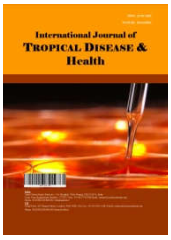

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Prevalence and Determinants of Low Birth Weight in Maseru, Lesotho

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Authors' contributions

This work was carried out in collaboration among all authors. Author ABN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OFN and MLCN managed the analyses of the study and did the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of the study was to determine the prevalence of low birth weight and factors that could be associated with low birth weight in a tertiary hospital in Maseru.
Study Design: Cross-sectional study.
Place and Duration of Study: Queen Mamohato Memorial Hospital, Maseru, Lesotho, February to May, 2016.
Methods: The mothers who participated were 402 with age range of 15 to 48 years. The study included 412 newborns. Direct measurement of variables was complemented with questionnaire-derived data. There was re-categorization of primary variables. Associations between low birth weight and maternal and newborn characteristics were assessed with multiple logistic regression with a 95% confidence level.
Results: The prevalence of low birth weight was high at 25% out of the 412 newborns. Multivariate analysis suggested that multiple gestations POR=26.39 (95% CI 5.29-131.75), preterm delivery

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POR=11.64 (95% CI 5.88-23.04), use of unclean energy POR=6.14 (95% CI 2.72-13.85), hypertension POR=3.48 (95% CI 1.70-7.11), HIV POR=2.08 (95% CI 1.07-4.08) and a low paid job POR =2.35 (95% CI 1.08-5.10) were independently associated with low birth weight.

Conclusion: Preventing low birth weight could be addressed by early detection and prompt treatment of hypertension and human immunodeficiency virus infection, and by implementing strategies to prevent premature births.

Keywords: Low birth weight; determinants of low birth weight; morbidity; mortality; Maseru.

ABBREVIATIONS

ABW : Appropriate birth weight
HIV : Human immunodeficiency virus
IUGR : Intrauterine growth restriction
LBW : Low birth weight
LDHS : Lesotho Demographic and Health Survey
MUAC : Mid upper arm circumference
WHO : World Health Organization

1. INTRODUCTION

Babies born with a low birth weight (LBW) of less than 2500 grams constitute a global public health concern, with delivery of approximately 30 million LBW babies annually [1]. The burden of LBW is highest in developing countries with low per capita income, where women are exposed to inadequate nutrition, environmental hazards and are impacted by adverse social determinants of health [2,3]. There has been a consistent increase in the estimated prevalence of LBW in Lesotho in recent years. In 2004 it was indirectly measured at 7% via the Lesotho Demographic and Health survey and this rose to 9.5% using the same survey in 2009 and then to 10% in the 2014 survey [4]. Even though the accuracy of these prevalence figures are questionable, due to the indirect assessment of whether babies had LBW or not using the estimation method of mothers' reporting newborn size and then heaping newborns into LBW or normal birth weight categories, this increasing trend is worrying. This is particularly so since the World Health Assembly has a target of reducing LBW by 30% by the year 2025 [5].

LBW is strongly associated with stillbirths and has a variety of adverse effects on live newborns, including impacting on neonatal mortality [6,7]. Birth complications, such as birth asphyxia, is associated commonly with LBW and translates into reduced or impaired intellectual development and general growth and developmental delay [8,9].

Other consequences of LBW are newborn malnutrition and poor weight gain especially in the first two years of life, and adverse emotional effects on children and their parents [6,10]. Additionally, caring for LBW babies, especially those with very low birth weights (below 1500 grams) that need long stays in intensive care units, utilizes the limited resources of health facilities [11]. Hence preventing low birth weight occurrence will improve children's survival, growth and psychosocial development, and allow health facilities to divert resources to other much needed services, rather than on the expensive services required by those with LBW [12].

Many factors potentially contribute to LBW including maternal factors such as - age, educational level, economic status, marital status, parity, birth spacing, mid upper-arm circumference, weight, height and body mass index; pregnancy associated factors such as - maternal stress, hypertension in pregnancy, HIV infection, anaemia, abruptio placenta, placenta praevia and preterm delivery; environmental factors such as - housing condition and type of fuel used indoors; socio-economic factors such as - income level, physical abuse, long working hours, smoking, use of alcohol and illicit drugs; and factors associated with the fetus such as - congenital abnormality, fetal malnutrition and multiple gestations [6,13,14].

