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Abstract

Purpose Under-5 mortality rates (U5MR) have declined drastically globally. However, it remains high in Nigeria, with variations across the Country's six geo-political zones. Understanding the factors associated with under-5 mortality (U5M) among lesser-explored subpopulations will inform strategies to curtail U5M. We investigated the factors associated with U5M in the south-south geopolitical zone (SSGZ) of Nigeria and population attributable risk percent (PAR%).

Method We analyzed population-based data from the Nigeria Demographic and Health Survey (NDHS) for 2013 and 2018. Logistic regression analysis was used in SPSS version 26.0 to calculate the Odds Ratios (OR) with 95% Confidence Intervals (CI) for U5M associated with various factors, while the PAR% was computed using Levine's formula.

Results The adjusted logistic regression analysis model showed maternal overweight (OR = 1.39, 95% CI 1.12–1.72, $p < 0.05$), primary education (OR = 2.18, 95%CI 1.18–4.04 $p < 0.05$) and secondary education (2.05, 95%CI 1.13–3.72, $p < 0.05$) levels, male gender (OR=1.22, 95%CI 1.01–1.47, $p < 0.05$), birth interval of less than two years (OR = 2.93, 95%CI 2.10–4.10, $p < 0.001$), and small birth size (OR = 2.54, 95% CI 1.94–3.31, $P < 0.001$) significantly increased U5M risk, while having seven or more household members (OR = 0.73, 95%CI 0.59–0.89, $p < 0.05$) and 2 under-five children in the household (OR = 0.66, 95% CI 0.52–0.83, $p < 0.001$) were protective factors, with PAR% for the factor significantly associated with U5M ranging from 4.5% to 47.1%.

Conclusion Increased interventions on maternal weight, maternal education, low birth size, and child spacing could reduce U5M in the SSGZ of Nigeria.

Keywords Under-5 mortality · Population attributable risk · Nigeria

Abbreviations

AOR	Adjusted Odds Ratio
FMoH	Federal ministry of health Nigeria
GZ	Geopolitical Zone
LMIC	Low- and Middle-Income Countries
NDHS	National Demographic and Health Survey
NPC	National Population Commission
OR	Odds Ratio

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PAR Population Attributable Risk
SSGZ South-South Geopolitical Zone
U5M Under 5 Mortality
U5MR Under 5 Mortality Rate
WHO World Health Organization

1 Introduction

The mortality of children between 0 and 59 months is an important indicator of global health and social development [1, 2]. The U5MR (number of under-5 deaths per 1000 live births), a proxy for the overall state of pediatric healthcare used to track the results of initiatives to keep children healthy [2] has experienced remarkable progress globally, reducing from 93 deaths per 1000 live births in 1990 to 38 deaths per 1000 live births in 2020 [3–5] due to global collaboration through Policies and programs [6, 7], changes in economic development, standards of living, social well-being, illness rates, quality and accessibility of medical care, public health practices, and environmental factors [8–12]. However, the same cannot be said for Nigeria where the U5MR currently stands at 132 deaths per 1000 births [9] with variations across its geopolitical zones (GZ) ranging from 187 deaths per 1000 live births in the northwest to 62 deaths per 1000 live births in the southwest [9] due to socio-economic and cultural inequalities [13, 14].

