

Levels and Differentials of Infant and Child Mortality Rates in Malakal in Upper Nile State, South Sudan

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ABSTRACT

This study aimed to establish the levels and differentials of infant and child mortality in Malakal, using primary data from a random sample of 1317 women aged (15-49 years). The results of Chi-square test show that mother education, mother employment, family income, parity, birth order, preceding birth interval, drinking water source, type of toilet facility, type of the floor, place of delivery and breastfeeding duration were significantly associated with infant and child mortality. Age of the mother and cooking fuel source were significantly associated with child mortality. The results of direct method of estimation show that the levels of infant and child mortality were higher among infants and children for mothers with no education, infants and children in households with low income, infants and children for mothers aged 30+, infants and children of first birth order, infants and children of preceding birth interval < 24 months, male infants and children, infants and children in households used non-improved water, infants and children in households used non-improved toilet facility, infants and children in households with natural floor, infants and children delivered at home and infants and children breastfed < 6 months. Also, the levels of infant mortality were higher among infants for employed mothers; infants of parity 6+. Furthermore, the levels of child mortality were higher among children for unemployed mothers; children of parity 1-3 and children in households used high polluting fuel. The study recommends for improve accessibility to health services to reduce infant and child mortality rates to reasonable levels.

Keywords: Differentials, Infant mortality, Child mortality, Chi-square (χ^2) test.

1. INTRODUCTION

Infant and child mortality rates reveal a nation's socioeconomic development and value of life. In spite of the wide progress towards infant and child health, the decrease in infant and child mortality rates in numerous African nations have been still slower since the 1980 than in the 1960s and the 1970s^[22-23]. From the thirty nations with the globe's highest infant and child death rates, twenty seven were in Sub-Saharan Africa^[24]. In 1998, child death rate was 173 per 1000 live births compared with 70 per 1000 live births the lowest goal of globally approved in the 1990 World Summit for children^[25]. It has been indicated that eighteen of the twenty nations across the globe with the highest infant and child mortality rates were in Sub-Saharan Africa (United Nations report, 1995)^[26]. A main hindrance to improvement may be the chronic or protracted civil wars and political instability that characterize several nations in Sub-Saharan Africa (Macassa et al , 2003)^[12].

Despite the recent decline, the infant and child mortality in South Sudan are still amongst the highest in the globe. The 1993 Sudan Population Census showed very high levels of infant and child mortality rates which were 141 and 210 per 1000 live births, respectively^[21]. However, the 1999 South Sudan Safe Mother Survey reveal that levels of infant and child death rates were 93 and 123 per 1000 live births, consecutively^[18]. Also, the results of the 2010 Sudan Household Health Survey II demonstrated that

levels of infant and child death rates were 75 and 105 per 1000 live births, respectively ^[19]. This indicates downward trend in infant and child mortality rates in South Sudan.

The results of Sudan Demographic and Health Survey 2006 reveal that levels of infant and child mortality rates were 82 and 110 deaths per 1000 live births, respectively in Malakal ^[20]. However, the study by Abol et al ^[8] reveals that infant and child mortality rates were 86 and 108 per 1000 live births, consecutively in Malakal. No more recent study has been undertaken to estimate the levels of infant and child mortality rates. This study seeks to undertake a more comprehensive analysis of current levels and differentials of infant and child mortality in Malakal and the findings will help the seeing of rates, levels and differences in the rates among the variables.

2. REVIEW OF EMPIRICAL STUDIES ON INFANT AND CHILD MORTALITY

Numerous research on infant and child mortality have been accomplished utilizing census and survey data at various levels and dissimilar areas across the developing globe in a try to discover the levels and differentials of infant and child mortality with various factors. Anywise, the next pages try to summary these studies.

Adepoju et al (2012) ^[2] did a study to establish the determinants of child mortality in Nigeria. The results showed that mother education, place of delivery, mother's age at first births, breastfeeding, sex, type of delivery have significantly associated with child mortality. The study recommended that awareness of benefits of maternal education, breastfeeding, access to adequate health care should be encouraged to reduce child mortality in Nigeria.

Aigbe and Zannu (2012) ^[3] conducted a study to highlight the unevenness in childhood mortality rates in Nigeria, using the data from 1999 and 2008 Nigeria Demographic and Health Survey (NDHS). The results showed that geo-political zones have significant effects on higher infant and child death rates. This study concluded that enhance accessibility to medical service, and education of the mother to reduce childhood mortality rates.

Mojekwu & Mesike (2012) ^[13] conducted a study to establish the environmental determinants of child mortality in Nigeria, using data from the 2008 Nigeria Demographic and Health Survey (NDHS) by employed Logistic Regression Model to analyze the data. The findings revealed that use of non improved toilet facilities, high polluting fuels; mothers with no education and drinking water were positively associated with child mortality. The study concluded that use of clean cooking fuel should be encouraged to reduce child mortality.

Abed et al (2010) ^[1] did a study to establish the demographic and socioeconomic factors of infant and child mortality in Sudan. The findings of Chi-square test showed that preceding birth interval, child immunization and mother education have significant association with infant and child mortality. The study concluded that strategy makers and researchers should provide more concentration to improve the vaccination services and mother education to lower infant and child death.