Tackling the factors that are mainly responsible for LBW in Maseru would therefore both reduce the burden of disease due to LBW and conserve scarce health resources. The study therefore aimed to determine the prevalence of LBW and the factors affecting LBW in a tertiary hospital in Maseru.

2. METHODS

A cross-sectional analytical study design was used. The sole tertiary hospital in Maseru, the capital city of Lesotho, caters for the majority of the public-sector patient deliveries that occur in the city, due to a lack of enough birthing units at public hospitals, and hence covers a range of patients from low risk normal deliveries to high risk deliveries. However, it also admits high risk patients from all over the country referred from primary and secondary health facilities. The study population included neonates and mothers who delivered in the tertiary hospital in Maseru and who were residents of Maseru. Other specific inclusion criteria were all babies delivered after 28 completed weeks (the cut-off for viability used in Lesotho) and who had their birth weights measured within 6 hours of life, to ensure accuracy of measurement of birth weight. The exclusion criteria were newborns referred from other facilities and other districts, severely ill and psychologically distressed mothers who would have difficulty completing a questionnaire and babies with obvious physical deformities affecting body mass.

The annual number of newborns in Maseru district was estimated to be more than 10,000. The sample size was calculated via Epi-Info^{TM} 7.1.3.0 to be 402 mothers and their neonates, based on the estimated over 10,000 annual deliveries, a confidence level of 95%, power of 80%, percentage outcome of LBW in the unexposed of 8% (using HIV status as the measure of exposure), a prevalence ratio of 2.5, ratio of unexposed to exposed of 5 to 1 (based on an assumption of a 16% prevalence of HIV positive pregnant women) and a non-response rate of 10%. Time-delimited sequential sampling was used. All newborns delivered who met the inclusion criteria were selected over a time-period of four months from February to May 2016. Data collected by interviewer administered questionnaire included demographic, social, medical, pregnancy related and environmental details of the mother. HIV status was collected from the antenatal medical records.

Direct measurement of the weights of the newborns (in grams) and their respective mothers (in kilograms) were made. Length of newborns, height and mid-upper arm circumference (MUAC) of the mothers were assessed using a measuring tape. The sex of the newborns was determined by physical examination.

Both prevalence and the potential determinants of LBW were calculated using frequency tables with accompanying 95% confidence intervals. Associations of the different primary and secondary variables with LBW were determined using multivariate logistic regression analysis to obtain adjusted prevalence odds ratios (POR) and 95% confidence intervals.

3. RESULTS

A total number of 410 mother respondents were recruited and 402 mother participants were included in the study. Three mothers declined to participate and data was incomplete for 5 participants. 412 newborns were included in this study due to multiple pregnancy deliveries during the research period. The age of maternal participants ranged from 15 to 48 years with a median age of 26 years, a mean age of 26.7 (± 6.0 SD) years. The interquartile range was 22.5 to 31.5 years.

The majority of the maternal participants were in the age group of 20 to 29 years. Maternal age patterns did not vary between those with LBW deliveries (<2500 g) and those with adequate birth weight (ABW) deliveries of ≥2500 grams, as shown in Fig. 1.

The mean birth weight was 2871 (±706 SD) grams with weights ranging from 860 grams to 4780 grams. The prevalence of newborns with LBW (<2500 g) was quite high at 24.75% and similarly preterm births (<37weeks gestation) were high at 22.33%. A full description of birth weight and length as well as other newborn parameters, in defined categories, are shown as frequencies with 95% confidence intervals, in Table 1.

There was a high marriage rate (78%), high level of unemployment (65%), low personal income (median of 1230 Maloti with interquartile range of 0 to 1230) and low household income (median of 2650 Maloti with interquartile range of 1500 to 6000) among the respondents. Bleeding during the pregnancy was high at 11% and hypertension was even higher at 22%. The prevalence of human immunodeficiency virus (HIV) infection was high among the participants at 31%, with 8% of those infected not receiving antiretroviral treatment. Most of the participants used a clean source of energy (82%). Only one participant admitted to smoking and only 5 (1.25%) admitted to imbibing alcohol during pregnancy. These low self-reported figures are likely to be due to social desirability bias, where mothers present themselves as having followed a healthy lifestyle during pregnancy. The relationships between maternal socio-demographic, physical factors, reproductive and constitutional factors, and newborn factors with respect to LBW (birth weight <2500 grams) were assessed using relative and absolute bivariate analysis, to ascertain the prevalence ratios and the prevalence differences with their respective 95% confidence intervals (CIs), as shown in Table 2. Overall, maternal education, energy source, residence, antenatal visits, gestational