Globally, conditions such as birth complications, intrapartum-related events, lower respiratory infections, diarrhea, and other infectious diseases have been implicated as major causes of U5M [4, 15, 16], also several studies in low and middle-income countries (LMIC) have suggested, socioeconomic, household, community, nutritional, environmental, maternal, and child factors to be associated with U5M [17–21]. However, most of those studies in Nigeria have concentrated on national aggregate data, with particular emphasis on the northwest geopolitical zone, and to our knowledge, there have been none for the south-south region. Focusing on the south-south zone is important because it is well known that the region is affected by environmental degradation from crude oil spillage and pollution, which have been implicated in the poor living conditions linked with child mortalities [22]. Furthermore, given the variations in cultural, structural, and socioeconomic development within and across Nigeria's communities, adopting and generalizing findings from studies that concentrated on national aggregate data could obscure regionally unique health and socioeconomic problems thus providing insufficient evidence for interventional designs for the different GZs. Therefore, to improve U5MR it is necessary to conduct studies that identify risk factors for U5M among Nigeria's disaggregated geographical communities by grouping zones with comparable traits (i.e., socioeconomic, ethnic, cultural, and religious beliefs) together to eliminate reporting discrepancies and enable appropriate intervention designs. Therefore, this study explored the factors associated with U5M in the South-South Geopolitical Zone (SSGZ) of Nigeria and their Population Attributable Risk Percent (PAR%) using the 2013 & 2018 Nigeria Demographic and Health Survey (NDHS). To achieve its aim this study was guided by the Mosley and Chen Analytical framework for the study of child survival in developing countries [23]. This framework incorporates both social and biological variables to study child mortality and suggests that the physical and socioeconomic context in which the child is conceived or born has an impact on the processes that affect child survival by acting through proximate factors [24]. Proximate determinants are therefore seen to hold the key to understanding the mechanism by which a variety of underlying factors contribute to disorders that cause child mortality. Mosley & Chen grouped social and economic determinants of under-5 mortality into; individual, family, and community-level variables. While proximal determinants are grouped into; Maternal/conception factors, environmental contamination, nutrient deficiency, injury, and Personal illness control [24]. The evidence from this study will guide policies and inform the development of intervention programs.

2 Methods

2.1 Study setting and population

This study is based on data from the 2013 and 2018 NDHS. The population base of this study was live births to respondents of these surveys living within the SSGZ, one of Nigeria's six GZs made up of: Rivers, Akwa Ibom, Bayelsa, Cross River, Delta, and Edo state.

Sources of data The study employed nationally representative data from the NDHS which are large sample size household surveys implemented by the National Population Commission (NPC) in collaboration with the Federal Ministry of Health Nigeria (FMoH). It employed a two-stage stratified cluster sampling design detailed elsewhere [9, 24] consisting of 904 clusters from which 45 and 30 households were selected in 2013 and 2018 respectively where women aged between 15 and 49 were administered questionnaires to gather information on live births and deaths in the preceding five years. During this period a weighted total of 27,293 live births were reported in the SSGZ, with 12,438 obtained from the 2018 NDHS and 14,855 from the 2013 NDHS.

Description of variables To determine factors associated with U5M, the dependent variable U5M was defined as the death of infants between birth and 59 months of life, while Live births defined as the complete delivery of a product of conception from the mother which exhibits signs of life, such as breath, heartbeat, umbilical cord pulsation, or distinct voluntary muscle movement irrespective of the length of pregnancy [25], was represented by the variable "survival status" for infants between 0 and 59 months for the SSGZ. The independent variables were socioeconomic and proximate factors identified from the Mosley and Chen framework and previous studies in LMICs [18, 24, 26–28] adapted to the available datasets. At the socioeconomic level, Individual-level factors consisted of maternal characteristics such as education level, occupation, and body mass index. Household level factors were household wealth index, gender of household head, number of household members, and decision-making power (represented by the variables; Person who usually decides how to spend respondent's earnings, and Person who usually decides on respondent's health care) while place of residence, place of delivery (with the options home or healthcare facility) and religion were used to represent community level factor. At the proximate level, conceptual/maternal factors were represented by the mother's age at birth, gender, place of delivery, birth interval, birth size, birth order, and number of U5 in the household. When breastfeeding was initiated and the Source of drinking water was used as a Nutritional factor, Personal illness control was represented by the variable "ever had vaccination", Environmental contamination by type of toilet facility, and type of cooking fuel.

2.2 Data analysis

All statistical analysis was done on SPSS version 26.0. The distribution of under-fives (U5s) in the SSGZ by survival status and sociodemographic characteristics was summarised using descriptive statistics.