Mondal et al (2009) ^[14] conducted a study to determine the influence of factors on infant and child mortality in Bangladesh. The results showed that breastfeeding, child immunization, age of mother at first delivery; previous birth interval had a significant effects on infant and child death. The study concluded that awareness supposed to be offered to mother education and increasing access to health services to decrease infants and children mortality.

Mutunga (2004) ^[15] used survival analysis to investigate impact of environmental determinants on child mortality in Kenya, using the data from 2003 Kenya Demographic and Health Survey dataset (KDHS). The results showed that safe drinking water, low polluting fuels, sanitation and maternal education have significantly associated with child mortality. The study recommended that policies should be directed on improving household environmental factors to reduce child mortality.

Macassa et al (2003) ^[12] conducted a study to explain the trends of infant and child mortality in Mozambique (1973-1997) by mother place of residence, using direct method of estimation to analyze the data. The results showed that infants and children mortality rates were higher in rural areas than in urban areas. Further study is required to examine the differentials of infant and child mortality in urban and rural areas in Mozambique.

Ascherio et al (1992) ^[4] conducted a research to estimate the effects of war and the economic embargo on infant and child mortality in Iraq during the 1991 war. The results showed that the Gulf war has significant impacts on higher infants and children mortality rates in towns. The study concluded that Gulf war and trade sanctions increased infant and child mortality.

DaVanzo and Habicht (1986) ^[7] conducted a study to examine why the infant mortality had decline rapidly in Malaysia, using data from the Malaysia Family Life Survey (MFLS) (1946-1975). The results showed that significant augments in mothers' education and enhancements in water and hygiene have significantly associated with infant mortality decline. But, breastfeeding decreases had protected the infant mortality rate from dropping. These results are similar to Preston (1976) ^[16] and (1980) ^[17]'s results based on country aggregates that structural change explains infant mortality decline than do alters in socioeconomic and other variables.

3. DATA AND METHODS

The data for this study was obtained from the field work survey carried out in Malakal, 2016 using questionnaire. Sample of 1109 infant live births and 2229 child live births were obtained from 1317 mothers in the reproductive age (15-49 years). The main

methods of data analysis are descriptive statistics and direct method of estimation. Descriptive statistics analysis was carried out to describe background characteristics of the mothers regarding to suitable variables in terms of frequencies and percentages distribution. Chi-square was utilized to run bivariate analysis to demonstrate whether there was significant association between variables and infant and child mortality. Also, direct method of estimation was utilized to compute infant and child mortality rates.

3.1. Percent

Percent was used to compute percentage as follows:

$$P = \frac{F}{N} \times 100$$

Where: **P** = percent **F** = Frequency **N** = Total number of population

3.2. Chi-square Analysis

Chi-square was used to test for significance and computed as follows:

$$\chi^2 = \frac{\sum [f(O) - f(E)]^2}{\sum f(E)}$$

Where: χ^2 = Chi-square **f (O)** = Observed Frequencies **f (E)** = Expected Frequencies. Σ = Symbol for summation.

3.3. Direct Method of Estimation

Direct method was employed to estimate infant and child mortality rates as follows:

Infant mortality rate is the likelihood of dying between birth and the first birthday – during age 0 to 11 months, multiple by 1000. From the definition, it is clear that the infant mortality rate does not take into consideration either to fetal death or stillbirth, but only live births and infant deaths.

$$\text{Infant Mortality Rate} = \frac{\text{Infant deaths (0-11 months) (D0)}}{\text{Live births (0-11 months) (B0)}} \times 1000$$

Child mortality rate is the likelihood of dying between the precisely age one and the fifth birthday – during age 12 to 59 months, multiple by 1000.

$$\text{Child Mortality Rate} = \frac{\text{Child deaths (12-59 months)(D0)}}{\text{Live births (12-59 months) (B0)}} \times 1000$$

4. RESULTS AND DISCUSSION

4.1. Percentage Distribution of Infant live births (0-11months) by the Study Variables

The results in (Table 4.1.1) showed percentage distribution of infant live births by the study variables. Majority (92.8%) of the infants were alive, while slightly (7.2%) were died. More than half (55.6%) of the infants for mothers with no education, (28.0%) for mothers with primary education, while slightly (16.4%) for mothers with secondary education or more. In respect to mother’s employment, (45.0%) of the infants for mothers who were employed, while (55.0%) for mothers who were unemployed. With respect to family income, majority (50.7%) of the infants in households with low income, (26.0%) in households with medium income, while (23.3%) in households with high income. This it agrees with the findings of World Bank [27] in which around (51%) of the households in South Sudan were found to be poor. In regard to family size, majority (63.1%) of the infants belonged to family size 7 persons or more, (29.9%) belonged to family size 5-6 persons, while (7.0%) belonged to family size ≤ 4 persons. Distribution by zone of residence showed that (37.8%) of the infants living in Southern zone, (32.2%) in the Northern zone, while (30.0%) in the Central zone. Regarding to age of mother at first firth, majority (36.0%) of the infants to young mothers aged 15-19 years, while slightly (11.2%) for mothers aged 30 years or more. Distribution by parity showed that, (43.9%) of the infants belonged to parity 1-3, (31.7%) belonged to parity 4-5, while (24.4%) of the infants belonged to parity 6+. With regard to birth order, slightly (7.9%) of the infants belonged to first birth order, (36.3%) belonged to birth order 2-3, while majority (55.8%) belonged to birth order 4 or more. Relating to preceding birth interval, majority (89.3%) of the infants have previous birth interval of less than 24 months, while a little (2.8%) have previous birth interval of 24 months or more. Sex of the baby is a significant factor when studying infant mortality, the results showed that more than half (50.9%) of the infants were females, while (49.1%) of the infants were males. source of drinking water revealed that, majority (77.2%) of the infants residing in households used non-improved drinking water source, while slightly (22.8%) residing in households used improved drinking water source. Type of toilet facility also plays a major role as an environment aspect within which infants live, the results further showed that, majority (74.9%) of the infants for mothers residing in households used non-improved toilet facility; while more than quarter (25.1%)