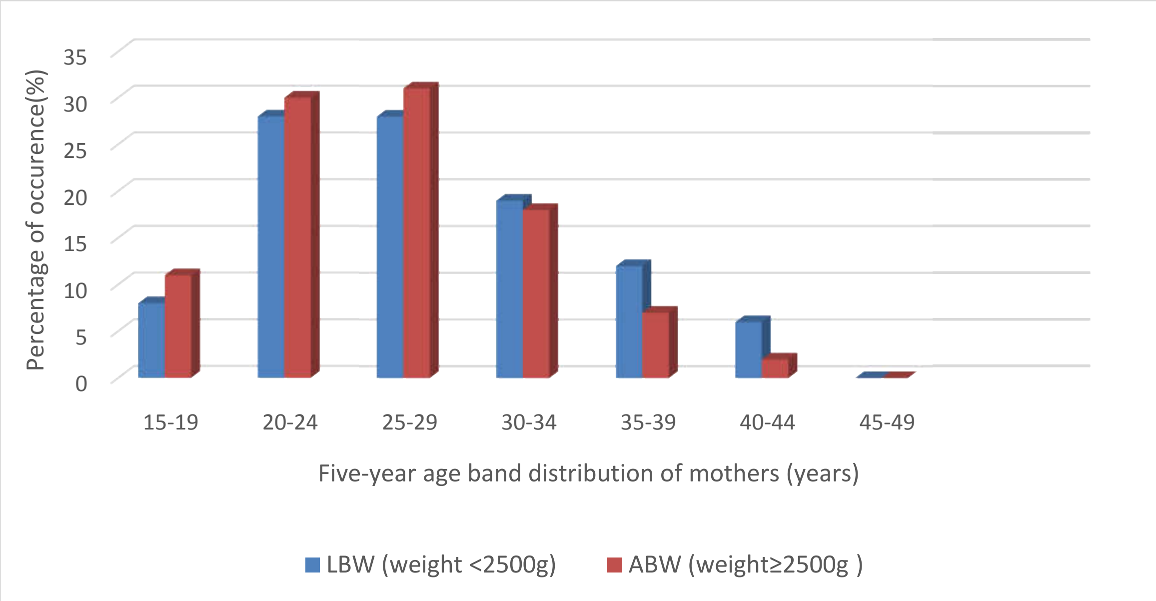

Fig. 1. Age distribution (in years) of study participants (mothers) in 5-year age bands, stratified by birth weight into mothers with low birth weight (LBW) deliveries (n =90) and mothers with appropriate birth weight (ABW) deliveries (n =312)

Table 1. Frequency distribution of newborn characteristics

Newborn characteristics	Percentage	95%CI	Number
Baby sex (n=404)			
Male	51.98	46.99 – 56.93	210
Female	48.02	43.03 – 53.01	194
Birth length (cm) (n=391)			
<46 cm	19.18	15.47 – 23.51	75
46 – 52 cm	76.47	71.78 – 80.52	299
>52 cm	4.35	2.63 – 7.01	17
Number of Gestation (n=400)			
Singleton	96.50	94.06 – 98.00	386
Twins	3.25	1.82 – 5.63	13
Triplets	0.25	0.01 – 1.61	1
Birth Weight (grams) (n=412)			
ELBW (<1000 g)	0.24	0.01 – 1.56	1
VLBW (1000 – 1499 g)	4.61	2.88 – 7.23	19
LBW (1500 – 2499 g)	19.90	16.22 – 24.16	82
ABW 2500 – 4000 g)	70.63	65.93 – 74.94	291
BBW (>4000 g)	4.61	2.88 – 7.23	19
LBW and ABW (grams) (n=412)			
LBW (<2500)	24.75	20.72 – 29.27	102
ABW (≥2500)	75.25	70.73 – 79.28	310
Gestational age (weeks) (n=385)			
Preterm (<37)	22.33	18.56 – 26.12	86
Terms (≥37)	77.67	73.42 – 81.41	299
Average Birth weight (gram)	**SD**	**Range**	
2871	±706	860 - 4780	