To determine the factors associated with U5M in the SSGZ, the 2013 and 2018 NDHS datasets were pooled, and logistic regression analysis was carried out using 3 models to estimate the Odds of mortality at a 95% confidence interval with a p-value for statistical significance set at 0.05. Combining the NDHS 2013 and 2018 data was necessary to maximise sample size and increase statistical power thereby limiting the challenge of reduced sample from focus on data for the South-South region only. In Model 1 univariate (unadjusted) analysis was done by entering each of the independent variables separately in a model with the dependent variable (survival status) to provide a crude estimate of their association with U5M. In model 2 multivariate analysis was done to adjust for the confounding effect of other factors at the same level of the Mosley and Chen framework and to determine the direction and magnitude of this effect. Thus, all socioeconomic factors and survival status were entered into model 2a, and all proximate factors and survival status were entered into model 2b. Model 3 was used to compute the fully adjusted Odd Ratio for each determinant of U5M after accounting for confounding due to proximate and socioeconomic variables together. In model 3 all socioeconomic and proximate factors identified from model 1 to have a statistically significant association with U5M were included. The above steps were followed because our study is guided by the Mosley and Chen's framework for the study of child survival in developing countries. Therefore, separating the multivariate analysis into socioeconomic (Model 2a) and proximate (Model 2b) sets of variables before considering both in the final model (3) enabled us to test Mosley and Chen's conceptual core idea of their framework that the socioeconomic variables interact with each other and must operate through a limited set of proximate determinants that directly influence the risk of health outcomes like U5M. Combining both socioeconomic and proximate factors in model 3 enabled us to observe the main factors associated with U5M taking into account confounding from all other factors. The Population Attributable Risk (PAR)% for factors found to be significantly associated with U5M was computed using the Levine equation which utilized the aOR as an approximation for the relative risk as recommended in the literature [29, 30]. The PAR percent and its confidence interval were computed using the formula.

$$PAR = Pr\,(aOR - 1)$$

$$PAR\% = \left[Pr \times \frac{(aOR - 1)}{aOR}\right] \times 100$$

$$95\%\ CI\ (\%Pop\ AR) = \%PAR \pm 1.96 \times SE\%PAR$$

3 Result

3.1 Distribution of Under 5s and U5M by sociodemographic factors in the SSGZ

A total of 2,286 under-5 deaths were recorded for the SSGZ with 1,304 occurring in males and 982 among females, and 30.1% of the respondents in this region lived in urban areas while 69.9% lived in rural areas after combining 2013 and 2018 NDHS. More details are available in Table 1 of supplementary material.

3.2 Socioeconomic factors and under 5 mortality

The odds of U5M were higher (OR = 1.78, 95% CI 1.47–2.14, p < 0.001) amongst mothers with just primary education, and those engaged in manual labor (OR = 1.52, 95%C1 1.25–1.87, p < 0.001), compared to those with higher education and professionals respectively. At the household level U5s in homes with over six family members (OR = 0.86, 95% C1 0.78–0.94, p < 0.05) had reduced odds of mortality while U5s born into the poorest households (OR = 1.22, 95% CI:1.08–1.37p < 0.05) and rural areas had higher odds of mortality (OR = 1.24, 95% CI 1.12–1.37, p < 0.001).

After adjusting for confounding by other factors at the socioeconomic level (see supplementary material), the association between maternal occupation, sex of household head, wealth index, decision on use of maternal income, place of delivery, religion, and U5M was no longer significant. However, the odds of U5M among overweight mothers (OR = 1.28, 95% CI 1.11–1.48, p < 0.005), and mothers with only primary education increased (OR = 1.93, 95% CI 1.39–2.68 p < 0.0001). When both socioeconomic and proximal factors were included in model 3, the odds of U5M among overweight mothers increased even further (OR = 1.39, 95% CI 1.12–1.72 p < 0.05), however, the relationship between obese mothers and U5

Table 1 Distribution of under 5 mortalities by some sociodemographic characteristics (2013 and 2018 dataset merged)