residing in households used improved toilet facility. With respect to type of cooking fuels, the results showed that (43.4%) of the infants residing in households used high polluting fuel (firewood), (46.0%) living in households used medium polluting fuel (charcoal), while minority (10.6%) residing in households used low polluting fuel (gas). Type of floor of the house as an environment aspect, the results showed that majority (57.8%) of the infants residing in households with natural floor, while (42.2%) residing in households with furnished floor. More than half (52.0%) of the infants were delivered at home, while (48.0%) were delivered at hospitals. It is a reality that giving births at health institutions are secure, together for mother and newborns because they may have less possibility to be infected. Without doubt, breastfeeding fights different communicable disease and reinforced necessary antibody system of the infants, more than half (51.9%) were breastfed 6 months or more, while (48.1%) of the infants were breastfed less than 6 months.

Table 4.1.1: Percentage Distribution of Infants live births by the Study Variables

Variable	No. of Infants	Percentage
Infants survival status		
Alive	1029	92.8
Dead	80	7.2
Mother education		
No education	617	55.6
Basic/Primary	310	28.0
Secondary +	182	16.4
Mother employment		
Employed	499	45.0
Not employed	610	55.0
Family income		
Low income	562	50.7
Medium income	289	26.0
High income	258	23.3
Family size		
≤ 4 persons	77	7.0
5 – 6 persons	332	29.9
7 persons or more	700	63.1
Zone of residence		
Northern	357	32.2
Central	333	30.0
Southern	419	37.8
Mother's age at first birth		
15-19 years	399	36.0
20-24 years	323	29.1
25-29 years	263	23.7
30 + years	124	11.2
Parity		
1 - 3 children	487	43.9
4 - 5 children	351	31.7
6 + children	271	24.4
Birth order		
First birth order	88	7.9
2-3 birth order	402	36.3
4 + birth order	619	55.8
Preceding birth interval		
First births	88	7.9
< 24 months	990	89.3
24 + months	31	2.8
Sex of the infant		
Male	545	49.1
Female	564	50.9
Drinking water source		
Improved water	253	22.8

Non-improved water	856	77.2
Type of toilet facility		
Improved toilet	278	25.1
Non-improved toilet	831	74.9
Cooking fuel source		
Low polluting	117	10.6
Medium polluting	510	46.0
High polluting	482	43.4
Type of floor of the house		
Natural floor	641	57.8
Furnished floor	468	42.2
Place of Delivery		
At hospital	577	52.0
At Home	532	48.0
Duration of breastfeeding		
Less than 6 months	576	51.9
6 + months	533	48.1

4.2. Levels and Differentials of Infant Mortality Rates by the Study Variables

The estimates of infant mortality rate by the study variables are shown in (Table 4.2.1). It was clear that mother education was significantly associated with infant mortality at 5% confidence level. This significant association implies that mother education has been recognized as one of the main vital factors of infant mortality. As expected, infant mortality rate was lower among infants for mothers with at least secondary level of education 22 deaths per thousand live births, followed by infants for mothers by primary education 35 deaths per thousand live births, whilst higher among infants for mothers by no education 105 deaths per thousand live births. The result proposed that deaths among infants were more among infants for mothers by no education pursues by infants for mothers by primary education. This may be owing to the matter of reality that infant mortality rate lean to decrease with augment in educational level of the mothers. This finding is concurred with findings of prior studies by Abed et al (2010) ^[1] and DaVanzo and Habicht (1986) ^[7]

The results in (Table 4.2.1) showed that mother employment was significantly linked with infant mortality at 5% confidence level. Unexpected, infant death rate was higher amongst infants for mothers who were employed 108 deaths per thousand live births while lower amongst infants for mothers who were not employed 43 deaths per thousand live births. Several historical studies by Brandstrom (1988) ^[5] and Graham (1994) ^[10] in 19th and 20th centuries point out that the highest infant death rate in households with employing mothers, which refer to the lack of mother's time for baby care, early preface of non-natural feeding and bad living circumstances.

Definitely, family income is one of the most main determinants of living standard, economic and social welfare. The results in (Table 4.2.1) showed that family income was significantly linked with infant mortality at 5% confidence level. As expected, infant death rate was lower amongst infants belonged to households with high income 8 deaths per thousand live births, while higher amongst infants belonged to households with low income and medium income 94 deaths and 87 deaths per thousand live births, consecutively. The results proposed that infants belonged to households with high income experience lower infant death rate when compared to infants belonged to households with medium income and low income.