ELBW = Extremely low birth weight; VLBW = Very low birth weight; LBW = Low birth weight ABW = Adequate birth weight; BBW = Big birth weight; SD = Standard Deviation age and parity were statistically significant on bivariate analysis. Also, statistically significant were HIV status, history of hypertension, job type, maternal height, number of deliveries and birth length. However, maternal age, marital status, employment, income, weight, mid upper arm circumference, body mass index, alcohol use, smoking, birth interval, antepartum bleeding, working hours and newborn gender, did not show any association with LBW.

Table 2. Association of maternal sociodemographic, reproductive, constitutional and newborn factors with low birth weight via relative and absolute bivariate analysis

Variables	Variables	LBW n (%)	ABW n (%)	PR (95%CI)	PD% (95%CI)
Age (years)					
Q1 Lowest quartile (15–22.5)	110	26 (23.64)	84 (76.36)	1.0	
Q2 Lower quartile (22.6–26)	96	15 (15.63)	81(84.38)	0.60	8.01
Q3 High quartile (26.1–31.5)	103	22 (21.36)	81 (78.64)	0.88	2.01
Q4 Highest quartile (31.6– 8)	88	27 (30.68)	61 (69.32)	1.43	-7.04
Education completed					
≤Lower secondary education	141	45(31.91)	96 (68.08)	**1.80* (1.26-2.60)**	14.21 (5.15-23.29)
≥Upper secondary education	243	43(17.70)	200 (82.30)		
Marital status					
Not currently married	88	25(28.41)	63(71.9)	1.35 (0.91-2.01)	7.37 (-3.09-17.83)
Currently married	309	65(21.04)	244(78.96)		
Residence					
Rural	113	36(31.86)	77(68.14)	**1.67* (1.16-2.40)**	12.78 (3.02-22.51)
Urban	283	54(19.08)	229(80.9)		
Employment					
Unemployed	250	55(22)	195(78)	0.87 (0.60-1.27)	-3.19 (-12.13-5.76)
Employed	135	34(25.19)	101(74.81)		
Household income quartile (Maloti)**					
Q1 Lowest quartile (0-1500)	85	23 (27.06)	62 (72.94)	1.0	
Q2 Lower quartile (1501-2950)	65	17 (26.15)	48 (73.85)	0.95	0.91
Q3 Higher quartile (2951-6500)	71	15 (22.54)	55 (77.46)	0.74	4.52
Q4 Highest quartile (6501-3000)	68	11 (16.18)	57 (83.82)	0.52	10.88
Mothers' income quartile (Maloti)**					
Q1-Q3 Lowest to third (≤1230)	298	71(23.83)	227(76.17)	1.33 (0.81-2.20)	6.39 (-3.54-15.48)
Q4 Highest (>1230)	84	15(17.44)	69(82.14)		
Energy source					
Unclean energy (Wood/paraffin/coal)	72	31 (43.06)	41(56.94)	**2.38* (1.67-3.38)**	23.93 (12.74-37.12)
Cleaner energy (Electric/gas)	320	58 (18.13)	262 (81.88)		