Variable	Categories	Live U5 Births N	Under 5 deaths N
Maternal educational level	No education	2,834	257
	Primary	10,073	1,001
	Secondary	11,890	898
	Higher	2,221	130
Wealth index (Income level)	Poorest/poorer	4,192	397
	Middle	7,946	711
	Richer/richest	14,880	1,178
Type of place of residence	Urban	8,126	597
	Rural	18,892	1,689
Mothers age at birth	< 20	5,331	535
	20–29	14,726	1,170
	30–39	6,471	526
	40–49	490	55
Sex of child	Male	13,960	1,304
	Female	13,058	982
Birth size	Small/very small	20,953	1,950
	Average or large	5,986	323

mortality was no longer statistically significant. The odds of mortality were increased among U5s born to mothers with primary (OR = 2.18, 95%CI 1.18–4.04 p < 0.05) and secondary education (OR = 2.05 95%CI 1.13–3.72, p < 0.05), while the odds of U5M in homes with over 7 family members was reduced (OR = 0.73, 95%CI 0.59–0.89, p < 0.05). For further details see supplementary material.

3.3 Proximate factors and under 5 mortality

The result showed higher odds of U5M among mothers in the 40- 49 (OR = 1.43, 95%CI 1.07–1.92 p < 0.0001), less than 20 age groups (OR = 1.26, 95%CI 1.11–1.43, p < 0.05), Males (OR = 1.27, 95%CI 1.16–1.38, P < 0.001), U5s having a small size at birth (OR = 1.80, 95% CI 1.59–2.03, p < 0.001) and U5s born less than 2 years after the preceding birth (OR = 2.44, 95% CI 2.08–2.87, p < 0.001) compared to their reference categories. In model 2, the time of starting breastfeeding, type of toilet facility, and mother's age at birth were found to no longer have a statistically significant association with U5M. However, the odds of U5M among mothers between 40 and 49 years reduced (OR = 0.87, 95% CI:0.55–1.38 p > 0.05), while that of mothers less than 20 years old (OR = 1.35, 95% CI 0.90–2.03, p < 0.005) and males increased (see supplementary material).

In the final model 3 (Table 2), the mother's age at birth, time of starting breastfeeding, source of drinking water, type of toilet, and type of fuel were found to not have a statistically significant association with U5M. However, males had higher odds of U5M (OR=1.22, 95%CI 1..01–1.47,p < 0.05), seventh or above births had a 2.5 fold increased odd of death (OR = 2.52, 95% CI 1.76–1.59, p < 0.001), U5s with less than 2 years interval from successive births had almost 3 times the odds of mortality (OR = 2.93, 95% CI 2.10–4.10, p < 0.001), and U5s with small birth size had a 2.5 fold increase in the odds of mortality (OR=2.54, 95% CI 1.94–3.31, P < 0.001) when compared to their reference groups. For further details see supplementary material.

Footnotes in model 2 socio-economic factors (BMI, maternal education level, maternal occupation, sex of household head, wealth index, maternal use of healthcare, maternal use of income, number of household members, place of residence, place of delivery, and religion) were analyzed together, while proximate factors (mothers age at birth, sex of child, birth order, birth interval, birth size number of U5s in household, time put to breast, ever vaccinated, source of drinking water, type of toilet, type of cooking fuel) were also analyzed to adjust for confounding at the same level. However in model 3 factors were found to be significant at both socioeconomic and proximal levels (BMI, maternal education level, maternal occupation, sex of household head, wealth index, maternal use of income, number of household members, place of residence, religion, mothers age at birth, sex of a child, birth order, birth interval, birth size number of U5s in the household, time put to the breast, source of drinking water, type of toilet, type of cooking fuel were analyzed to adjust for confounding by factors at both levels.

3.4 Population attributable risk

The attributable risk which reflects the anticipated decline in mortality if the factor is eliminated [27] is presented in the supplementary material. It shows that 8.28% (95% CI 5.53%-11.01%) of increased U5M in the SSGZ was attributable to overweight mothers, 22.52% (95CI;20.82%–24.22%) attributable to mothers with secondary education 20.18% (95%CI 17.24%–23.12%) to primary education, 47.12% (95% CI 37.77%–59.47%) of U5M was attributable to small birth size among U5s. However, a 19.40% (95%CI – 15.68%–23.12%) reduction in U5M was attributable to having two under U5s in the household.