The results in (Table 4.2.1) showed that family size was insignificantly linked with infant mortality at 5% confidence level. As expected, infant death rate was lower among infants belonged to family size ≤ 4 persons 39 deaths per thousand live births, whilst higher among infants belonged to family size 7 or more and 5-6 persons 81 and 60 deaths per thousand live births, consecutively. The result in (Table 4.2.1) showed that zone of residences also was not significantly associated with infant mortality at 5% confidence level. Infant death rate was higher amongst infants residing in Southern and Northern zones 74 and 73 deaths per thousand live births, in that order, whereas lower among infants residing in Central zone 69 deaths per thousand live births. These results are agreed with Aigbe and Zannu ^[3] that geo-political zones have significant on infant mortality rates.

Age of the mother at first delivery was insignificantly associated with infant mortality at 5% confidence level. As anticipated, infant death rate was higher amongst infants for older and younger mothers aged 30 or more and 15-19 years 113 and 75 deaths per thousand live births, consecutively whilst lower amongst infants for mothers aged (20-24 years) and (25-29 years) 53 and 72 deaths per thousand live births, consecutively.

From (Table 4.2.1) it was clear that parity was significantly linked with infant mortality at 5% confidence level. Infant mortality rate was higher among infants of parity 6 or more 140 deaths per thousand live birth, at the same time as lower among infants of parity (1-3) and parity (4-5) 57 and 40 deaths per thousand live births, consecutively.

From (Table 4.2.1) it was obvious that birth order was significantly connected with infant mortality at 5% confidence level. As expected, infant mortality rate was higher for infants belonged to first and higher order births 4 or more 318 and 82 deaths per 1000 live births, respectively, while lower for infants belonged to order births (2-3), 2 deaths per 1000 live births. Obviously, previous birth interval was significantly associated with infant mortality at 5% confidence level. As expected, infant mortality rate was higher amongst infants of preceding birth intervals less than 24 months 72 deaths per thousand live births; at the same time as lower amongst infants of preceding birth interval of 24 months or more 63 deaths per thousand live births. This finding is supported by previous studies by Abed et al (2010) [1] and Mondal et al (2009) [14] who established that shorter birth interval increases the probability of infant mortality. The results in (Table 4.2.1) showed that sex of the infant also was not significantly associated with infant mortality at 5% confidence level. As expected, infant death rate was higher among male infants 84 deaths per thousand live births than among female infants 60 deaths per thousand live births. This supported by several studies by D'Souza and Bhuiya (1982) [9], Kabir and Chowdhury (1989) [11] and Macassa et al (2003) [12] that male infants die more at any infancy age than female infants owing to biological factors faced by male. From (Table 4.2.1) it was evident that drinking water source was significantly connected with infant death at 5% confidence level. As expected, infant mortality rate was higher among infants residing in households used non-improved drinking water 81 deaths per thousand live births, whereas lower among infants residing in households used improved drinking water 43 deaths per thousand live births.

Table 4.2.1: Levels and Differentials of Infant Mortality Rates by the Study Variables

Variables	Infant live births	Survival Status		Infant mortality rate (Per 1000 live births)	Sig (χ^2)
		Alive	Dead		
Mother's education					0.000 (23.231)
No education	617	89.5 (552)	10.5 (65)	105.0	
Basic/Primary	310	96.5 (299)	3.5 (11)	35.0	
Secondary +	182	97.8 (178)	2.2 (4)	22.0	
Mother's employment					0.000 (17.643)
Employed	499	89.2 (445)	10.8 (54)	108.0	
Not employed	610	95.7 (584)	4.3 (26)	43.0	
Family income					0.000 (20.997)
Low income	562	90.6 (509)	9.4 (53)	94.0	
Medium income	289	91.3 (264)	8.7 (25)	87.0	
High income	258	99.2 (256)	0.8 (2)	8.0	
Family size					0.238 (2.871)
≤ 4 persons	77	96.1 (74)	3.9 (3)	39.0	
5-6 persons	332	94.0 (312)	6.0 (20)	60.0	
7 persons or more	700	91.9 (643)	8.1 (57)	81.0	
Zone of residence					0.965 (0.071)
Northern zone	357	92.7 (331)	7.3 (26)	73.0	
Central zone	333	93.1 (310)	6.9 (23)	69.0	
Southern zone	419	92.6 (388)	7.4 (31)	74.0	
Mothers age at first birth					0.174 (4.970)
15 – 19 years	399	92.5 (369)	7.5 (30)	75.0	
20 – 24 years	323	94.7 (306)	5.3 (17)	53.0	
25 – 29 years	263	92.8 (244)	7.2 (19)	72.0	
30 + years	124	88.7 (110)	11.3 (14)	113.0	
Parity					0.000 (25.783)
1 - 3 children	487	94.3 (459)	5.7 (28)	57.0	
4 - 5 children	351	96.0 (337)	4.0 (14)	40.0	
6 + children	271	86.0 (233)	14.0 (38)	140.0	
Birth order					0.000 (109.700)
first birth order	88	68.2 (60)	31.8 (28)	318.0	
2-3 birth order	402	99.8 (401)	0.2 (1)	2.0	
4 + birth order	619	91.8 (568)	8.2 (51)	82.0	
Preceding birth interval					0.000 (86.618)
First birth	88	68.2 (60)	31.8 (28)	318.0	
< 24 months	990	94.8 (939)	5.2 (51)	52.0	
24 + months	31	96.8 (30)	3.2 (1)	32.0	
Sex of the infant					0.121 (2.409)

