Igunga. In addition to the hospital, Nzega District Council oversees six Public Health Centres (PHCs), one Faith Based Organization Health Centre (FBOHC) and fifty-four dispensaries (23). Based on the TDHS-MIS 2015-16 report (22), the Tabora region had the highest prevalence of adolescent pregnancies in Tanzania (10.4%) (24). According to the 2022 report 22.2% of women aged 15-19 in Tabora had ever had a live birth, and 29.1% had ever been pregnant. Both proportions exceed the national average by a substantial margin (18,20). Nearly half of all pregnant women had less than four ANC visits (49.7%) (18). Hospital records from 2024 reported 1470 deliveries, of which 1450 were live births. A total of 452 caesarean sections were performed. Documented obstetric complications included uterine rupture (n=6), antepartum haemorrhage (APH) (n=32), postpartum haemorrhage (PPH) (n=43), and eclampsia (n=46). Two maternal deaths were reported. Additionally, 30 babies were born prematurely, and neonatal complications appeared to increase, possibly due to a rise in health facility referrals. There were 30 fresh stillbirths (FSB) and 28 macerated stillbirths (MSB). However, data in the Annual Report (23) was not categorized by age, making it impossible to determine the incidence of adolescent pregnancies and associated obstetric outcomes within Ndala Hospital's catchment area. This research aims to bridge this gap and contribute to improved health outcomes in this vulnerable group.

Methods

This retrospective observational study was conducted at Ndala Hospital, located in the Nzega District of the Tabora Region, Tanzania. The study population comprised all mothers giving birth at the hospital between January 1 and December 31, 2025.

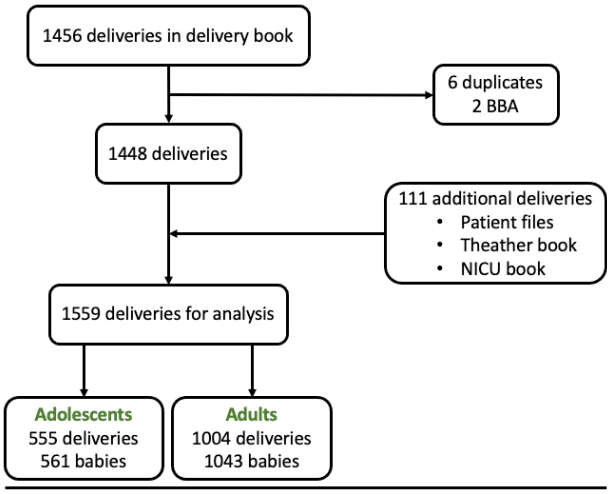
Age categories

The WHO defines adolescent pregnancies as occurring in women aged 10-19 years (1). In this study, however, women up to 20 years of age were included in the adolescent category. This decision was based on contextual considerations: in certain cases, adolescents may have reported an older age to avoid potential legal consequences associated with underage pregnancy. Extending the definition to include participants aged 20 years increased the

likelihood of capturing enough relevant cases while maintaining ethical integrity.

Data collection

Primary data source was the maternity delivery book. Secondary sources were patient files, ANC cards, theatre procedure book, neonatal intensive care unit (NICU) admission book, and Inaya (electronic patient system). The dataset included demographic and clinical characteristics, pregnancy-related complications and outcomes, and maternal and neonatal morbidity and mortality. Figure 1 shows the flowchart of data collection.



BBA = born before arrival; NICU = neonatal intensive care unit

Figure 1. Flow chart of data collection.

Data recorded in Inaya was prioritized whenever inconsistencies arose between Inaya and paper files. The rationale is that this system is designed to document patient information in a structured and reliable way, whereas paper records often contain notes based on verbal reports, which could sometimes deviate from the facts. For example, discrepancies were most found in personal details such as place of residence or age. In some cases, medical procedures (e.g., cervical tear repair) or diagnoses (e.g., anaemia) were only written in Inaya. Therefore, unless Inaya was the only source showing an aberrant entry, this source was held as truth.

Sometimes in the delivery book, parity and living children were not written correctly according to gravidity (e.g., G1P1L1 instead of G1P0L0). In such a case, both parity and living children were documented as number of gravidities minus one. Gestational age (GA) was calculated using the last menstrual period (LMP) and written in weeks and sometimes in weeks plus days. For statistical purposes the latter was written in Microsoft Excel using the following formula: *=weeks+days/7*.

Statistical analysis

Data was collected in Microsoft Excel and primary calculations were done. Data was then exported into SPSS (version 30) for further analysis. Since this version did not have generalised estimating equations (GEE) or generalised linear models (GENLIN) to analyse clustered data (in this case twins), every second row per twin pregnancy was removed from the dataset analysing general characteristics and maternal outcomes. As for the neonatal outcomes, all babies (including twins) were included in the dataset.

Normality of continuous variables was assessed using the Kolmogorov-Smirnov test and visual inspection of histograms and Q-Q plots. Although statistical tests indicated deviations from normality due to the large sample size, visual inspection showed distributions that were sufficiently symmetric to justify reporting means and standard deviations. The continuous variables were then compared using either T-test or one-way ANOVA. Post-hoc tests included Welch and Games-Howell. Categorical variables were compared using Chi-squared test, Fisher's exact test or logistic regression, as appropriate. P-values less than 0.05 were considered significant. Odds ratio (OR) and corresponding 95% confidence intervals (CI) were calculated for the association between outcomes and maternal age. Tables were created using Microsoft Excel. In case of

very small sample sizes in on or both groups (n=0 or n=1), no statistical test was performed to avoid misinterpretation of the results. Instead, 'n/a' (not applicable) was reported in the table.