4 Discussion

The study identified maternal overweight, maternal primary and secondary education levels, male gender, high birth order, and small birth size as significantly associated with increased odds of U5M, while ≥ 7 household members and having 2 U5s in the household were protective. Of the factors identified, low birth size alone accounted for over 47% of the U5M risks. These findings emphasize the role of socioeconomic and proximate level factors in elevating U5M in SSGZ, Nigeria, and support Mosley and Chen's framework. After adjusting for confounding in model 2 the modification to the odds ratio suggests that multiple socioeconomic factors interact to influence the magnitude of the U5M risk, while the change in odds of mortality for socioeconomic factors in the presence of proximate factors support Mosley and Chen's idea that socioeconomic factors exert their effect on U5M through proximate factors [26].

Table 2 Crude and adjusted odd ratios, 95% confidence interval for factors related to under-5 mortality in the SSGZ, Nigeria

Variable	Categories	Univariate regression analysis			Multivariate regression analysis		
		Unadjusted (Crude estimate) model 1			Adjusted Model 3		
		OR	95%CI	P-value	OR	95%CI	P-vales
Socio-economic/distal determinants							
Individual level determinants							
Body mass index	Underweight	1.28	0.98–1.67	0.067	0.69	0.33–1.46	0.334
	Normal	Ref		0.027			0.010
	Overweight	1.17	1.04–1.04	0.007	1.39	1.13–1.72	0.002
	Obese	1.08	0.94–1.25	0.261	1.17	0.87–1.56	0.307
Maternal educational level	No education	1.60	1.29–2.00	0.000	1.55	0.78–3.06	0.209
	Primary	1.78	1.47–2.14	0.000	2.18	1.18–4.04	0.013
	Secondary	1.31	1.09–1.59	0.005	2.05	1.13–3.72	0.018
	Higher	Ref		0.000			0.024
Maternal occupation (Maternal skill/time)	Not working	1.43	1.13–1.82	0.003			
	Agriculture/manual labor	1.52	1.25–1.87	0.000	1.18	0.70–1.98	0.532
	Professional/Clerical			0.000			0.134
	Services/domestic/others	1.24	1.03–1.51	0.261	0.95	0.58–1.56	0.837
Household-level							
Sex of household head	Male	0.91	0.89–1.00	0.051	0.83	0.65–1.07	0.151
	Female	Ref					
Wealth index (Income level)	Poorest/poorer	1.22	1.08–1.37	0.001	1.04	0.65–1.07	0.802
	Middle	1.14	1.04–1.26	0.007	1.11	0.88–1.42	0.379
	Richer/richest	Ref		0.001			0.672
Decision marking power1 (use of maternal income)	Mother	Ref					
	Others	0.86	0.77–0.96	0.008	0.96	0.79–1.18	0.715
Number of household members	Between 1–6	Ref					
	7 and above	0.86	0.78-.94	0.001	0.73	0.59–0.90	0.003
Community level determinants							
Type of place of residence	Urban	Ref					
	Rural	1.24	1.12–1.37	0.000	0.95	0.78–1.21	0.779
Religion	Christian	0.98	0.73–1.29	0.906	1.70	0.74–3.94	0.215
	Islam	Ref		0.026			0.401
	Traditionalist	0.63	0.42–0.96	0.030	2.01	0.71–5.69	0.188
Proximal determinants							
Conception/maternal factors							
Mothers age at birth	< 20	1.26	1.11–1.43	0.000	1.35	0.90–2.03	0.143
	20–29	0.98	0.88–1.09	0.651	1.05	0.82–1.34	0.726
	30–39	Ref		0.000			0.474
	40–49	1.43	1.07–1.92	0.017	0.92	0.51–1.67	0.783
Sex of child	Male	1.27	1.16–1.38	0.000	1.22	1.01–1.47	0.043
	Female	Ref					
Birth order	1	1.08	0.96–1.20	0.193			
	2 to 3	Ref		0.000			0.000
	4 to 6	1.14	1.03–1.28	0.016	1.35	1.07–1.71	0.011
	7 +	1.99	1.72–2.31	0.000	2.52	1.76–3.60	0.000
Birth interval	< 2	2.44	2.08–2.87	0.000	2.93	2.10–4.10	0.000
	2	1.56	1.33–1.84	0.000	1.87	1.34–2.62	0.000
	3	1.25	1.03–1.52	0.026	1.53	1.04–2.24	0.300