Male	545	91.6 (499)	8.4 (46)	84.0	
Female	564	94.0 (530)	6.0 (34)	60.0	
Source of drinking water					0.045 (4.022)
Improved sources	253	95.7 (242)	4.3 (11)	43.0	
Non-improved sources	856	91.9 (787)	8.1 (69)	81.0	
Type of toilet facility					0.015 (5.879)
Improved toilets	278	96.0 (267)	4.0 (11)	40.0	
Non-improved toilets	831	91.7 (762)	8.3 (69)	83.0	
Source of cooking fuel					0.224 (2.988)
Low polluting fuel	117	94.9 (111)	5.1 (6)	51.0	
Medium polluting	510	91.4 (466)	8.6 (44)	86.0	
High polluting	482	93.8 (452)	6.2 (30)	62.0	
Type of floor of the house					0.000 (26.152)
Natural floor	641	89.4 (573)	10.6 (68)	106.0	
Furnished floor	468	97.4 (456)	2.6 (12)	26.0	
Place of delivery					0.000 (76.403)
At hospital	577	99.3 (573)	0.7 (4)	7.0	
At home	532	85.7 (456)	14.3 (76)	143.0	
Breastfeeding duration					0.000 (12.881)
Less than 6 months	576	90.1 (519)	9.9 (57)	99.0	
6 + months	533	95.7 (510)	4.3 (23)	43.0	

Definitely, an improved toilet facility is a major health care perform and also decreases infant mortality. Type of toilet facility was significantly associated with infant mortality at 5% confidence level. As expected, infant mortality rate was lower among infants residing in households used improved toilet facility 40 deaths per thousand live births at the same time as higher among infants residing in households used unimproved toilet facility 83 deaths per thousand live births.

The results in (Table 4.2.1) showed that type of cooking fuel was not significantly associated with infant mortality at 5% confidence level. Unexpected, infant death rate was higher among infants for mothers residing in households used medium polluting fuel 86 deaths per thousand live births at the same time as lower among infants for mothers residing in households used low and high polluting fuels 51 and 62 deaths per thousand live births, consecutively.

From (Table 4.2.1) it was clear that type of the floor of the house was significantly connected with infant mortality at 5% confidence level. The results found that rate of infant death was lower among infants residing in households with furnished floor 26 deaths per thousand live births, while higher among infants residing in households with natural floor 106 deaths per thousand live births.

Place of delivery is also a vital determinant of infant survival. The results in (Table 4.2.1) showed that place of delivery was significantly linked with infant mortality at 5% confidence level. As expected, infant mortality rate was lower among infants born at hospitals 7 deaths per thousand live births at the same time as higher among infants born at home 143 deaths per thousand live births. This result implies that continued existence is higher among infants delivered in good hospitals and prepared by specialized medical doctors than infants delivered at home prepared by unqualified dais.

From (Table 4.2.1) it was distinctly that duration of breastfeeding was significantly linked with infant mortality at 5% confidence level. As expected, rate of infant death was lower among infants who have breastfed 6+ months 43 deaths per thousand live births at the same time as higher among infants who have breastfed less than 6 months 99 per thousand live births. Several prior studies by DaVanzo and Habicht (1986)^[7], Preston (1976)^[16] and Preston (1980)^[17] confirmed that shorter breastfeeding duration higher infant mortality rate.

4.3. Percentage Distribution of Child live births (12-59 months) by the Study Variables

The results in (Table 4.3.1) showed that, majority (90.9%) of the children were alive, while slightly (9.1%) were died. According to education of the mother, the results showed that more than half (58.4%) of the children for mothers with no education, (26.4%) for mothers with primary education, while slightly (15.2%) for mothers with at least secondary education level. In respect to mother's employment, the results showed that (55.5%) of the children for mothers who were not employed, whereas (44.5%) for mothers who were employed. Family income is one of the most essential determinants of standard of living and social welfare. The results in (Table 4.3.1) demonstrated that (52.1%) of the children belonged to households with low income, (25.7%) belonged

to households with medium income, while (22.2%) belonged to households with high income. Regarding to family size, the outcomes showed that majorities (64.6%) of the children belonged to households with family size of 7+ persons, (31.7%) belonged to households with 5-6 persons, while slightly (3.7%) belonged to households with ≤ 4 persons. Zone of residence is a major factor of child survival. The results showed that, (38.5%), (29.1%) and (32.4%) of the children residing in Southern, Northern and Central zones, respectively.

With regard to age of the mother at first delivery which ranged between 15 to 49 years, the results showed that (29.9%) of the children for mothers aged (15-19 years), (28.6%) for mothers aged 20-24 years, (28.2%) for mothers aged 25-29 years, while slightly (13.3%) for mothers aged 30 years or more. Results of parity showed that (34.4%) of the children belonged to parity 1-3, (36.0%) belonged to parity 4-5, while (29.6%) belonged to parity 6 children or more. With regard to birth order, the results showed that, slightly (18.9%) of the children belonged to first birth order, (40.4%) belonged to birth order 2-3, while (40.7%) belonged to birth order 4+. Previous birth space is the major factors that affect death during childhood. 45.5% of the children of preceding birth interval of less than 24 months, whereas (35.6%) of preceding birth interval of 24 months or more. Sex of the child is a very important determinant when studying child death. the results revealed that, (54.0%) of the children were females, while (46.0%) of the children were males.