Definitions

According to the WHO, preterm birth was defined as being born before 37 weeks of gestation. Subcategories were extremely preterm (<28 weeks), very preterm (28 to <32 weeks) and moderate preterm (32 to <37weeks) (25). Prematurity, the state of a neonate being born to early, was defined accordingly. Low birth weight was defined as weight less than 2.5 kilograms (26). Neonatal death refers to the death of a live-born infant within the first 28 days of life (27).

Ethics

Ethical clearance was given by the National Institute for Medical Research (NIMR) with approval number NIMR/HQ/R.8a/Vol.IX/5195. The retrospective data was used anonymously, therefore consent and assent were not obtained.

Results

During the year 2025, a total of 1559 mothers delivered at Ndala Hospital. Over one-third (35.6%) were adolescents aged 13-20 years. The mean age was 18.04 years for adolescents and 29.36 years for adults. Table 1 shows the general characteristics of included mothers.

Table 1. General characteristics.

	Adolescents (10-20 years) N = 555		Adults (>21 years) N = 1004		
Variable	**Number**	**Mean (±SD) / %**	**Number**	**Mean (±SD) / %**	**P-value**
Age (years)	555	18.04 (±1.50)	1004	29.36 (±6.19)	**<0.001**
Education					0.483
Adult education	0	0.0%	2	3.5%	n/a
Primary	18	85.7%	40	70.2%	0.488
Secondary	2	9.5%	6	10.5%	0.719
Highschool	0	0.0%	6	10.5%	n/a
Other	1	4.8%	3	5.3%	n/a
Gravidity					**<0.001**
Primigravida	427	77.6%	107	10.8%	
Multigravida	123	22.4%	881	89.2%	
Number of fetuses					**0.001**
Singleton	549	98.9%	965	96.1%	
Twin	6	1.1%	39	3.9%	
Number ANC visits					**0.001**
1 to 3	43	31.9%	101	42.4%	**0.047**
4 to 7	84	62.2%	136	57.1%	0.381
8 or above	8	5.9%	1	0.4%	n/a
GA at delivery (weeks)	485	36.78 (±1.99)	906	37.18 (±2.21)	**<0.001**
Hb at admission (g/dL)	426	10.48 (±1.61)	781	10.21 (±1.81)	**0.007**

ANC = antenatal care; GA = gestational age; g/dL = gram per decilitre; Hb = haemoglobin; SD = standard deviation

n/a = not applicable: statistical analysis not performed due to insufficient number of cases

Significantly more adolescents were primigravida (p<0.001), and adults were mostly multigravida. A total of 45 twins were born, significantly more to adult mothers (p=0.001), In 373 cases, the number of ANC visits was written. The number most recorded in both groups was 4 to 7 visits. The GA at delivery differed significantly (p<0.001) between the groups, 36.78 (±1.99) and 37.18 (±2.21) weeks for adolescents and adults respectively. The level of haemoglobin at admission was with a difference of 0.27 gram per decilitre significantly higher in adolescents (p=0.007).

Table 2. Pregnancy outcomes and maternal complications.

	Adolescents (10-20 years) N = 555		Adults (>21 years) N = 1004			
Variable	**Number**	**Percentage**	**Number**	**Percentage**	**OR (95% CI)**	**P-value**
Polyhydramnios	0	0.0%	12	1.2%	n/a	n/a
Oligohydramnios	15	2.7%	42	4.2%	0.64 (0.35-1.16)	0.159
Gestational diabetes	0	0.0%	1	0.1%	n/a	n/a
PIH	1	0.2%	6	0.6%	n/a	n/a
Pre-eclampsia	18	3.2%	41	4.1%	0.79 (0.45-1.38)	0.489
Eclampsia	16	2.9%	7	0.7%	4.23 (1.73-10.34)	**<0.001**
Infection						
Malaria	15	2.7%	9	0.9%	3.07 (1.34-7.06)	**0.009**
HIV	31	5.6%	53	5.3%	1.06 (0.67-1.68)	0.815
Other	5	0.9%	4	0.4%	2.27 (0.61-8.50)	0.295
Anaemia	47	8.5%	125	12.5%	0.65 (0.46-0.93)	**0.016**
Anaemia prepartum	32	5.8%	65	6.5%	0.88 (0.57-1.37)	0.662
Anaemia postpartum	15	2.7%	60	6.0%	0.44 (0.25-0.78)	**0.004**
APH	6	1.1%	56	5.6%	0.19 (0.08-0.43)	**<0.001**
Placenta praevia	5	0.9%	30	3.0%	0.30 (0.11-0.77)	**0.007**
Abruptio placentae	2	0.4%	24	2.4%	0.15 (0.04-0.63)	**0.002**
PROM	9	1.6%	18	1.8%	0.90 (0.40-2.02)	1.000
Preterm delivery	222	45.9%	295	32.7%	1.75 (1.39-2.19)	**<0.001**
Extremely preterm	2	0.4%	4	0.4%	0.93 (0.17-5.11)	1.000
Very preterm	9	1.9%	19	2.1%	0.88 (0.40-1.96)	0.843
Moderate preterm	211	43.6%	272	30.1%	1.79 (1.43-2.26)	**<0.001**
Induction of labour	6	1.1%	24	2.4%	0.45 (0.18-1.10)	0.083
Failure of induction	2	0.4%	5	0.5%	0.72 (0.14-3.74)	1.000
Prolonged labour	22	4.0%	29	2.9%	1.39 (0.79-2.44)	0.298
Obstructed labour	140	25.2%	223	22.2%	1.18 (0.93-1.51)	0.189
Fetal distress	47	8.5%	84	8.4%	1.01 (0.70-1.47)	1.000
Uterine rupture	5	0.9%	22	2.2%	0.41 (0.15-1.08)	0.069
Mode of delivery	555	35.6%	1004	64.4%		**<0.001**
Spontaneous vaginal	369	66.5%	652	64.9%	1.07 (0.86-1.33)	0.578
Assisted vaginal	29	5.2%	13	1.3%	4.20 (2.17-8.15)	**<0.001**
Caesarean section	157	28.3%	339	33.8%	0.77 (0.62-0.97)	**0.027**
Episiotomy	13	2.3%	6	0.6%	3.99 (1.51-10.56)	**0.006**
Perineal tear						
1st degree	95	17.1%	80	8.0%	2.39 (1.74-3.28)	**<0.001**
2nd degree	83	15.0%	47	4.7%	3.58 (2.46-5.21)	**<0.001**
3rd degree	4	0.7%	8	0.8%	0.90 (0.27-3.02)	1.000
4th degree	4	0.7%	2	0.2%	3.64 (0.66-19.92)	0.195
Cercival tear	11	2.0%	21	2.1%	0.95 (0.45-1.98)	1.000
PPH	17	3.1%	23	2.3%	1.35 (0.71-2.55)	0.403
Retained placenta	4	0.7%	4	0.4%	1.82 (0.45-7.29)	0.466
Maternal death	0	0.0%	2	0.2%	n/a	n/a