Table 2 (continued)

Variable	Categories	Univariate regression analysis			Multivariate regression analysis		
		Unadjusted (Crude estimate) model 1			Adjusted Model 3		
		OR	95%CI	P-value	OR	95%CI	P-vales
	4 +	Ref		0.000			
Birth size	Small/very small	1.80	1.59–2.03	0.000	2.54	1.94–3.31	0.000
	Average or large	Ref					
Number of children under 5 in household	1	Ref		0.000			0.002
	2	0.78	0.69–0.87	0.000	0.66	0.52–0.83	0.000
	3 and above	0.70	0.70–0.81	0.000	0.80	0.61–1.05	0.111
Environmental contamination & Sanitation							
Source of drinking water	Improved	Ref		0.000			0.558
	Unimproved	1.22	1.12–1.34	0.000	1.07	0.86–1.33	0.566
Type of toilet	Improved	Ref		0.011			0.228
	Unimproved	1.09	1.00–1.19	0.042	0.87	0.70–1.09	0.228
Type of cooking fuel	Clean	Ref		0.000			0.411
	Polluting	1.77	1.43–2.18	0.000	0.81	0.50–1.33	0.411

The association between maternal education and U5M for the SSGZ was a departure from the findings of other researchers [17, 33–35]. After adjusting for the confounding effect of proximate factors the association between U5M and "no formal education" was eliminated contrary to findings from previous studies. The increased odds of U5M among mothers with primary or secondary education could be due to a combination of poverty and poor quality of education. Inadequate funding for education (5.4% of the annual budget), poor policy implementation and regulation, and corruption negatively affect the quality and quantity of educational resources in Nigeria [36]. The low level of participation of women in the labor force (48.4%) [37, 38] due to high unemployment and the traditional role of mothers as homemakers may result in a lack of resources to implement knowledge to improve child survival. Also, women with some level of education are less likely to engage in certain types of jobs, increasing unemployment among this group when compared with those with no formal education who are less selective about employment opportunities and are more likely to be engaged in trading, farming, and the provision of services which are major sources of employment in this region thereby increasing their access to financial resources [39].

The increased odds of U5M among overweight mothers are consistent with the findings of Creswell et al. (2012) [40] but contradicts Khan and Awan [41]. Maternal overweight increases the risk of negative health outcomes for newborns through complications such as pre-eclampsia and diabetes which increase the risk for birth complications, restricted intrauterine growth, congenital anomalies, and birth trauma [42, 43], which is further exacerbated by the unavailability of facilities and resources to manage high-risk births. Also, mothers are the major decision-makers for family nutrition, thus poor nutritional habits may translate to poor nutritional outcomes for U5s. The reduced odds of U5M in households with over seven members mirrored the findings of some researchers [44, 45] but contradicted those of others [46–48]. This finding could be because the SSGZ like most African communities is communal, and childcare is seen as a community responsibility thus large family sizes are a source of sustenance, knowledge, care, and supervision [49, 50].

The increased odds of U5M among males were similar to the findings of other researchers [17, 20, 24]. This may be attributed to the effects of genetics which result in delayed fetal lung maturation in boys increasing the incidence of respiratory illness and the inhibitory effect of the male hormones on the immune system [51]. Furthermore, the association of U5M with 4th and higher birth order, and short birth interval found in this study is consistent with the findings of past literature [19, 20, 31], and may be explained by maternal reproductive health, parent–child behavior, and sibling relationships. Birth order refers o a child's position in the age hierarchy of siblings while household members are not limited to immediate family but the number of people living in a household and may include extended family members. Women require time to recover after childbirth, however, short intervals between successive pregnancies may result in poor uterine healing, anemia, and cervical insufficiency which may hamper the ability to sustain fetal growth increasing the risk of fetal malnutrition, infection, death, and preterm births respectively [52,