Variables	Variables	LBW n (%)	ABW n (%)	PR (95%CI)	PD% (95%CI)
Alcohol during pregnancy					
Yes	5	1(20)	4(80)	0.88 (0.15-5.12)	-2.76 (-38.07-32.54)
No	391	89(22.76)	302(77.24)		
Smoking during pregnancy					
Yes	1	0(0)	1(100)	0.00 (Undf)	-22.73 (-26.85-18.6)
No	396	90(22.73)	306(77.27)		
Number of antenatal visits					
0-1	26	10(38.46)	16(61.54)	**1.80* (1.06-3.04)**	17.07 (-2.10-36.25)
≥2	360	77(21.39)	283(78.61)		
Gestational age (weeks)					
Preterm (<37)	95	57(60)	38(40)	**5.80* (3.98-8.45)**	49.66 (39.20-60.11)
Term (≥37)	290	30(10.34)	260(89.66)		
Parity					
0-1	176	38(21.84)	134(78.16)	1.0	
2-3	182	36(19.78)	146(80.22)	0.87	2.06
≥4	37	15(40.54)	22(59.6)	2.40	-18.7
Birth interval (months)					
Short (<24 months)	6	2(33.33)	4(66.67)	1.46 (0.46-4.63)	10.44 (-27.70- 48.57)
Long (≥24 month)	214	49(22.90)	165(77.10)		
MUAC (cm)					
Poorly nourished (<23 cm)	41	13(31.71)	28(68.29)	1.45 (0.89-2.4)	9.93 (-4.96-24.82)
Well nourished (≥23 cm)	349	76(21.78)	273(78.22)		
Mothers' height (cm)					
Short stature (<152 cm)	47	19(40.43)	28(59.57)	**2.03* (1.3-3.05)**	20.54 (5.89-35.20)
Normal stature (≥152 cm)	342	58(19.88)	274(80.12)		
Mothers' weight (Kg)					
Highest (>72 – 109)	97	15 (15.46)	82 (84.54)	1.0	
Higher (>64 – 72)	91	19 (20.88)	72(79.12)	1.44	-5.42
Lower (>57 – 64)	100	25(25)	75(75)	1.82	-9.54
Lowest (36 -57)	102	28(27.45)	74(72.55)	2.07	-11.99
Body Mass Index (Kg/m^2)					
Lower (<23)	108	20(18.52)	88(81.48)	0.79 (0.51-1.24)	-3.35 (3.72-3.99)
Higher (≥23)	278	65(21.87)	213(78.13)		
HIV Status					
Positive	124	36(29.03)	88(70.97)	**1.46* (1.01-2.11)**	9.18 (-0.13-18.49)
Negative	267	53(19.85)	214(80.15)		
Use of HAART					
No	9	4(44.44)	5(55.56)	1.56 (0.71-3.44)	16 (-17.55-49.56)
Yes	109	31(28.44)	78(71.56)		
GA on HAART initiation					
1st trimester	20	8(40.00)	12(60.00)	1.15 (0.59-2.24)	5.22 (-20.29-30.72)
After 1st trimester	46	16(34.78)	30(65.22)		

Variables	Variables	LBW n (%)	ABW n (%)	PR (95%CI)	PD% (95%CI)
History of bleeding in pregnancy					
Yes	43	13(30.23)	30(69.77)	1.36 (0.83-2.24)	8.08 (-6.34-22.49)
No	343	76(22.16)	267(77.84)		
History of hypertension in pregnancy					
Yes	85	41(48.24)	44(51.76)	**3.04* (2.17-4.28)**	32.39 (21-43.78)
No	303	48(15.84)	255(84.16)		
Type of job					
Low paid work (DFW$^{\theta}$)	79	25(31.65) 7(14.29)	54(68.35)	**2.22* (1.04-4.73)**	17.36 (3.18-31.54)
Adequate pay work	49		42(85.71)		
Working hours per day					
Above ILO recommended (>8)	57	11(19.30)	46(80.70)	0.67 (0.35-1.27)	-9.47 (-24.06-5.12)
ILO recommended (≤8)	73	21(28.77)	53(71.23)		
Number of gestation					
Multiple	14	11(78.58)	3(21.43)	**3.85* (2.75-5.39)**	58.16 (36.28-80.02)
Singleton	382	78(20.42)	304(79.58)		
Length of the baby (cm)					
Short babies (<46 cm)	75	7(76)	18(24)	**6.16* (4.47- 8.48)**	63.66 (53.33-73.98)
Normal length babies (≥46 cm)	316	39(12.34)	277(87.66)		
Sex of the baby					
Male	209	52(24.88)	157(75.12)	0.99 (0.70-1.39)	-0.25 (-8.75-8.25)
Female	191	48(25.13)	143(74.87)		

** Statistically significant. Statistically significant factors are also in **'Bold'** font*
***1 Lesotho Maloti was equivalent to 14.6 US dollars; DFW = Domestic and Factory Workers; ILO = International Labour Organization; LBW = Low Birth Weight; ABW = Adequate Birth Weight; PR = Prevalence Ratio; RD% = Risk Difference Percentage; 95%CI = 95% Confidence Interval*

Table 3. Multivariate logistic regression analysis of factors associated with low birth weight