APH = antepartum haemorrhage; CI = confidence interval; HIV = human immunodeficiency virus; OR = odds ratio; PIH = pregnancy induced hypertension; PPH = post partum haemorrhage; PROM = premature rupture of membranes

n/a = not applicable: statistical analysis not performed due to insufficient number of cases

Table 2 shows the pregnancy outcomes and maternal complications. Adolescents were at significantly increased risk of eclampsia (OR 4.23, 95% CI [1.73-10.34], p<0.001). They also had more than a threefold risk of malaria (OR 3.07, 95% CI [1.34-7.06], p=0.009), although the total number of cases was low (n=24). In contrast, the odds for APH were 81% lower in adolescents (OR 0.19, 95% CI [0.08-0.43], p<0.001). Placenta praevia was recorded more often than abruptio placentae as a cause of APH, but both happened significantly more in adults (p=0.007 and p=0.002, respectively). PROM occurred in nearly identical quantities across age groups (p=0.906).

Preterm delivery was recorded in approximately one-third of total deliveries, with adolescents showing an increased risk (OR 1.75 95% CI [1.39-2.19], p<0.001). There were 30 cases of induction, 7 failed and ended in a caesarean section, distribution did not significantly differ between the groups (induction (p=0.083) and failure (p=1.000), respectively). Caesarean sections were seen significantly more in adults (p=0.027). In contrast, adolescents had over fourfold higher risk of assisted vaginal deliveries (OR 4.20, 95% CI [2.17-8.15], p<0.001). Besides, the risk of getting an episiotomy was nearly four times higher (OR 3.99, 95% CI [1.51-10.56], p=0.006). First- and second-degree perineal tears were also significantly more frequent in young mothers (both p<0.001). More severe tears, including cervical tears, were recorded considerably less, and happened in comparable rates in both groups. No other obstetric complications differed statistically between adolescents and adults. Unfortunately, two maternal deaths were recorded in 2025.

Table 3. Neonatal outcomes and complications.

	Adolescents (10-20 years) N = 555		Adults (>21 years) N = 1004			
Variable	**Number**	**Mean (±SD) / %**	**Number**	**Mean (±SD) / %**	**OR (95% CI)**	**P-value**
Sex of baby						0.753
Male	269	48.0%	508	48.9%		
Female	291	52.0%	531	51.1%		
Prematurity	226	45.9%	313	33.1%	1.72 (1.37-2.14)	**<0.001**
Extremely premature	3	0.6%	4	0.4%	1.44 (0.32-6.47)	0.697
Very premature	9	1.8%	21	2.2%	0.82 (0.37-1.80)	0.701
Moderate premature	214	43.5%	288	30.5%	1.76 (1.40-2.20)	**<0.001**
Newborn weight (kg)	560	2.91 (±0.49)	1034	3.03 (±0.64)		**<0.001**
Low birth weight	82	14.6%	147	14.2%	0.97 (0.72-1.29)	0.823
Low APGAR score						
At 1 minute	61	11.3%	67	6.9%	1.73 (1.20-2.49)	**0.004**
At 5 minutes	25	4.6%	22	2.3%	2.10 (1.17-3.77)	**0.013**
NICU admission	34	6.1%	39	3.7%	1.66 (1.04-2.66)	**0.044**
Stillbirth	20	3.6%	64	6.1%	0.57 (0.34-0.95)	**0.034**
FSB	10	1.8%	27	2.6%	0.68 (0.33-1.42)	0.384
MSB	8	1.4%	28	2.7%	0.52 (0.24-1.16)	0.114
Neonatal death	6	1.1%	12	1.2%	0.93 (0.35-2.45)	1.000

