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Predictors of Birth Weight Among Infants in Uasin Gishu County, Kenya

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Abstract

Birth weight is a predictor of survival rate among neonates and a marker of neonatal and maternal nutrition and health. Low birth weight is associated with both short-term and long-term consequences for neonates that include risk for chronic diseases later in life. This study determined the prevalence of low birth weight as well as factors associated with birth weight in Uasin Gishu County, Kenya. This was a retrospective study in which health records of 970 mothers who delivered at Moi Teaching and Referral Hospital in Kenya were evaluated. Data were analyzed using descriptive statistics and linear regression modelling. The mean birth weight (BW) was 3.0±0.6 kg and the prevalence of low birth weight was 13.5%. The mothers' mean age (years) was 26.0±5.8 with a median of 25 (range:14-46) years. Factors associated with low birth weight were: employment status, marital status, sex of the child, gestation, presence of deformity and pregnancy outcome. In the final multivariate linear regression model, mean infant BW reduced by 15.1% when the mother was unemployed compared to 8.7% for those who were formally employed. Infants born via CS had 9.6% higher BW than those born vaginally. BW reduced by 15.5% when the infant was female compared with those who were male. There was an increase in the infant BW by 46.0% when infant had no deformity. The relationship between the gestation period at delivery and infant BW depended on the pregnancy outcome. Factors associated with low birth weight were employment status, marital status, sex of the child, gestation period, presence of deformity and pregnancy outcome. Interventions aiming at improving BW and reducing the prevalence of LBW should consider these factors.

Keywords: *Birthweight, low birth weight, unemployment, sex, Kenya*

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Introduction

Birth weight (BW) or size at birth is an indicator of the child's vulnerability to and risk of childhood illnesses and it predicts a child's future health, growth and psychosocial development (Wubetu *et al.*, 2021). It is defined as the first weight of an infant measured within the first hour after birth and before a significant occurrence of postnatal weight loss occurs (Nhial *et al.*, 2022). BW is a predictor of survival rate among neonates and a marker of neonatal and maternal health and nutrition. According to United Nations Children's Fund (UNICEF) and World Health Organization (WHO), BW can be classified as high, normal, low, very low and extremely very low (UNICEF and WHO, 2019). Low birth weight (LBW), refers to an absolute weight of <2500g at birth regardless of gestational age (UNICEF and WHO, 2004).

Globally, it is estimated that 30 million (23.4% of all births) children born annually are LBW (WHO, 2014). In addition, Low- and Middle-Income Countries (LMIC) account for over 95% of the LBW burden (Tessema *et al*., 2021), and it is estimated that 22% are in sub-Saharan Africa (SSA) (Muchemi *et al.*, 2015). In Kenya, the prevalence of LBW was estimated to be 12% (Kenya National Bureau of Statistics *et al*., 2015), although this has been reported to be as high as 30% in some parts of the country (Irimu *et al*., 2021). The Geographical distribution of LBW is associated with socio-economic factors prevailing within the counties as well as climatic conditions (Ahmed, 2021). LBW is a significant global health problem associated with both short- and long-term consequences (WHO, 2014). According to Toru and Anmut (2020), LBW is an important indicator of the health status of an infant, and it is the principal factor that determines the infant's survival, physical and mental growth (Toru and Anmut, 2020). LBW is an indicator of multifaceted public health problems that include poverty, long-term maternal malnutrition, ill-health and poor health care during pregnancy. Several studies have revealed that a child's nutritional status is determined by the nutritional and health status of the mother, socio-economic status, demographic factors as well as political stability, among others. Maternal factors such as anemia, unemployment, smoking or tobacco use, and short interpregnancy interval are some of the predictors of LBW (Kader and Perera, 2014; Jemal, 2021; Kargbo *et al*., 2021). In addition, several studies indicate that hygiene, sanitation and environmental factors such as smoking and tobacco use also have been documented to predict LBW (Kader and Perera, 2014; Jemal, 2021). Birth order also plays a significant role in LBW. A high proportion of LBW was identified among first-order births (Muchemi *et al*., 2015). Maternal frequency of antenatal clinic attendance (Alem *et al*., 2022), antimalarial drugs (Tagbor *et al*., 2014), and multivitamin supplementation (Keats *et al.*, 2019; Oh *et al*., 2020) are among the important predictors of pregnancy outcome. WHO recommends that pregnant women attend at least 4 ante natal visits starting the first trimester in order to reduce maternal and neonatal morbidity and mortality (WHO *et al*., 2018). It is not only provision of antenatal services but quality of services that is associated with LBW risk. Provision of antenatal and delivery services and care have been identified as important in preventing adverse pregnancy outcomes that include premature delivery, still birth, LBW, perinatal and maternal mortality (Muchemi *et al.*, 2015). Whereas baby's weight at birth is influenced predominantly by maternal nutrition, premature delivery is influenced by the poor quality of antenatal care given (Magadi *et al.*, 2004).