53]. A short birth interval may also indicate that a mother does not breastfeed extensively depriving her children of the nutritional and immunological benefits of breastmilk. There may be fewer maternal and household resources available for each successive pregnancy, and higher-order pregnancies are more likely to be unintended conceptions and are linked to a late start of antenatal care and vaccinations [54]. The increased odds of mortality for U5s who were smaller at birth were similar to the findings of available literature [20, 27, 28, 32]. However, of the factors identified in this study, low birth size alone accounted for over 47% of the U5M risks. Children born with a low birth weight are at a higher risk of morbidity and mortality due to malnutrition, susceptibility to infections, respiratory distress, birth trauma, growth failure, developmental delay, and the development of chronic non-communicable diseases [55, 56]. The reduced odds of U5M in households with two U5s support the findings of previous studies [25, 33]. The explanation could be that mothers of other U5s might have learned and experienced parenting through time, which could account for the protective effect of this characteristic on child survival. Besides, the communal nature of families in these regions might have provided opportunities to support and learn from one another's experiences, as well as share health resources and information.

The results of the PAR% for children born to overweight mothers indicate a change of overweight BMI to within the optimal range would eliminate about 8% of U5M among children born to this group of mothers, while 47.12% (95% CI 37.77% -59.47%) of U5 deaths could be prevented if interventions could prevent small birth size. However, a 19.40% (95%CI15.68%-23.12%) reduction in U5M is attributed to having two U5s within a household, but not all these characteristics are amenable to public health interventions.

5 Strengths and limitations

To our knowledge, this is the only study on U5M focused on the SSGZ of Nigeria which also provides information on PAR thus providing data relevant to this region. It also used a pooled dataset, and categories increasing its statistical power and making it possible to detect significant associations. However, the quality of the findings may have been undermined because of the retrospective nature of the information collected by the NDHS. It is important because the estimates are derived from birth history, making recall bias a possible issue that could lead to underestimation of U5M in the study. Besides, our estimates for the determinants of U5M may have been biassed by combining two datasets spanning over 10 years with data collected at different time points. This is because we could not account for changes in the factors influencing U5M over time, and given the cross-sectional nature of the NDHS data, it is difficult to infer causality. We also considered several confounders in our analysis. However, there may be unknown confounding effects of variables not considered, which can not be accounted for.

6 Conclusions

Findings from this study showed that mothers being overweight, maternal primary education level and secondary education, male gender, high birth order, and small birth size were significantly associated with increased odds of U5M, while households with seven and above members, and 2 children under five years old in the household were protective against U5M in the SSGZ. The population attributable risk percent (PAR%) findings from this study indicate that policies and strategies to address maternal weight, maternal education, and child spacing could reduce the risk of U5M in SSGZ.

6.1 What is known

Maternal education, male gender, small birth size, and low birth interval are associated with increased risk for U5M.

6.2 What is new

We found that 47.12% (95% CI 37.77%–59.47%) of U5M was attributable to small birth size among U5s, and large household size, having two U5s in a household is associated with reduced risk for U5M in the SSGZ of Nigeria.

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Author contributions I.A and I.M.D contributed to the study conception and design. The study methodology was developed by I.A and I.M.D. The formal analysis was conducted by I.A. I.M.D. supervised the study. The First draft of the manuscript was written by I.A., and I.M.D. reviewed and approved the final manuscript.

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Data availability The relevant information on the data source/dataset used for the analysis and how to access the 2013 and 2018 NDHS data is contained in the supplementary material file. The raw dataset used can be accessed from the DHS website (https://dhsprogram.com).

Declarations

Ethics approval and consent to participate All the methods in this study were carried out in accordance with relevant guidelines and regulations. Ethical clearance and approval were obtained from the Sheffield Hallam University Research Ethics Committee of the College of Social Sciences and Arts, Sheffield Hallam University, and the Demographic Health Survey Program/ICF granted access for the use of the DHS data for study after submitting a formal request. The National Health Research Ethics Committee of Nigeria (NHREC) and the ICF Institutional Review Board examined and approved the survey protocol for the NDHS. This study is based on a secondary analysis of the NDHS dataset, and DHS informed consent was obtained from all study participants.

Consent for publication Not applicable.

Competing interests The authors declare they have no conflict of interest, whether financial or non-financial.

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