CI = confidence interval; FSB = fresh stillbirth; kg = kilogram; MSB = mascerated stillbirth; NICU = neonetal intensive care unit; OR = odds ratio; SD = standard deviation

Table 3 shows the neonatal outcomes and complications. More female babies were born than male ones, 822 versus 777 respectively, with equal distribution between the age groups. Infants born to adolescent mothers weighted significantly less (mean difference 0.12

kilograms, p<0.001), although the clinical relevance of this association was limited. In terms of LBW, there was no substantial difference between the groups. Low APGAR scores were significantly more frequent among infants of adolescent mothers, both at 1 minute (p=0.004) and at 5 minutes (p=0.013). Relatively more babies born to adolescents required NICU admission (p=0.044), with birth asphyxia being the most prominent indication. In contrast, adult mothers had more stillbirths (p=0.034). Recorded neonatal deaths were sparse and overall rates were comparable between the groups.

Discussion

This study initially aimed to improve health outcomes in adolescent pregnancies by investigating obstetric outcomes, birth preparedness and peripartum experiences. Due to unforeseeable circumstances concerning medical-ethical clearance, only retrospective research could be done during the stay of the principal investigator (PI) at Ndala Hospital. As a matter of fact, questionnaires on birth preparedness and complication readiness (BPCR) were not enrolled, and interviews were not held. Moreover, the study title has been modified to better cover the current performed research.

Age categories

The overall number of adolescents was higher than initially anticipated. A total of 109 mothers aged 20 years were included in the study. To assess whether this affected the findings, the cut-off for adolescence was subsequently lowered from 20 to 19 years, and the statistical analyses were repeated. Most outcomes remained unchanged, although some previously significant differences disappeared, such as ANC visits, episiotomy, and malaria incidence. Stillbirths, however, became more strongly associated with adult mothers, contrasting with findings from other African countries where adolescents are at higher risk (17). Nevertheless, with 2.4%, the proportion of stillbirths among adolescents (10-19 years) in this present study exceeded the national average of 2.0% (20).

Parity

To assess whether differences in outcomes could be explained by parity, an additional analysis was conducted comparing nulliparous and multiparous women across both age groups. Most patterns were consistent with the primary analyses, as can be seen in Appendix I, Tables 4-6. Odds ratios were calculated using adolescent nullipara as the reference group; detailed results are presented in Table 7. Adult nullipara attended significantly more ANC visits (p=0.015). Twin pregnancies were observed over six times more among multiparous adults. These findings, however, should be interpreted with caution, since no case of twin pregnancy was recorded among adult nulliparous women. Because no cases of episiotomy were recorded among multiparous women, reliable conclusions regarding this variable could not be drawn. Episiotomies were documented exclusively in nulliparous mothers, who also experienced significantly more perineal tears, underscoring the increased risk associated with first delivery. Adult multiparous women were at increased risk of anaemia, particularly when it occurred in the postpartum period. Adults showed higher rates of APH, but only adult multipara had a significant elevated risk of this complication. Women with an history of CS are at elevated risk of uterine rupture (UR) in subsequent pregnancies (28). In this cohort, only one case of UR was documented among nulliparous women, underscoring the disproportionate risk faced by multiparous women. Data on previous pregnancies were limited and recall among participants was often poor. Nevertheless, it is reasonable to assume that most cases of UR occurred in mothers with a

history of CS. Adult multipara showed fewer low APGAR scores and were less likely to have neonates admitted to NICU. In contrast, multiparous women had markedly higher rates of stillbirths, aligning with recent research where higher parity was found to be a negative factor in relation to stillbirths (29).

Hospital setting

Adolescents in rural areas are more likely to become pregnant than their counterparts in urban settings (22). At Ndala Hospital, adolescents accounted for over one-third of total deliveries, whereas at St Ann's Hospital (a mission-based facility in Tabora) it was less than ten percent. This difference might be caused by socio-economic factors such as education (24,30). The GA at delivery was at least one week higher in the urban hospital, which could be caused by difference in adequate documentation (see Gestational age). Outcomes were generally poorer in Ndala, with more complications and adverse neonatal results, reflecting the challenges of giving birth in rural hospitals (30).

Relation to expected outcomes

Most findings in the present study aligned with the literature, although some results diverged from expectations. While PPH was more frequent among adolescents, the difference was not significant. PROM occurred more often in adults, whereas prolonged labour was proportionally more frequent in adolescents, which contrasts with national data where both were found significantly more among adolescents (21). Both pre-eclampsia and eclampsia were expected to be more prevalent among adolescents (1,5-7,17). However, only eclampsia reached statistical significance, and pre-eclampsia was recorded more often in adults. Babies with LBW were more found among adolescents, although the expected significance was not reached (22). These discrepancies may reflect diagnostic accuracy and documentation practices, rather than true epidemiological differences.

Antenatal care

The number of ANC visits was not consistently documented in patient files. However, analysis of available data revealed that attendance was significantly higher among adolescents. With 68.1% attending four or more ANC visits, adolescent mothers exceeded the national average (18). However, only nine women achieved the WHO-recommended minimum of eight ANC visits (16), and approximately one-third attended less than four. These findings highlight the need to strengthen ANC promotion and adherence, as inadequate attendance increases the risk of adverse neonatal outcomes (15).