The consequences of being born LBW are far-reaching. Preterm and LBW have been associated with the risk of developing chronic diseases later in life. A systematic review indicates that mortality in adulthood due to risks associated with developing cancer, diabetes, and hypertension is linked to LBW (Risnes *et al*., 2011; Ediriweera *et al*., 2017). LBW also predisposes infants to early onset of adult chronic diseases such as cardiovascular and renal diseases (Reyes and Mañalich, 2005; Risnes *et al.*, 2011; Ediriweera *et al*., 2017).

The significance of BW in predicting survival among children makes a study on factors associated with LBW critical and timely. In addition, the intergenerational consequences of LBW which is far-reaching, make this study a priority in terms of understanding the trends and predicting factors so as to make recommendations for action. In Kenya, several studies have shown the prevalence of LBW to be on the increase; however, the national prevalence shows a decrease. Therefore, this study was conducted to determine the patterns and prevalence of LBW and to identify factors associated with BW at Moi Teaching and Referral Hospital (MTRH), Kenya.

Materials and methods

Study design, description of the area and sampling approach

This was a retrospective study design which investigators accessed hospital records at Moi Teaching and Referral Hospital (MTRH), Uasin Gishu County in Kenya. MTRH is a level 5 National Teaching and Referral Hospital offering outpatient, inpatient and specialized services and is located along Nandi Road in Eldoret Town, Uasin Gishu County. The catchment area for the referral hospital is more than 24 counties in Kenya (*Moi Teaching and Referral Hospital*, n.d.). However, the data records specific to Uasin Gishu County were retrieved and it included descriptions of all women who delivered in MTRH in 2019 and those women with singletons. Records of multiple births and incomplete data were excluded from this analysis.

Study tools and data collection

We used a checklist to retrieve the information from the records. Variables identified in the checklist included: the socio-demographic and economic characteristics of the mothers (age, date of birth, parity, marital status, household size, employment, education, geographic location, rural or urban settlement); Nutritional status of the mother (anemia, weight/height, whether vitamin A or folate were given); Gestation (term or preterm); Birth weight (BW); Birth outcome (sex, length, stillborn, live birth, caesarian section/normal delivery); Health status of the mother (any illness recorded any time during pregnancy such as Malaria and TB etc.); Documented prenatal clinics attended; Health status of infant (congenital malformation, jaundice).

Data management and analysis

Data were first entered into MS Excel 2010 (Microsoft Inc., Sacramento, California, USA), coded and then exported to Stata® 15.1 statistical software (StataCorp LLC, College Station, TX, USA) for statistical analyses.

Descriptive statistics, such as means, standard deviations, median and ranges, were determined for all outcome variable under study, while proportions were calculated for binary and categorical variables. Ordinary least-squares linear regression was used in building models using infant birth weight as the outcome of interest. The normality of infant BW was assessed using histograms, Q-Q plots and the Shapiro-Wilk test. In the first regression step, univariable linear regression models for all the predictor variables were fitted into separate models, with those having $P \leq 0.25$ being eligible for the multivariable analyses. Multicollinearity was then evaluated among the univariable association variables, and one of the correlated predictors was dropped based on statistical significance unless there was a substantial difference in the biological plausibility. A multivariable model was then built through backward stepwise elimination while evaluating for potential confounders. Two-way interactions between the biologically plausible variables in the final model were tested. An interaction term was retained if the P value of interaction terms was found to be significant at $P \leq 0.05$.

Residual analysis was performed to evaluate model assumptions and diagnostics. The residuals' normality was assessed using histograms, Q-Q plots and normality tests. Homoscedasticity was evaluated by plotting standardised residuals against predicted values and using the Breusch-Pagan test. Identification of extreme and influential observations was done by sorting and graphing the standardised residuals and comparing changes in coefficient estimates and their significance when modelling with and without influential observations.