Factors	Adjusted prevalence ratio	95% CI	*P*-value*
Number of gestation			
Multiple vs Singleton	26.39	5.29 – 131.75	**0.0001***
Gestational age (weeks)			
Preterm vs Term	11.64	5.88 – 23.04	**<0.0001***
Energy source			
Unclean vs Clean	6.14	2.72 – 13.85	**<0.0001***
Hypertension			
History of Hypertension Vs No history of Hypertension	3.48	1.70 – 7.11	**0.0006***
Job Type			
Low paid work vs Adequate paid work	2.35	1.08 – 5.10	**0.03***
HIV Status			
Positive vs Negative	2.08	1.07 – 4.08	**0.03***
Mother's height			
Short vs Normal stature	1.91	0.80 – 4.60	0.14

** = Statistically significant*

Multivariate analysis was performed using a backward stepwise logistic regression analysis approach. Gestational age less than 37 weeks and multiple gestations were very strongly independently associated with LBW. Energy source, HIV status, hypertension and job type were also significantly independently associated with LBW. These variables with significant association with LBW are shown in Table 3.

However, maternal education level, residence, maternal height, number of ANC visits and parity of mothers all lost their association with LBW as was seen in the bivariate analysis, during the multivariate analysis.

4. DISCUSSION

This study showed a very high LBW prevalence of 25%, coupled with a high prevalence of prematurity (22%), making these of public health importance in Maseru. A study in 66 villages in a rural area in West Bengal in India, also showed a very high prevalence of LBW of 29% [15]. However, the prevalence of LBW at the tertiary hospital in Maseru was much higher than the prevalence of LBW throughout Lesotho, found in the latest Lesotho Demographic and Health Survey (LDHS) 2014 of the Ministry of Health Lesotho, which was 10% [4]. The difference in the LBW prevalence could be because the LDHS study was conducted on births that occurred at all types of health facilities, whereas this study was conducted at a tertiary hospital with more complicated pregnancies, which in turn would probably result in more LBW babies. However, we did attempt to mitigate this skewing of the prevalence by only including residents of Maseru in the study, and hence excluded all complicated cases referred from outside of Maseru. Even though we took this precaution, more complex cases would probably still be over-represented in the sample, despite the reality that most pregnant residents of Maseru, irrespective of the risk level of their pregnancy, give birth at the tertiary hospital. The higher level of LBW in this study could also be due to increased detection, as it was done in a facility with weighing scales, which allowed accurate measurement and detection of the babies with true LBW. The lower rates of LBW found in the LDHS of 2014 might hence be because they asked mothers to estimate the weight of their babies during the survey. Thus, some mothers could have incorrectly estimated the weight of their babies as ‘normal’, when they were actually LBW, due to difficulty with both estimating accurately and due to a social desirability effect.

The prevalence of prematurity in this study at 22% is almost double the level reported for Sub-Saharan countries of 12% by Blencowe et al. in 2012, and for low income countries reported by WHO in 2016 of 12% [2,16]. However, in the WHO study, Zimbabwe and Malawi had preterm prevalence’s of 17% and 18% respectively, confirmed by the Blencowe et al. study, which also found Malawi to have a preterm prevalence of 18%, which is closer to the level found in our study [2,16]. The higher levels we found could be partially due to our tertiary study location, but it is likely that levels of prematurity in Lesotho are indeed quite high. Unsurprisingly, as with our study, several studies have shown a strong association between prematurity and low birth weight, which is logically expected since the premature babies have had less time in utero to grow, translating into a lower birth weight [6,15,17]. The absolute risk of prematurity, assessed by the prevalence difference, was 50%, which shows that half of all low birth weight children can be averted by interventions to prevent prematurity. In this regard interventions suggested by Chang et al., 2013, such as antiretroviral treatment provision, hypertension treatment and smoking cessation are likely to prove useful in reducing prematurity in Lesotho [18].

Hypertension is known to be associated with prematurity, intra-uterine growth restriction and stillbirth [19,20]. This study showed 22% of mothers had a history of hypertension during the index pregnancy. A prospective study among pregnant women in India showed a prevalence of 8% for hypertensive disease [21]. Another Indian study had a prevalence of 5% [22]. The high prevalence of hypertension in Maseru could again be accounted for by the fact that the facility is a tertiary hospital and thus has more complicated pregnancies. The association of history of hypertension with low birth weight was quite strong with a high prevalence odds ratio of 3.48 and the prevalence difference was also very high at 32% reflecting the excess risk of LBW due to hypertension. This finding is of great public health importance and presents a practicable opportunity for the health services to influence LBW by treating hypertension appropriately and encouraging adherence to medication, to obtain good hypertension control.