Strengths and limitations

This study has several strengths and limitations

Completeness of data

A comprehensive dataset was established by digitizing the delivery book and supplementing it with additional records. Each patient file was thoroughly cross-checked in Inaya, resulting in a complete and well-structured dataset. This process added 111 deliveries beyond those initially recorded in the delivery book, thereby improving the accuracy of the hospital's annual statistics, and providing a valuable resource for future research.

Maternal age

Most mothers did not know their exact date of birth, which is common in LMICs (31). Opening a file in Inaya was mostly done with information provided by relatives or friends, occasionally leading to higher documented ages, potentially placing mothers in the wrong age category. Such misclassification may have led to a slight underestimation of adolescent outcomes.

Mortality

Documentation of both maternal and neonatal mortality was incomplete or adjusted, which may reflect the sensitive implications of such events for local and national authorities. Maternal deaths were not always properly recorded, particularly when women were referred in critical condition from other facilities and despite maximal efforts died shortly after admission. To avoid potential administrative or legal repercussions, such cases may not have been reported. This underreporting is consistent with national surveys that suggest declining MMR (20,32), while UN modelled estimates remain substantially higher (10), underscoring underreporting as persistent challenge (32). The PI also personally observed an undocumented maternal death, highlighting the likelihood of further unrecorded cases and suggesting that maternal mortality in this study might be underestimated.

Neonatal mortality was similarly underreported. Infants did not automatically receive a hospital number, unless admitted to NICU or the premature ward, and deaths within the first 24 hours were sometimes omitted. In addition, APGAR scores of stillbirths were occasionally altered in the delivery book to avoid administrative difficulties. These practices contributed to underestimation, although the stillbirth rate in Ndala (52 per 1000 births) was already more than seven times above national average (32). Documentation in Inaya generally reflected actual outcomes and could therefore be used as a reliable reference. However, in some cases both Inaya and paper records did not correspond with the clinical reality. The PI applied clinical judgment to correct these errors in the dataset. Such corrections were possible only between September and December while the PI was present on the maternity ward. Prior to this, data may have been modified, further contributing to underestimation. Taken together, these findings indicate that both MMR and NMR presented here are likely conservative, and the true burden of these adverse outcomes is higher than reported.

Peripartum complications

Complications recorded in the delivery book were limited in number, with frequent omissions of anaemia, malaria, PPH, and severe perineal tears. By integrating multiple sources, the dataset was supplemented to allow more robust analysis, though some complications may still have been missed, as both paper and electronic documentations tented to be brief and concise.

Gestational age

Assessment of GA was hindered by multiple factors. Many women did not know their last menstrual period (LMP), making it hard to calculate estimated date of delivery (EDD) and GA. Even when LMP was known, GA was not always calculated or recorded correctly. In some cases, GA was based on clinical judgement or entered arbitrarily. Most ultrasound (US) examinations were performed in the third trimester, when GA is less reliable, and foetal growth restriction may be misclassified as prematurity (33). As a result, inconsistencies were observed between US measurements and GA calculated from LMP. Furthermore, GA was mostly recorded as rounded weeks rather than weeks plus days, both by radiology and maternity staff, therefore reducing precision. Current observed difference in GA at delivery between adolescents and adults might have been absent, as was found at St Ann's Hospital.

According to the WHO, all deliveries before 37 weeks are considered preterm (25). In this hospital, however, a GA of 36 weeks was sometimes regarded term. Analysis using the local threshold eliminated previously significant differences in prematurity, reducing the

overall rate from 33.2% to 8.7%. These findings highlight the sensitivity of outcomes to definitional criteria, and the need for consistent standards in maternal and neonatal research.

Conclusion

Adolescent pregnancies account for one-third of the total number of deliveries in Ndala Hospital and therefore represent a major public health concern. Adolescents were associated with significantly higher rates of eclampsia, malaria, assisted vaginal deliveries, episiotomies, first- and second-degree perineal ruptures, low APGAR scores, and NICU admission. These findings highlight the urgent need for targeted interventions to improve maternal and neonatal morbidity and mortality in this population. Based on the findings of this study and clinical observations by the PI, several recommendations were made as can be found in Appendix III.

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Appendices

Appendix I. Outcomes by age and parity

Table 4. Four groups: general characteristics.

	Adolescents (10-20 years)				Adults (>21 years)				
	Nullipara N = 433		Multipara N = 117		Nullipara N = 111		Multipara N = 876		
Variable	**Number**	**Mean (±SD) / %**	**Number**	**Mean (±SD) / %**	**Number**	**Mean (±SD) / %**	**Number**	**Mean (±SD) / %**	**P-value**
Age (years)	433	17.75 (±1.49)	117	19.06 (±1.05)	111	23.54 (±2.72)	876	30.08 (±6.12)	**<0.001**
Education									**<0.001**
Adult education	0	0.0%	0	0.0%	0	0.0%	2	4.2%	n/a
Primary	17	89.5%	1	50.0%	3	33.3%	37	77.1%	n/a
Secondary	2	10.5%	0	0.0%	2	22.2%	4	8.3%	n/a
Highschool	0	0.0%	0	0.0%	4	44.4%	2	4.2%	n/a
Other	0	0.0%	1	50.0%	0	0.0%	3	6.3%	n/a
Number of fetuses									**<0.001**
Singleton	430	99.3%	114	97.4%	111	100.0%	838	95.7%	
Twin	3	0.7%	3	2.6%	0	0.0%	38	4.3%	
Number ANC visits									**<0.001**
1 to 3	32	29.1%	10	41.7%	3	10.3%	96	46.8%	**<0.001**
4 to 7	71	64.5%	13	54.2%	26	89.7%	108	52.7%	**<0.001**
8 or above	7	6.4%	1	4.2%	0	0.0%	1	0.5%	n/a
GA at delivery (weeks)	385	36.77 (±1.98)	100	36.92 (±2.27)	106	36.90 (±1.93)	788	37.21 (±2.26)	**0.009**
Hb at admission (g/dL)	345	10.44 (±1.60)	76	10.59 (±1.67)	85	10.77 (±1.80)	681	10.17 (±1.78)	**0.002**