Results

Number of records and socio-demographic characteristics of the mothers

This study examined maternity records from 970 infants and mothers at MTRH living in Uasin Gishu county in 2019 and are summarized in **Table 1**. Majority of the patients resided in Turbo subcounty (28.6%), while the fewest of them came from the Soy sub-county (10.7%). About three-quarters of the mothers were unemployed, while the rest were either formally or self-employed. The mothers' mean age (years) was 26.0±5.8 with a median of 25 years and ranged between 14 to 46. Single mothers were 21% and 36% had either secondary or tertiary education while 69% had achieved full-term of the gestation period. 43% were first-time mothers. More than three-quarters of the mothers gave birth

normally, while the rest were assisted through the caesarian section (CS). Only 0.3% and 3% of the mothers had taken antimalaria and ART prophylaxis, respectively. More than 96% of the mothers were HIV-negative. About 6% of the mothers experienced complications at delivery, and about 4% presented with anemia.

Table 1

Descriptive Statistics and Significance of Univariable Associations with Birth Weight for Children Born at Moi Teaching and Referral Hospital, Uasin Gishu County, Kenya

Description	Categories	Frequency (%)	Birth weight mean± SD	p-value
Subcounty from which the mother comes from	Ainabkoi	152 (15.7)	3.1±0.6	0.707[a]
	Kapseret	178 (18.4)	3.0±0.6	
	Kesses	106 (10.9)	3.0±0.6	
	Moiben	153 (15.8)	3.0±0.6	
	Soy	104 (10.7)	3.0±0.5	
	Turbo	277 (28.6)	3.0±0.6	
Employment status of the mother	Self-employment	166 (17.2)	3.1±0.6	0.007*[a]
	Formal employment	71 (7.4)	3.1±0.7	
	Unemployed	729 (75.5)	3.0±0.6	
Age (years) of the mother at delivery	<25	512 (52.8)	3.0±0.6	0.002*
	>25	458 (47.2)	3.1±0.6	
Marital status of the mother	Married	762 (78.6)	3.1±0.6	0.001*
	Single	208 (21.4)	2.9±0.6	
Highest education level of the mother	None	109 (11.2)	3.1±0.5	0.567
	Primary	217 (22.4)	3.0±0.6	
	Secondary	349 (36.0)	3.0±0.6	
	Tertiary	295 (30.4)	3.0±0.6	
Gestation period at delivery	Full term	666 (68.7)	3.1±0.5	<0.001*
	Not full term	304 (31.3)	2.9±0.8	
The mother is primi at gestation (never given birth before)	Yes	419 (43.2)	3.0±0.6	0.013*
	No	551 (56.8)	3.1±0.6	
Mother's parity including current delivery (no of children)	1	417 (43.0)	3.0±0.6	0.055*
	2	259 (26.7)	3.0±0.6	
	≥3	294 (30.3)	3.1±0.7	
Mode of child delivery	Normal	746 (76.9)	3.0±0.6	0.009*
	Caesarian section	224 (23.1)	3.1±0.6	
Mother taken malaria prophylaxis during antenatal period	Yes	3 (0.3)	3.2±0.7	0.550
	No	967 (99.7)	3.0±0.6	
HIV status of the mother	Positive	34 (3.5)	2.9±0.6	0.365
	Negative	936 (96.5)	3.0±0.6	
Mother on maternal ART prophylaxis	Yes	32 (3.3)	2.9±0.6	0.248
	No	938 (96.7)	3.0±0.6	
Presence of anemia at delivery	Yes	39 (4.0)	2.9±0.6	0.167
	No	931 (96.0)	3.0±0.6	
Complications occurred after delivery	Yes	62 (6.4)	3.0±0.6	0.891
	No	908 (93.6)	3.0±0.6	
Sex of the child	Male	513 (52.9)	3.1±0.6	<0.001*