Source of drinking water as an environment aspect within which children live has an effect on their health. The results showed that majority (81.3%) of the children residing in households relying on non-improved water, while slightly (18.7%) residing in households relying on improved sources of water. Without doubt, type of toilet facility also plays a great role as an environment aspect within which children live and interact. The results showed that (78.8%) of the children residing in households used non-improved toilet, while only (21.2%) residing in households used improved toilet facility.

Type of cooking fuel as an environment aspect and has an effect on child survival, as a lot of children are risky to deadly contaminants from the use of unrefined biomass fuel from wood and charcoal. The results showed that approximately (48.0%) of the children residing in households used high polluting fuel (firewood) for cooking, (42.0%) residing in households used medium polluting fuel (charcoal), while minority (10.0%) residing in households used low polluting fuel (gas). Type of floor of the house as an environment aspect, the outcomes demonstrated that greater part (62.2%) of the children residing in households with natural floor, while (37.8%) residing in households with furnished floor.

Place of delivery is an essential determinant of child continued existence. The results of place of delivery showed that more than half (52.3%) of the children were delivered at home, while (47.7%) delivered at hospitals. The results of breastfeeding duration also showed that majority (99.5%) of the children breastfed 6+ months, while slightly (0.5%) breastfed less than 6 months.

Table 4.3.1: Percentage Distribution of Child live births by the Study Variables

Variables	No. of Children	Percentage
Children survival status		
Alive	2027	90.9
Dead	202	9.1
Mother's education		
No education	1303	58.4
Basic/Primary	588	26.4
Secondary +	338	15.2
Mother's employment		
Employed	992	44.50
Not employed	1237	55.50
Family income		
Low income	1161	52.1
Medium income	572	25.7
High income	496	22.2
Family size		
≤ 4 persons	83	3.7
5 – 6 persons	706	31.7
7 persons or more	1440	64.6
Zone of residence		
Northern zone	722	32.4
Central zone	649	29.1
Southern zone	858	38.5

Mother age at first birth		
15 – 19 years	667	29.9
20 – 24 years	637	28.6
25 – 29 years	628	28.2
30 + years	297	13.3
Parity		
1 - 3 children	766	34.4
4 - 5 children	804	36.0
6 + children	659	29.6
Birth order		
First birth order	422	18.9
2-3 birth order	900	40.4
4 + birth order	907	40.7
Preceding birth interval		
First birth	422	18.9
< 24 months	1014	45.5
24 + months	793	35.6
Sex of the child		
Male	1026	46.0
Female	1203	54.0
Drinking water source		
Improved water	416	18.7
Non-improved water	1813	81.3
Type of toilet facility		
Improved toilet facility	473	21.2
Non-improved toilet facility	1756	78.8
Source of cooking fuel		
Low polluting fuel	221	10.0
Medium polluting	937	42.0
High polluting	1071	48.0
Type of floor of the house		
Natural floor	1387	62.2
Furnished floor	842	37.8
Place of Delivery		
At hospital	1063	47.7
At home	1166	52.3
Duration of breastfeeding		
Less than 6 months	11	0.5
6 + months	2218	99.5

4. 4. Levels and Differentials of Child Mortality Rates by the Study Variables

Child mortality rate is completely believed to be one of the pointers of a country's wellbeing, since it reveals socioeconomic situations in which children live as well as their health care. The results in (Table 4.4.1) showed that mother's level of education was significantly associated with child mortality at 5% confidence level. As expected, child mortality rate was lower among children for mothers with primary and at least secondary level of education 73 and 21 deaths per thousand live births, respectively, at the same time as higher among children for mothers with no education 117 deaths per thousand live births. Educated mothers are more expected to have prenatal care to have delivery with some medicinal attendants, and to have taken their kids at several time to visit a medical doctor. This finding is consistent with findings in earlier studies by Abed et al (2010) ^[1], Adepoju et al (2012) ^[2], Mojekwu & Mesike (2012) ^[13] and Mutunga (2004) ^[15].

The results in (Table 4.4.1) showed that mother employment was significantly linked with child mortality at 5% confidence level. As expected, child mortality rate was lower among children born to mothers who were employed 57 deaths per thousand live births, whereas higher among children born to mothers who were not employed 117 deaths per thousand live births. This justifies

that child mortality rate may be lower amongst children born to mothers who are working owing to the translation of the mothers' employment into higher financial resources which may be directed towards child welfare.

Family income is one of the most vital determinants of living standard, economic and social welfare. The results in (Table 4.4.1) showed that family income was significantly associated with child mortality at 5% confidence level. As expected, child mortality rate was lower among children belonged to households with high income 32 deaths per thousand live births, whilst higher among children belonged to households with low and medium income 114 and 94 deaths per thousand live births, respectively. Higher household income allows mothers to buy better food and cleaner water and provide better healthcare for their children. This result is agreed with results by Abol et al [8].