The prevalence of multiple gestations was 3.5% which was similar to both the Nigerian study in a tertiary hospital with a rate of 3.25% and a hospital-based study in Tanzania with a prevalence of 2.9% [23,24]. The association of multiple gestations with LBW had a very high prevalence ratio of 26. This association is well known and is attributed to the limited intrauterine environment and competition for transplacental nutrients by each of the fetuses [6,24]. Although multiple gestations are mainly familial and largely unpredictable, early ultrasound and checking family history for multiple gestation, would help in preparation for the care of multiple gestation and their complications.

As expected, based on previous population surveys, the HIV infection prevalence among the mothers was very high at 31%, which is similar to that of women in the age group 15-49 years of 30%, in a national community survey [4]. Gratifyingly, the treatment rate of those HIV infected was quite high at 92%, but this high treatment rate did not prevent HIV infection from impacting on LBW, as previously confirmed by a systematic review [25]. Similar to previous studies, while HIV infection was associated with LBW, antiretroviral treatment had no effect on LBW. Hence, to decrease the effect of HIV on LBW requires efforts to reduce the incidence and hence the prevalence of HIV infection.

The prevalence of low paid work was 62% showing that the majority of the mothers had indecent jobs, were of low socio-economic status and had a high level of economic dependence. The association found of maternal low paid work with LBW, is probably due to the lack of adequate nutrition which flows from the low wages which they receive. However, it could also have been due to pregnant women having to stand for long hours and having no maternity leave, as the majority of low paid jobs were factory and domestic worker jobs and these occupations are well known to require women to stand for long hours and they usually have no or minimal maternity leave. A case-control study in Tehran showed a positive association between standing or sitting for long hours at work with LBW [26]. However, a study done in Pakistan did not show any association between indecent or low paid jobs and low birth weight [27]. Improving the remuneration and working conditions of pregnant women might reduce LBW, but its implementation would require complex economic and labour law changes.

Energy source was very strongly associated with low birth weight with those using paraffin, wood or coal (all unclean energy sources) being at OR of 6.14 greater risk of LBW than those using electricity and/or gas (clean energy sources) to cook. The absolute effect of unclean over clean sources of energy on LBW was high with a prevalence difference of 24%. A study in Ethiopia also showed a significant association between the energy source of cooking and low birth weight [28]. Type of energy source used is strongly influenced by income, effectively splitting the sample of public health sector into low/moderate (clean energy) and very low socio-economic circumstances (unclean energy), allowing the effect of very low socio-economic circumstances to be assessed by proxy. It is of course not a perfect proxy for a socio-economic effect, as the air pollution caused by unclean energy sources might independently of socio-economic circumstance, affect LBW [28]. Providing a social grant to pregnant women for clean energy and maternal nutrition could be a good way of reducing LBW, as noted in a recent systematic review of pregnancy support programmes [29]. Also, pregnant women using unclean sources of energy could be encouraged to cook outside their homes, if they cannot afford to use cleaner sources of energy.

A limitation of this study is that the exclusion of those who delivered at home probably underestimated the prevalence of LBW, as those who deliver at home are more likely to have LBW due to their lower socio-economic status. However, the exclusion of those who delivered at other facilities probably resulted in an overestimate of the prevalence of LBW found in this study, as those who delivered at lower level facilities are less likely to have LBW as they would probably have low risk pregnancies. Similarly, the exclusion of those who delivered at a private health care facility probably resulted in an overestimate of the prevalence of LBW found in this study, as they are more likely to have a higher socio-economic profile and hence are less likely to have LBW. Despite the efforts taken to ensure accurate and precise direct measurements, the inherent possibility of errors creeping in, due to different observers being used to measure the weight, height and gestational age of the babies, and height, weight and mid upper arm circumference of the mothers, is acknowledged, but it would have pushed any association towards the null effect, and hence can be discounted. Body mass index was used as a proxy estimation of maternal nutritional status, but it might be too coarse a measure of nutritional status to detect any nutritional effect on LBW. It could not be ascertained if hypertensive participants' blood pressures were controlled or not during pregnancy, due to a lack of data on this and hence the effect of adequately treated hypertension versus inadequately treated hypertension on LBW could not be assessed. Information on anaemia was not readily available for all patients and hence could not be included as a variable in this study.