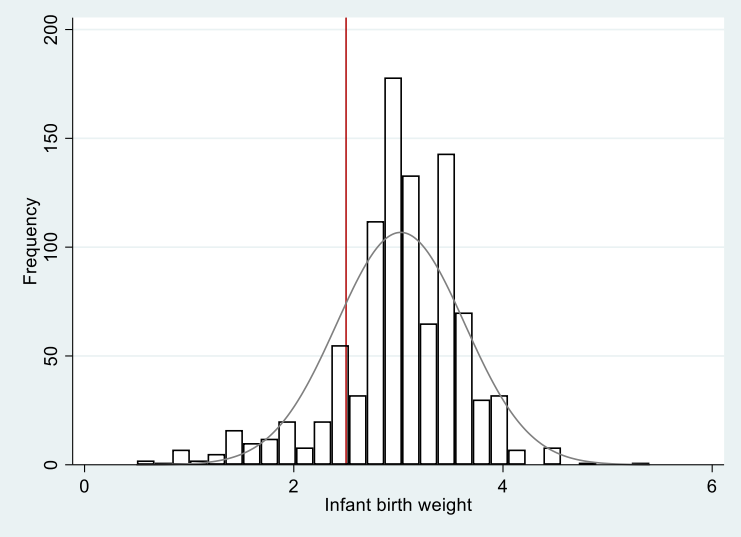
Description	Categories	Frequency (%)	Birth weight mean± SD	p-value
	Female	457 (47.1)	2.9±0.6	
Birth deformity	Yes	6 (0.6)	2.2±0.8	0.001*
	No	964 (99.4)	3.0±0.6	
HIV status of the child	Positive	35 (3.6)	3.0±0.6	0.554
	Negative	935 (96.4)	3.0±0.6	
Pregnancy outcome	Live birth	938 (96.7)	3.1±0.6	<0.001*
	Stillbirth	32 (3.3)	2.0±0.6	

*p-value <0.2
[a]Overall p-value

Profile and health characteristics of the infants
Information of 970 infants delivered at MTRH in the study period were examined. The infant birth weight (kg) was normally distributed and had a mean of 3.0±0.6 with a median of 3.1 and ranged between 0.5 to 5.4 **(Figure 1)**. About 13.5% (131/970) of all the infants had LBW and the sub-county distribution of low birth weight was: Ainabkoi 9.9% (15/152), Kapseret 15.7% (28/178), Kesses 15.1% (16/106), Moiben 13.7% (21/153), Soy 9.6% (10/104) and Turbo 14.8% (41/277). Overall, the sex of the infants was almost equal for males and females. About 0.6 of the infants had birth deformities and 3.6% tested positive for HIV. About 3% of the infants were stillbirths (**Table 1**).

Figure 1

Infant Birth Weight for Children Born at Moi Teaching and Referral Hospital, Uasin Gishu County, Kenya (Red Line=2.5 Kg Cut-Off for low birth weight)



Factors associated with the infant birth weight

The results from the univariable linear regression analyses with infant birth weight as the outcome variable are presented in **Table 1**. The following maternal- and infant-level variables met the p-value ≤0.25 inclusion criterion for the multivariable analyses: Subcounty of residents, Employment status of the mother; Age (years) of the mother at delivery; Marital status of the mother; Gestation period at delivery; The mother is primi at gestation (never given birth before); Mother's parity including current delivery (no of children); Mode of child delivery; Presence of maternal anemia at delivery; sex of the child; Presence of birth deformity; and Pregnancy outcome

In the final model, the following explanatory variables were found to be significantly associated with infant BW: Employment status of the mother, Marital status of the mother, Mode of child delivery, sex of the child and Presence of birth deformity. In an interaction term, the relationship between gestation period at delivery and infant BW depended on the pregnancy outcome. Infant BW was significantly lower for stillbirth than livebirth but more when the full term of gestation was not achieved. Infant birth weight was generally high irrespective of the pregnancy outcomes (Table 2).

The coefficients of variables not involved in interactions can be interpreted directly through exponentiation of the coefficients. Based on the exponentiated coefficients the infant BW reduced by 8.7% and 15.1% when the mother was formally employed and unemployed, respectively. The infant BW reduced by 12.0% when the mother was single compared with those who were married. There was an increase in the infant BW by 9.6% when the infant was delivered by Caesarian section compared to normal. The infant BW was reduced by 15.5% when the infant was female compared with those who were male. There was an increase in the infant BW by 46.0% when the infant had no birth deformity.

Table 2

Final Linear Regression for The Birth Weight of Children Born at Moi Teaching and Referral Hospital, Uasin Gishu County, Kenya

Description	Categories	β-coefficient	95% Confidence Interval
Employment status of the mother	Self-employment	Reference	
	Formal employment	-0.083	-0.239, 0.072
	Unemployed	-0.141	-0.235, -0.047
Marital status of the mother	Married	Reference	
	Single	-0.113	-0.199, -0.027
Mode of child delivery	Normal	Reference	
	Caesarian section	0.092	0.008, 0.0175
Sex of the child	Male	Reference	
	Female	-0.144	-0.215, -0.073
Presence of birth deformity	Present	Reference	
	Absent	0.900	0.450, 1.351
Gestation period at delivery	Full term	Reference	
	Not full term	-0.083	-0.161, -0.005
Pregnancy outcome	Livebirth	Reference	
	Stillbirth	-0.452	-.0.758, -0.145
Gestation period	Full term	Reference	
Pregnancy outcome	Livebirth		
	Not full term# Stillbirth	-1.002	-1.404, -0.600

Residual analysis

The model assumptions of normality and homoscedasticity were met. Scatter plots of fitted values and standardised residuals did not depict distinct patterns in the distribution of residuals (Figure 2). The standardised residuals had a fairly good fit on the histogram and Q-Q plot (Figure 3 and 4).