Table 4.4.1: Levels and Differentials of Child Mortality Rates by the Study Variables

Variables	Child live births	Survival Status		Child mortality rate (Per 1000 live births)	Sig (χ^2)
		Alive	Dead		
Mother's education					0.000 (32.944)
No education	1303	88.3 (1151)	11.7 (152)	117.0	
Basic/Primary	588	92.7 (545)	7.3 (43)	73.0	
Secondary +	338	97.9 (331)	2.1 (7)	21.0	
Mother's employment					0.000 (23.856)
Employed	992	94.3 (935)	5.7 (57)	57.0	
Not employed	1237	88.3 (1092)	11.7 (145)	117.0	
Family income					0.000 (28.101)
Low income	1161	88.6 (1029)	11.4 (132)	114.0	
Medium income	572	90.6 (518)	9.4 (54)	94.0	
High income	496	96.8 (480)	3.2 (16)	32.0	
Family size					0.127 (4.126)
≤ 4 persons	83	88.0 (73)	12.0 (10)	120.0	
5 - 6 persons	706	92.6 (654)	7.4 (52)	74.0	
7 persons or more	1440	90.3 (1300)	9.7 (140)	97.0	
Zone of residence					0.762 (0.543)
Northern zone	722	90.3 (652)	9.7 (70)	97.0	
Central zone	649	91.4 (593)	8.6 (56)	86.0	
Southern zone	858	91.1 (782)	8.9 (76)	89.0	
Mother's age at first birth					0.000 (79.133)
15 – 19 years	667	88.0 (587)	12.0 (80)	120.0	
20 – 24 years	637	94.3 (601)	5.7 (36)	57.0	
25 – 29 years	628	95.9 (602)	4.1 (26)	41.0	
30 + years	297	79.8 (237)	20.2 (60)	202.0	
Parity					0.000 (47.585)
1 - 3 children	766	87.6 (671)	12.4 (95)	124.0	
4 - 5 children	804	96.5 (776)	3.5 (28)	35.0	
6 + children	659	88.0 (680)	12.0 (79)	120.0	
Birth order					0.000 (156.684)
First birth order	422	78.0 (329)	22.0 (93)	220.0	
2-3 birth order	900	98.8 (889)	1.2 (11)	12.0	
4 + birth order	907	89.2 (809)	10.8 (98)	108.0	
Preceding birth interval					0.000 (108.986)
First birth	422	78.0 (329)	22.0 (93)	220.0	
< 24 months	1014	93.0 (943)	7.0 (71)	70.0	
24 + months	793	95.2 (755)	4.8 (38)	48.0	
Sex of the child					0.103 (2.661)
Male	1026	89.9 (922)	10.1 (104)	101.0	
Female	1203	91.9 (1105)	8.1 (98)	81.0	
Source of drinking water					0.000 (13.917)
Improved sources	416	95.7 (398)	4.3 (18)	43.0	
Non-improved sources	1813	89.9 (1629)	10.1 (184)	101.0	

Type of toilet facility					0.000 (12.850)
Improved toilet facility	473	95.1 (450)	4.9 (23)	49.0	
non-improved toilet facility	1756	89.8 (1577)	10.2 (179)	102.0	
Source of cooking fuel					0.001 (14.970)
Low polluting fuel	221	94.1 (208)	5.9 (13)	59.0	
Medium polluting	937	93.0 (871)	7.0 (66)	70.0	
High polluting	1071	88.5 (948)	11.5 (123)	115.0	
Type of floor of the house					0.000 (56.301)
Natural floor (earth)	1387	87.4 (1212)	12.6 (175)	126.0	
Furnished floor	842	96.8 (815)	3.2 (27)	32.0	
Place of Delivery					0.000 (162.647)
At hospital	1063	99.1 (1053)	0.9 (10)	9.0	
At home	1166	83.5 (974)	16.5 (192)	165.0	
Duration of breastfeeding					0.000 (27.750)
Less than 6 months	11	45.5 (5)	54.5 (6)	545.0	
6 + months	2218	91.2 (2022)	8.8 (196)	88.0	

The results in (Table 4.4.1) showed that family size was insignificantly connected with child mortality at 5% confidence level. Child death rate was 74 deaths per thousand live births lower among children belonged to family size 5-6 persons at the same time as higher among children belonged to family size ≤ 4 and 7+ person 120 and 97 deaths per thousand live births, in that order. Furthermore, (Table 4.4.1) showed that zone of residence was not significantly linked with child mortality at 5% confidence level. Rate of child death was 97 deaths per thousand live births higher among children residing in northern zone, whereas lower among children residing in southern and central zones 89 and 86 deaths per thousand live births, consecutively.

The outcomes in (Table 4.4.1) showed that mother's age at first birth was significantly associated with child mortality at 5% confidence level. As anticipated, child death rate was higher among children for older and younger mothers aged 30+ and 15-19 years 202 and 120 deaths per thousand live births while lower among children for mothers aged 20-24 and 25-29 years 57 and 41 deaths per thousand live births, respectively. This finding is confirmed in earlier study by Adepoju et al (2012) [2].

The results in (Table 4.4.1) showed parity was significantly associated with child mortality at 5% confidence level. As expected, child mortality rate was higher among children belonged to parity (1-3) and parity 6+ 124 and 120 deaths per thousand live births, consecutively while lower among children belonged to parity (4-5) 35 deaths per thousand live births.

The results showed that birth order was significantly associated with child mortality at 5% confidence level. First and higher birth orders have higher child death rate. As expected, child mortality rate was higher 220 deaths and 108 deaths per thousand live births for first order birth and high order birth 4 or more at the same time as lower 12 deaths per thousand live births for birth order 2-3. The augment in the child mortality with birth order might reveal a more strong rivalry faced by higher delivery order children in phrases of care provider time, medical wealth, and nourishing food whilst children required.