5. CONCLUSION

The prevalence of low birth weight in a tertiary public sector hospital in Maseru was shown to be high at 25%, constituting a serious public health concern. This study showed that there were several preventable and/or controllable factors which were associated with LBW, namely: prematurity, unclean source of energy, maternal HIV infection and maternal hypertension. Although multiple gestations were found to be associated with LBW, unfortunately little can be done to mitigate their effect on LBW. Similarly, although low paid work (indecent jobs), was positively associated with LBW, addressing this requires a concerted socio-economic developmental intervention and public and heath policies, including possibly the implementation of a decent minimum wage.

CONSENT

Written informed consent was obtained from the mothers after they were provided with information on the study and informed of their right to refuse to participate without any adverse consequences to them or their newborn babies' care. They were guaranteed confidentiality and informed that they could withdraw from the study at any time, without supplying a reason for their withdrawal.

ETHICAL APPROVAL

Ethical clearance was obtained from the University of the Western Cape South Africa, Research (Registration number 15/7/9) and Ethics Committee and from the Lesotho Ministry of Health Ethics and Research Committee (ID 84-2015). Permission was also granted by Queen Mamohato Memorial Hospital for the conduct of the study.

ACKNOWLEDGEMENTS

We wish to acknowledge the University of the Western Cape South Africa, the Ministry of Health Lesotho and the Queen Mamohato Memorial Hospital Maseru for granting permission to conduct the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX ONE: ETHICAL

LESOTHO

Ministry of Health
PO Box 514
Maseru 100

REF: ID 84 - 2015

Date: 21st January 2016

Category of Review:
[x] Initial Review
[ ] Continuing Annual Review
[ ] Amendment/Modification
[ ] Reactivation
[ ] Serious Adverse Event
[ ] Other ____________

To: A. Benjamin Nwako
Mph Candidate
University of Western Cape
Western Cape
South Africa

Dear A. Benjamin Nwako

RE: Prevalence & determinants of Low Birth Weight in Maseru Lesotho (ID 84-2015)

This is to inform you that on 21st January 2016 the Ministry of Health Research and Ethics Committee reviewed and **APPROVED** the above named protocol and hereby authorizes you to conduct the study according to the activities and population specified in the protocol. Departure from the approved protocol will constitute a breach of this permission.

This approval includes review of the following attachments:
[x] Protocol version 17th November 2015
[ ] English consent forms *[insert all consent form titles, versions, dates]*
[ ] Sesotho consent forms *[insert all consent form titles, versions, dates]*
[ ] Data collection forms *[insert all form titles, versions, dates]*
[ ] Participant materials *[insert types, versions, dates]*
[ ] Other materials *[insert types, versions, dates]*

This approval is **VALID** until 20 January 2017.

Please note that an annual report and request for renewal, if applicable, must be submitted at least 6 weeks before the expiry date.

All serious adverse events associated with this study must be reported promptly to the MOH Research and Ethics Committee. Any modifications to the approved protocol or consent forms must be submitted to the committee prior to implementation of any changes.

We look forward to receiving your progress reports and a final report at the end of the study. If you have any questions, please contact the Research and Ethics Committee at rcumoh@gmail.com (or) 22226317

Sincerely,

Dr. N. Letsie
Director General Health Services (a.i)

Mrs. V. T. Lehana
Chairperson NH-IRB

APPENDIX TWO: ETHICAL CLEARANCE FROM UNIVERSITY OF THE WESTERN CAPE

UNIVERSITY of the WESTERN CAPE

OFFICE OF THE DEAN
DEPARTMENT OF RESEARCH DEVELOPMENT

09 November 2015

To Whom It May Concern

I hereby certify that the Senate Research Committee of the University of the Western Cape approved the methodology and ethics of the following research project by: Dr A Nwako (School of Public Health)

Research Project:	Prevalence and determinants of low birth weight in Maseru Lesotho.
Registration no:	15/7/9

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
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