Figure 2

Interaction Plot of the Predicted Infant Birth Weight and the 95% Ci for Gestation Period at Delivery and Pregnancy Outcome, Based on a Final Model of Infants in Uasin Gishu County, Kenya

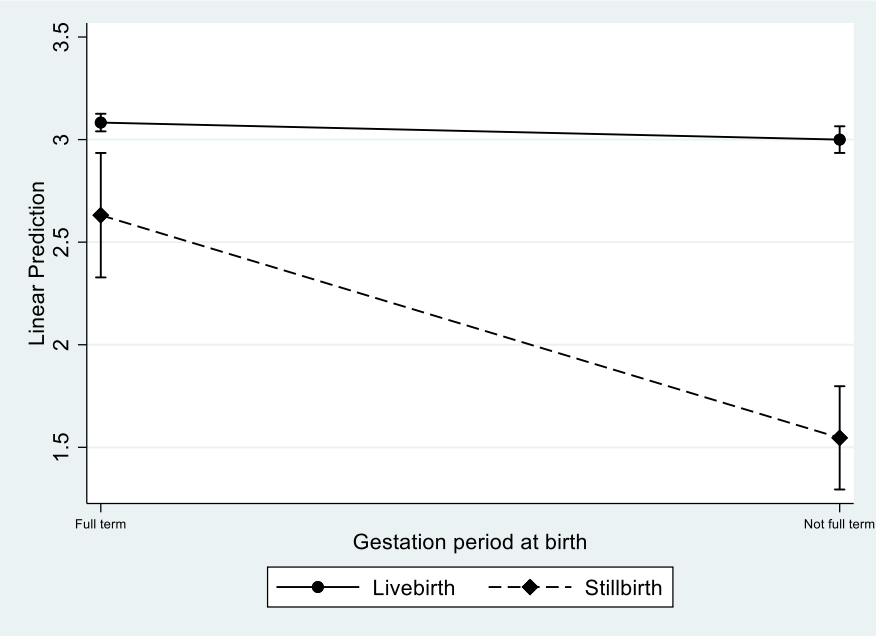


Figure 3

Histogram Showing the Distribution of the Standardized Residuals.

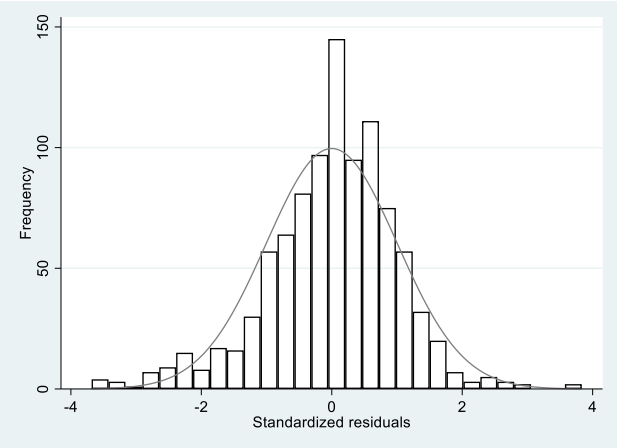
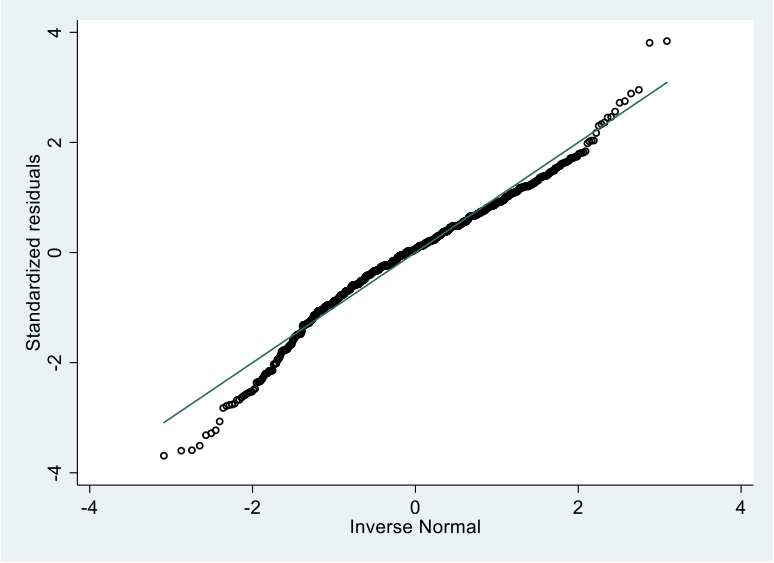