The results in (Table 4.4.1) showed that preceding birth space was significantly linked with child mortality at 5% confidence level. As expected, child death rate was higher amongst children of previous birth space less than 24 months 48 deaths per thousand live births whereas lower amongst children of preceding birth space of 24 or more months 70 deaths per thousand live births. This finding is corroborated with findings by Mondal et al (2009) [14].

The results in (Table 4.4.1) showed that sex of the child was not significantly associated with child mortality at 5% confidence level. As expected, child death rate was higher among males 101 deaths per thousand live births, whereas lower among females 81 deaths per thousand live births.

Observably, source of drinking water was significantly associated with child mortality at 5% confidence level. As expected, child death rate was 101 deaths per thousand live births higher among children residing in households used non-improved drinking water at the same time as lower among children residing in households used improved drinking water 43 deaths per thousand live births. This justifies that the higher rate may be as a result of used dirty water from non-improved sources of drinking water. This finding is confirmed by the studies by Mojekwu & Mesike (2012) [13] and Mutunga (2004) [15].

The results in (Table 4.4.1) showed that type of toilet facility was significantly associated with child mortality at 5% confidence level. As expected, child mortality rate was lower amongst children residing in households used improved toilet facility 49 deaths per thousand live births, while higher amongst children residing in households used non-improved toilet 102 deaths per thousand live births. This result is agreed with previous studies by Mojekwu & Mesike (2012) [13] and Mutunga (2004) [15].

The result in (Table 4.4.1) showed that source of cooking fuel was significantly connected with child mortality at 5% confidence level. As expected, child mortality rate was lower among children residing in households used low polluting fuel 59 per thousand live births at the same time as higher among children residing in households used higher and medium polluting fuel 115 and 70 deaths per thousand live births, respectively. This finding is consistent with findings by Mojekwu & Mesike (2012) ^[13] and Mutunga (2004) ^[15].

Type of floor of the house was significantly linked with child mortality at 5% confidence level. As expected, child mortality rate was lower among children residing in households with furnished floor 32 deaths per thousand live births whereas higher among children residing in households with natural floor 126 deaths per thousand live births. This gives good reason for natural floor being host of germs.

Also, the outcomes in (Table 4.4.1) showed that place of delivery was significantly associated with child mortality at 5% confidence level. As expected, child mortality rate was lower among children who were delivered at hospitals 9 deaths per thousand live births, while higher among children who were delivered at home 165 deaths per thousand live births. Higher rate for children delivered at home justifies that most of the mothers do not have knowledge about the benefits of delivery in health institutions i.e. hospitals, health centers, clinic, etc., which provide medical care for them and their children before and after birth. This finding is consistent with findings by Adepoju et al (2012) ^[2].

Furthermore, the results in (Table 4.4.1) showed that duration of breastfeeding was significantly associated with child death at 5% confidence level. As expected, child mortality rate was lower amongst children who have breastfed 6 months or more 88 deaths per thousand live births, while higher amongst children who have breastfed less than 6 months 545 deaths per thousand live births. This finding is agreed with findings by Adepoju et al (2012) ^[2].

5. CONCLUSION AND RECOMMENDATION

Infant and child mortality rates are completely believed to be one of the indicators of a state's welfare, since it reveals socioeconomic circumstances in which infants and children reside as well as their health care. The findings of Chi-square test showed that mother education, mother employment, family income, parity, birth order, preceding birth interval, drinking water source, type of toilet facility, type of floor of the house, place of delivery and breastfeeding duration were significantly linked with both infant and child mortality. Age of mother at first birth and cooking fuel source were significantly linked with child mortality. The findings of direct method of estimation showed that higher levels of infant and child mortality rates were among infants and children born to mothers with no education (105 and 117 per 1000), infants and children in households with low income (94 and 114 per 1000), infants and children born to mothers aged 30 years or more (113 and 202 per 1000), infants and children belonged to first birth order (318 and 220 per 1000), infants and children belonged to preceding birth interval less than 24 months (52 and 70 per 1000), male infants and children (84 and 101 per 1000), infants and children residing in households used non-improved water (81 and 101 per 1000), infants and children residing in households used non-improved toilet facility (83 and 102 per 1000), infants and children residing in households with natural floor (106 and 126 per 1000), infants and children delivered at home (143 and 165 per 1000) and infants and children breastfed less than 6 months (99 and 545 per 1000). Besides, higher levels of infant mortality rates were among infants born to mothers who were employed (108 per 1000), infants belonged to family size 7 persons or more (81 per 1000), infants living in Southern zone (74 per 1000), infants belonged to parity 6 or more (140 per 1000), infants residing in households used medium polluting fuel (86 per 1000). Furthermore, higher levels of child mortality were among children for mothers who were not employed (117 per 1000), children belonged to family size ≤ 4 persons (120 per 1000), children living in Northern zone (97 per 1000), children belonged to parity 1-3 (124 per 1000), children residing in households used high polluting fuel (115 per 1000). These findings will assist planners and policy makers to take suitable decision to lower the rates of infant and child mortality not only of Malakal but also entire regions of South Sudan. The study recommends that infant and child mortality need to be a regular area of serious attention for the government and researchers, because of its influence on the country's population structure in the future.

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