ANC = antenatal care; GA = gestational age; g/dL = gram per decilitre; Hb = haemoglobin; SD = standard deviation
n/a = not applicable: statistical analysis not performed due to insufficient number of cases

Table 5. Four groups: pregnancy outcomes and maternal complications.

	Adolescents (10-20 years)				Adults (>21 years)				
	Nullipara N = 433		Multipara N = 117		Nullipara N = 111		Multipara N = 876		
Variable	**Number**	**Percentage**	**Number**	**Percentage**	**Number**	**Percentage**	**Number**	**Percentage**	**P-value**
Polyhydramnios	0	0.0%	0	0.0%	0	0.0%	11	1.3%	n/a
Oligohydramnios	13	3.0%	2	1.7%	5	4.5%	35	4.0%	0.461
Gestational diabetes	0	0.0%	0	0.0%	0	0.0%	1	0.1%	n/a
PIH	1	0.2%	0	0.0%	0	0.0%	5	0.6%	n/a
Pre-eclampsia	16	3.7%	2	1.7%	2	1.8%	38	4.3%	0.270
Eclampsia	15	3.5%	0	0.0%	1	0.9%	6	0.7%	n/a
Infection									
Malaria	9	2.1%	6	5.1%	3	2.7%	5	0.6%	**0.002**
HIV	27	6.2%	3	2.6%	10	9.0%	43	4.9%	0.131
Other	5	1.2%	0	0.0%	0	0.0%	4	0.5%	n/a
Anaemia	35	8.1%	12	10.3%	6	5.4%	111	12.7%	**0.014**
Anaemia prepartum	23	5.3%	9	7.7%	2	1.8%	57	6.5%	0.111
Anaemia postpartum	12	2.8%	3	2.6%	4	3.6%	54	6.2%	**0.021**
APH	4	0.9%	2	1.7%	4	3.6%	47	5.4%	**<0.001**
Placenta praevia	4	0.9%	1	0.9%	2	1.8%	24	2.7%	n/a
Abruptio placentae	2	0.5%	0	0.0%	2	1.8%	19	2.2%	**n/a**
PROM	8	1.8%	1	0.9%	0	0.0%	17	1.9%	n/a
Preterm delivery	178	46.4%	43	43.4%	43	40.6%	250	31.9%	**<0.001**
Extremely preterm	1	0.3%	1	1.0%	1	0.9%	3	0.4%	n/a
Very preterm	6	1.6%	3	3.0%	1	0.9%	18	2.3%	n/a
Moderate preterm	171	44.5%	39	39.4%	41	38.7%	229	29.2%	**<0.001**
Induction of labour	4	0.9%	2	1.7%	3	2.7%	19	2.2%	0.339
Failure of induction	1	0.2%	1	0.9%	0	0.0%	3	0.3%	n/a
Prolonged labour	17	3.9%	5	4.3%	4	3.6%	24	2.7%	0.625
Obstructed labour	110	25.4%	27	23.1%	21	18.9%	196	22.4%	0.446
Fetal distress	37	8.5%	8	6.8%	12	10.8%	69	7.9%	0.702
Uterine rupture	1	0.2%	4	3.4%	0	0.0%	21	2.4%	n/a

Mode of delivery	443	28.2%	117	7.6%	111	7.2%	876	57.0%	**<0.001**
Spontaneous vaginal	291	67.2%	77	65.8%	79	71.2%	570	65.1%	0.580
Assisted vaginal	24	5.5%	4	3.4%	4	3.6%	9	1.0%	**<0.001**
Caesarean section	118	27.3%	36	30.8%	28	25.2%	297	33.9%	**0.044**
Episiotomy	13	3.0%	0	0.0%	6	5.4%	0	0.0%	n/a
Perineal tear									
1st degree	77	17.8%	18	15.4%	20	18.0%	60	6.8%	**<0.001**
2nd degree	75	17.3%	8	6.8%	19	17.1%	28	3.2%	**<0.001**
3rd degree	4	0.9%	0	0.0%	3	2.7%	5	0.6%	n/a
4th degree	4	0.9%	0	0.0%	0	0.0%	2	0.2%	n/a
Cercival tear	10	2.3%	1	0.9%	1	0.9%	19	2.2%	n/a
PPH	13	3.0%	4	3.4%	2	0.9%	22	2.5%	0.521
Retained placenta	3	0.7%	1	0.9%	0	0.0%	4	0.5%	n/a
Maternal death	0	0.0%	0	0.0%	0	0.0%	2	0.2%	n/a

APH = antepartum haemorrhage; HIV = human immunodeficiency virus; PIH = pregnancy induced hypertension;
PPH = post partum haemorrhage; PROM = premature rupture of membranes
n/a = not applicable: statistical analysis not performed due to insufficient number of cases

Table 6. Four groups: neonatal outcomes and complications.