Figure 4

Q-Q Plot Showing the Distribution of the Standardized Residual



Discussion

In the present study, we set out to determine prevalence of LBW and identify factors associated with BW using health records at Moi Teaching and Referral Hospital, Uasin Gishu, County, Kenya. The results show that the mean BW and standard deviation in this study was 3.0 ± 0.60 kg. In the final multivariate linear regression model, infant BW reduced by 8.7% and 15.1% when the mother was formally

employed and unemployed, respectively. The infant BW reduced by 12% when the mother was single compared with those who were married. There was an increase in the infant BW by 9.6% when the infant was delivered by caesarian section compared to normal delivery. The infant BW was reduced by 15.5% when the infant was female compared with those who were male. There was an increase in the infant BW by 46.0% when infant had no deformity. In an interaction term, the relationship between the gestation period at delivery and infant BW depended on the pregnancy outcome. Infant BW was significantly lower for stillbirth than live birth but more when the full term of gestation was not achieved. Infant birthweight was generally high irrespective of the pregnancy outcome.

The prevalence of LBW in this study was 13.5% compared to 8% reported nationally in 2014 by KDHS (Kenya National Bureau of Statistics., 2015) and 12.3% by Muchemi *et al*. (2015). In the Coastal region, LBW was reported to be 29% (Jumbale *et al.*, 2018). Uasin Gishu County is predominantly an agricultural-based economy, and poverty level is high among the rural population and those living in the urban informal settlements. Our findings were close to that reported by UNICEF in 2015 which estimated that globally 14.6% percent of all babies born suffered from LBW and in sub Saharan Africa (SSA) the prevalence was 14.0% (UNICEF and WHO, 2019). In Ethiopia the prevalence is varied whereby some studies have cited it to be between 12.5% (UNICEF and WHO, 2019; Adugna and Worku, 2022) and 24% (Wubetu *et al.*, 2021), which is an indicator of seasonal variations in time of data collection and underlying factors that contribute to the geographic distribution of the prevalence, which include drought and persistent food insecurity affecting most countries in SSA. Mostly LBW tends to be concentrated in regions where there is high food insecurity. Food insecurity is a major predictor of LBW and it is associated with inadequate intake, poor-quality dietary intake and decreased nutritional status among women (Chowdhury *et al.*, 2018).

The high prevalence of LBW could partly be explained by the fact that the 43% of the mothers in this study were primiparous. Research has shown that women who were delivering their first babies had higher rates of LBW and adverse birth outcomes (Garces *et al.*, 2020). Being primiparous also may mean that the women choose to deliver in a hospital. Choice of delivering their first baby in a hospital setting mainly is to calm their fears of encountering a complication during labour and any other complication arising as a result of LBW deliveries as evident in a study by Shah 2010 where primi pregnancy was associated with LBW and Small for gestational age (Shah , 2010). Anxiety and fear might be higher in first pregnancy more so regarding labour and birth experience and therefore primiparous women may choose where to deliver the baby (Witteveen *et al.*, 2016), especially where they perceive they may be getting adequate care, especially in an emergency and they may prefer to be hospitalized quickly for their reassurance (Green *et al.*, 2022). In addition, MTRH being a referral facility in most cases receive mothers who are already in active labour who may have been referred due to complications. In Uasin Gishu, ANC attendance (4+) was reported to be 71% against a national average of 66% according to KDHS suggesting that maternal care services are more available to women in the study population and therefore more chances of identifying LBW among the newborns (KNBS and ICF, 2023). However, prenatal services may be available but mothers may choose to attend ANC towards the last trimester only missing out on opportunities to detect early signs of poor fetal growth. Results from a multilevel analysis of prenatal care and BW done in Kenya indicate that infant health can be improved by using prenatal care adequately (Awiti, 2014). Poor health seeking behavior among women has been cited as one of the reasons for poor pregnancy outcomes. Another study in Ghana reported that delayed care-seeking and use of home remedies was associated with LBW (Tette *et al.*, 2020), indicating that pregnant women tend to seek for ANC services later in pregnancy, reasons are varied ranging from misinformation via other women's experiences. This may be captured as adequate attendance; however, it may be too late when no other interventions can be done to improve birth weight and adverse outcomes.

Within the county, the prevalence of LBW was higher in two sub-counties, namely Kesses and Kapseret, where the prevalence was 15.1% and 15.7%, respectively. Kapseret is home to one of the informal settlements in Eldoret Town, Langas, which may have contributed to the high number due to poor living conditions. Langas is the largest informal settlement in Eldoret and home to over 30% of the town's population, and they are low-income earners with a poverty level of 49% (Maleche et al., 2019). Additionally, a qualitative study done in Uasin Gishu County among Kalenjin the predominant inhabitants, indicated that the perceived health threats influence the nutritional behaviour of pregnant Kalenjin women (Riang'a *et al*., 2017). Riang'a *et al.* (2017) suggested that because of fear of having a difficult delivery such as those associated with having a big fetus leading to episiotomy, fear of complications during birth (obstructed labour) leading to CS and fear of lacking strength during delivery, women, therefore, subscribe to certain food beliefs and practices that may be detrimental to the growth of the fetus as well as health of the mother thus affecting BW (Riang'a *et al*., 2017).

Our study showed that neonatal BW reduced by 15% among unemployed compared to employed mothers. Being unemployed is associated with reduced income especially among women who are single (21%). According to the World Bank, women are less likely to work in formal employment and have fewer opportunities for business expansion or career progression and if they work they earn less (World Bank, 2022). Employment allows women to have income that can translate into households having the capacity and means to access food, health care and other needs for the pregnant woman before and after delivery. However, if the mother is unemployed the probability of her accessing these necessary resources is low. Some studies contradict our findings and have shown no associations between mothers' employment status and LBW (Ngo *et al*., 2022). A study done by Mahmoodi *et al* indicates that employed women were more likely to have LBW neonates, however LBWs were seen more among women who worked in unfavorable working conditions such as humid environments, had contact with detergents, standing or sitting for a long time (Mahmoodi *et al.*, 2015). Certain service sector jobs have been associated with LBW among women, such as food service and retail sales work (Meyer *et al*., 2008), being an unskilled worker and not being paid cash for work done (Jafree *et al*., 2015). It has been proven in interventions studies that cash transfers to women go a long way in improving nutritional status and birth weight if provided before or during pregnancy (Amarante *et al*., 2016).

This study showed that the infant BW reduced by 12.0% when the mother was single compared with those who were married. Being the primary provider for her family, a single pregnant woman may not have sufficient resources such as the time and money to care for herself and this coupled with other competing interests within the household such as meeting education and health needs, LBW may occur. Studies in Ghana and Rwanda agree with our findings that being single is associated with higher odds of LBW (Afaya *et al.*, 2021). On the contrary, other studies have found no association between marital status and BW (Chhea *et al*., 2017; Dello Iacono *et al*., 2022), indicating that children born in households in which the male partner was absent were not more likely to be LBW.

This study showed that BW increased by 9% among children born through CS compared to those born normally. In many studies, CS births are as a result of obstructed labour due to size of the fetus (Akinola *et al.*, 2014), eclampsia (Caste and Erigene, 2022) or cultural beliefs such as taboos (Suwanrath *et al*., 2021). We postulate that these deliveries through CS may have been due to underlying medical conditions or related to complications arising during labor or as a result of new mothers choosing CS as safe delivery method due to fear of vaginal birth. Again, in relation to majority of women being primiparous may contribute to the high CS cases. A study on choice of delivery method by Shakarami *et al.* (2021) indicated that anxiety about the delivery may affect the choice of delivery method and women may request for CS out of fear or anxiety. Studies that disagreed with our finding found CS increased the risk of LBW (Jumbale *et al*., 2018; Ahenkorah *et al*., 2022).