	Adolescents (10-20 years)				Adults (>21 years)				
	Nullipara N = 433		Multipara N = 117		Nullipara N = 111		Multipara N = 876		
Variable	**Number**	**Mean (±SD) / %**	**Number**	**Mean (±SD) / %**	**Number**	**Mean (±SD) / %**	**Number**	**Mean (±SD) / %**	**P-value**
Sex of baby									0.863
Male	208	47.7%	58	48.3%	58	52.3%	440	48.4%	
Female	228	52.3%	62	51.7%	53	47.7	470	51.6%	
Prematurity	179	46.1%	46	44.7%	43	40.6%	268	32.5%	**<0.001**
Extremely premature	1	0.3%	2	1.9%	1	0.9%	3	0.4%	n/a
Very premature	6	1.5%	3	2.9%	1	0.9%	20	2.4%	n/a
Moderate premature	172	44.3%	41	39.8%	41	38.7%	245	29.7%	**<0.001**
Newborn weight (kg)	435	2.88 (±0.46)	120	3.02 (±0.55)	109	2.96 (±0.54)	909	3.04 (±0.65)	**<0.001**
Low birth weight	63	14.5%	17	14.2%	13	11.9%	133	14.6%	0.893
Low APGAR score									
At 1 minute	50	11.7%	8	7.3%	10	9.1%	55	6.4%	**0.017**
At 5 minutes	23	5.4%	1	0.9%	4	3.6%	17	2.0%	n/a
NICU admission	30	6.9%	3	2.5%	9	8.1%	30	3.3%	**0.006**
Stillbirth	9	2.1%	10	8.3%	1	0.9%	59	6.5%	n/a
FSB	3	0.7%	6	5.0%	0	0.0%	26	2.8%	n/a
MSB	5	1.1%	3	2.5%	1	0.9%	25	2.7%	n/a
Neonatal death	6	1.4%	0	0.0%	1	0.9%	11	1.2%	n/a

FSB = fresh stillbirth; kg = kilogram; MSB = mascerated stillbirth; NICU = neonetal intensive care unit; SD = standard deviation
n/a = not applicable: statistical analysis not performed due to insufficient number of cases

Table 7. Four group: odds ratios.

	Adolescents multipara		Adults nullipara		Adults multipara	
Variable	**OR (95% CI)**	**P-value**	**OR (95% CI)**	**P-value**	**OR (95% CI)**	**P-value**
Number of fetuses						
Twin					6.50 (2.00-21.18)	0.002
Number ANC visits						
1 to 3			0.28 (0.08-0.99)	0.049	2.15 (1.31-3.52)	0.002
4 to 7			4.76 (1.35-16.74)	0.015	0.61 (0.38-0.99)	0.043
Infection						
Malaria					0.27 (0.09-0.81	0.002
Anaemia					1.65 (1.11-2.46)	0.014
Anaemia postpartum					2.31 (1.22-4.36)	0.010
APH					6.08 (2.18-16.99)	<0.001
Preterm delivery					1.85 (1.44-2.37)	<0.001
Moderate preterm					0.51 (0.40-0.66)	<0.001
Uterine rupture	15.29 (1.69-138.16)	0.015			10.61 (1.42-79.14)	0.021

Mode of delivery					
Assisted vaginal				0.18 (0.08-0.38)	<0.001
Caesarean section				1.37 (1.06-1.77)	0.015
Perineal tear					
1st degree tear				0.34 (0.24-0.49)	<0.001
2nd degree tear	0.35 (0.16-0.75)	0.007		0.16 (0.10-0.25)	<0.001
Prematurity				0.56 (0.44-0.72)	<0.001
Moderate premature				0.53 (0.41-0.68)	<0.001
Low APGAR score					
At 1 minute				0.52 (0.35-0.78)	0.001
NICU admission				0.46 (0.27-0.77)	0.003

ANC = antenatal are; APH = antepartum haemorrhage; CI = confidence interval; FSB = fresh stillbirth; MSB = mascerated stillbirth; NICU = neonatal intensive care unit; OR = odds ratio

Appendix II. Outcomes St Ann's Hospital

Table 8. St Ann's: general characteristics.

	Adolescents (10-20 years) N = 70		Adults (>21 years) N = 659			
Variable	**Number**	**Mean (±SD) / %**	**Number**	**Mean (±SD) / %**	**P-value St Ann's**	**P-value Ndala**
Age (years)	70	17.69 (±3.82)	659	30.64 (±12.86)		
Gravidity					**<0.001**	**<0.001**
Primigravida	56	80.0%	113	17.2%		
Multigravida	14	20.0%	543	82.8%		
Number of fetuses					0.250	**0.001**
Singleton	70	100.0%	638	96.8%		
Twin	0	0.0%	21	3.2%		
GA at delivery (weeks)	54	38.19 (±2.28)	510	38.54 (±2.56)	0.341	**<0.001**

GA = gestational age; SD = standard deviation

Table 9. St Ann's: pregnancy outcomes and maternal complications.