Our study showed that BW was reduced by 15.5% when the infant was female compared with

those who were male. Females biologically are smaller in stature and build compared to males (Touraille and Gouyon, 2008). Meakin *et. al* (2021) explained the BW differences among sex occur by postulating that placental genes that are different for boys and girls predict birth and overall health outcomes as poor among male neonates as opposed to females (Meakin *et al*., 2021). Further, the placenta of a male foetus functions more efficiently to enable boys to have accelerated growth in the womb having greater length and size compared to females leaving them with low capacity in terms of placental reserves to draw upon when adverse health conditions occur (Eriksson *et al*., 2010; Gabory *et al.*, 2013; Meakin *et al.*, 2021). Another study explains that placental morphometry (weight, surface area, volume) and the sex of the baby, determined the birth weight of the neonate efficiently and may be used to initiate corrective intervention measures (Balihallimath *et al.*, 2013). In the study by Balihallimath *et al.* (2013), the placenta weight for the duration of the pregnancy was low for female babies compared to male. Studies that agree with our findings indicate that females have increased risk for LBW (Muchemi *et al*., 2015; Afaya *et al*., 2021; Tessema *et al*., 2021; Wubetu *et al*., 2021), however, one study in Ghana found males to have high odds of LBW (Ahenkorah *et al.*, 2022).

This study found a 46% increase in BW for neonates born with no deformities. Deformities may occur due to underlying complications during pregnancy, such as genetic sequencing carried by the fetus that may predispose them to deformities. It has been documented that there is an overlap between birth defects and LBW whereby in some cases most birth defects were significantly associated with LBW (Mili *et al*., 1991). Research also has shown an inverse relationship between birth defects and infants' BW (Mili *et al.,* 1991; Dolan *et al*., 2007) indicating failure to thrive among children with congenital disorders. Environmental exposures during pregnancy such as maternal infections, exposure to pollutants and micronutrient deficiencies may lead to deformities and reduced BW among neonates (Ricciardi and Guastadisegni, 2003). Defects of the musculoskeletal system, those of the central nervous system and gastroschisis have been reported in Kenya (Agot *et al*., 2020; Anderson *et al*., 2022).

In our study we also found infant BW to be significantly low for stillbirth than livebirth but more so when the full term of gestation was not achieved. Infant birth weight was generally high irrespective of the pregnancy outcome. Studies have shown that LBW is a risk factor for still birth as demonstrated by case-control studies (Pilliod *et al.*, 2012; Bukowski *et al.*, 2014; Contag *et al*., 2016). Still births prior to 30 weeks has been associated with obstetric, placental and infectious complications, whereas those occurring after 30 weeks are associated with maternal and obstetric factors such as maternal age and parity (Contag *et al*., 2016). In our study over 30% of births were not full term indicating unknown underlying issues which may have resulted in some of the stillbirths of which obstetric factors, maternal age or infectious complications could have been the cause. Almost half of the mothers in our study site were above 25 years and over 30% had more than three children.

Limitations

This study was carried out retrospectively using hospital records. The results from this study only showed the BW, prevalence of LBW and associated factors in Uasin Gishu County. No other similar studies have been done in the study area and in a referral hospital. It may not reflect the situation in the entire country; therefore, it cannot be generalized to Kenya. The number of children born with LBW might be higher or lower elsewhere in the country. There are other factors that our study may not have covered affecting BW and other studies have found them to be significant including but not limited to education of the mother, illness during pregnancy or pre-existing medical conditions, residence (rural or urban) among others.

Conclusion

BW is a crucial indicator of survival among neonates and predictor of health outcomes later in life. In this study, both maternal (employment status, marital status, gestation period and pregnancy outcome) and neonatal (sex of the child and presence of deformity) factors were found to predict LBW.

Recommendations

In our study, we have determined that several factors combine to predict LBW. According to the

Global Nutrition Report of 2022, Kenya has made some progress in improving BW and reducing the prevalence of LBW, however, there is need for improvement of socioeconomic status through interventions such as cash transfer and other income generating activities that have been known to improve livelihoods. Of importance are policies that improve maternal income and overall child health.

Ethics approval and consent to participate.
Protocol for this study was submitted to Moi Teaching and Referral Hospital and Moi University Ethical Review Committee (IREC) for ethical clearance and approval was obtained with the reference no FAN: 0003601. Data was de-identified to remove any personal information linking the data to the participants therefore we did not need informed consent from the participants to use the records, however we sought permission from the hospital administration to access the health records. Therefore, the need for informed consent and the consent to participate was waived by IREC. We confirm that all methods were carried out in accordance with the relevant guidance and regulations.

Availability of data and materials

The datasets used during the current study are not publicly available due to the nature of ethical approval obtained for this study, but are available from the corresponding author on reasonable request.

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Competing Interest
We have no competing interests to declare.

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