	Adolescents (10-20 years) N = 70		Adults (>21 years) N = 659			
Variable	**Number**	**Percentage**	**Number**	**Percentage**	**P-value St Ann's**	**P-value Ndala**
Gestational diabetes	0	0.0%	1	0.1%	n/a	n/a
Pre-eclampsia	0	0.0%	6	0.9%	n/a	0.489
Eclampsia	1	1.4%	0	0.0%	n/a	**<0.001**
Infection						
HIV	0	0.0%	20	3.0%	n/a	0.815
APH						
Abruptio placentae	0	0.0%	2	0.3%	n/a	**0.002**
PROM	1	1.4%	7	1.1%	n/a	1.000
Preterm delivery	4	7.4%	41	8.1%	1.000	**<0.001**
Extremely preterm	1	1.9%	1	0.2%	n/a	1.000
Very preterm	0	0.0%	5	1.0%	n/a	0.843
Moderate preterm	3	5.6%	35	6.9%	1.000	**<0.001**
Induction of labour	0	0.0%	1	0.2%	n/a	0.083
Failure of induction	0	0.0%	1	0.2%	n/a	1.000
Prolonged labour	0	0.0%	2	0.3%	n/a	0.298
Obstructed labour	3	4.3%	20	3.0%	0.477	0.189
Fetal distress	1	1.4%	23	3.5%	n/a	1.000
Uterine rupture	0	0.0%	1	0.2%	n/a	0.069

Mode of delivery	70	9.6%	659	90.4%	0.077	**<0.001**
Spontaneous vaginal	55	78.6%	448	68.0%	0.077	0.660
Caesarean section	15	21.4%	211	32.0%	0.077	**0.027**
PPH	2	2.9%	10	1.5%	0.323	0.403
Retained placenta	0	0.0%	1	0.2%	n/a	0.466
Maternal death	0	0.0%	1	0.2%	n/a	n/a

APH = antepartum haemorrhage; HIV = human immunodeficiency virus; PPH = post partum haemorrhage; PROM = premature rupture of membranes

n/a = not applicable: statistical analysis not performed due to insufficient number of cases

Table 10. St Ann's: neonatal outcomes and complications.

	Adolescents (10-20 years) N = 70		Adults (>21 years) N = 659			
Variable	**Number**	**Mean (±SD) / %**	**Number**	**Mean (±SD) / %**	**P-value St Ann's**	**P-value Ndala**
Sex of baby					0.255	0.753
Male	44	62.9%	371	55.0%		
Female	26	37.1%	304	45.0%		
Prematurity	4	7.4%	44	8.4%	1.000	**<0.001**
Extremely premature	1	1.9%	1	0.2%	n/a	0.697
Very premature	0	0.0%	5	1.0%	n/a	0.701
Moderate premature	3	5.6%	39	7.5%	0.787	**<0.001**
Newborn weight (kg)	69	2.89 (±0.46)	664	3.07 (±0.50)	**0.004**	**<0.001**
Low birth weight	8	11.6%	76	11.4%	1.000	0.823
Low APGAR score						
At 1 minute	3	4.6%	11	1.7%	0.123	**0.004**
At 5 minutes	0	0.0%	1	0.2%	n/a	**0.013**
Stillbirth	4	4.7%	11	1.6%	**0.043**	**0.034**
FSB	2	2.9%	4	0.6%	0.101	0.384
MSB	2	2.9%	4	0.6%	0.101	0.114
Neonatal death	0	0.0%	1	0.1%	n/a	1.000

FSB = fresh stillbirth; kg = kilogram; MSB = mascerated stillbirth; SD = standard deviation

n/a = not applicable: statistical analysis not performed due to insufficient number of cases

Appendix III. Recommendations

Clinical research priorities:

- Studies on both birth preparedness and complication readiness, and adolescent peripartum experiences should be enrolled to gain insights and improve adolescent outcomes.

Improve documentation practices:

- Progress of labour should be consistently monitored and recorded in the patient file. In case of case of change of parameters, action can be taken immediately.
- All deliveries should be documented in the delivery book, immediately following delivery, to prevent underreporting of annual statistics.
- Complications and procedures should be documented thoroughly, preferably in Inaya, given its lower risk of data loss.

Clinical practices:

- Ultrasound in the third trimester should not be used to estimate GA, since this could lead to misdiagnosed cases of prematurity.
- If LMP is known, GA should be calculated using a validated application and documented as weeks plus days.
- A cut-off of 37 weeks should be applied for preterm birth/prematurity, in line with WHO standards.

Appendix IV. List of abbreviations

ANC	Antenatal care
APH	Antepartum haemorrhage
BBA	Born before arrival
BPCR	Birth preparedness and complication readiness
CI	Confidence interval
CS	Caesarean section
EDD	Estimated date of delivery
FBOHC	Faith based organisation health centre
FSB	Fresh stillbirth
GA	Gestational age
GEE	Generalised estimating equations
GENLIN	Generalised linear models
Hb	Haemoglobin
HICs	High-Income countries
HIV	Human immunodeficiency virus
LBW	Low birth weight
LMICs	Low- and middle-income countries
LMP	Last menstrual period
MMR	Maternal mortality rate
MSB	Macerated stillbirth
NICU	Neonatal intensive care unit
NIMR	National institute for medical research
NMR	Neonatal mortality rate
OR	Odds ratio
PHCs	Public health centres
PI	Principal investigator
PIH	Pregnancy induced hypertension
PPH	Postpartum haemorrhage
PROM	Premature rupture of membranes
SD	Standard deviation
SVD	Spontaneous vaginal delivery
TDHS-MIS	Tanzania demographic and health survey and malaria indicator survey
UR	Uterine rupture
US	Ultrasound
WHO	World health organization