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Socio-Demographic Variations on Age-Sex Mortality in Namibia: An Analysis of the 2016 Civil Registration and Vital Statistics Data

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ABSTRACT

Mortality studies are important for the effectiveness of subsystem of health services in a country. Before the Coronavirus pandemic outbreak, there has been a gradual decline in the global mortality indicators, which can be linked to the improving economic development and social wellbeing of the global population, especially, in developing regions such as East Asia and the Pacific, Latin America and the Caribbean, Eastern Europe and the Middle East. This decline in mortality and the high fertility in developing countries are the contributing factors to the increase on global population. Apart from the aggregated frequencies of deaths and crude death rates reported in population census reports, little to no attention has been paid to detailed inference mortality analysis with respect to the age-sex variation perspective in Namibia. Thus, this paper used the negative binomial regression modelling technique to perform an inference mortality analysis across all ages and both sexes in the country as well as across regions and marital status using the 2016 Civil Registration Vital systems data from the Ministry of Home Affairs and Immigration. Results showed that there was a significant relationship between mortality and the individuals' age, sex, marital status and region. In addition, Oshana, Kavango East, Khomas, Hardap and Omaheke regions had high mortality rates, while infants and elderly individuals had a high probability of dying. Furthermore, the study revealed that individuals who were single and aged 15-59 and 5-14 years had less expected death count. Hence, it is recommended that interventions (such as affordable and proper health care and well-being services) targeted at the (most) vulnerable age groups, marital group and regions be made a priority, in order to meet Sustainable Development Goal 3.

1. Introduction

Mortality can be defined as the deaths in a given population (Weeks, 2014) or the deaths recorded in a particular population due to a specific cause and at a specific period of time (Porta, 2014). There are two biological components of mortality: (i) the lifespan component - the oldest age to which human beings can survive; (ii) the longevity component - the ability of people to resist death (Weeks, 2014). Weeks (2014) further stressed that the associated mortality impact can be caused by multiple infectious diseases such as communicable diseases (like Tuberculosis and Human Immuno-deficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS)), non-communicable diseases (like cancer and degenerative diseases) and deaths due to accidental and intentional injuries (like vehicle accidents, homicide and suicide). There are six types of mortality indicator, depending on the time death has occurred. The first indicator is infant mortality which is the number of deaths of children under 1 year per 1000 live births in a population (United Nations, 2019). This indicator can also be used to examine the risk of infant death at the vulnerable stage of life (i.e., less than 1 year old). The second indicator is child mortality which is the number of children dying under the age of 5 years per 1000 live births in a population (United Nations, 2012), while the third indicator is the older children death for children aged 5 to 14 years (United Nations, 2019). The fourth indicator is the youth mortality for persons aged 15 to 34 years old, while the fifth and sixth indicators are the adult mortality for persons aged 35 to 64 years old and the old age mortality for persons over 65 years respectively (United

Nations, 2019).

Mortality measures are important as they can provide information that are useful for development levels of the country in terms of healthy lives and well-being for all at all ages. From the Millennium Summit of 2000 to the Sustainable Development Summit of 2015, the United Nations as well as the global community made it their agenda to promote good health and fight against several leading causes of death and diseases. The global burden of disease studies of 1990 and 2000 estimated that Sub-Saharan Africa has the highest burden of disease in the world (WHO, 2000). These and other related studies revealed that the high levels of mortality were resulted from multiple diseases. When looking at the age and sex specific mortalities globally, as life expectancy increased and people survived in large numbers to older ages, most societies experienced less variability in the ages at which the people died, while women generally live longer than men due to several factors including the basic biological superiority in the ability of females to survive longer than males (Weeks, 2014). In developed countries the life expectancy of people is high as compared to the people of developing countries of the world (Khan & Khan, 2016). Males had a global average life expectancy of 70 years and females had a global average life expectancy of 75 years in 2020 (Statista, 2021). Males lived an average of 79 years and females lived an average of 82 years in more developed countries (United Nations, 2019). The situation is different for developing countries, males had a life expectancy of 63 years and females had a life expectancy of 67 years (United Nations, 2019). Closer to home, males in South Africa were 60 years old and females were 67 years (Statistics South Africa, 2014).

In Namibia (Republic of Namibia, 1994), the age specific mortality pattern had a less severe W-shape in 2011, like many other countries in Sub-Saharan Africa. This was because mortality rose among younger and middle aged adults due to the high prevalence of HIV/AIDS and these age groups were more at risk of contracting HIV infections (Namibia Statistics Agency (NSA), 2014). To be precise, the overall mortality pattern and rates had changed over time from 2001 to 2011, with the W-shape worsened between 2002 and 2006, and less severe in 2011. This was because of the decreasing impact of HIV/AIDS on mortality due to the introduction of health intervention programmes in the country (NSA, 2014). Apart from the aggregated frequencies of deaths and crude death rates reported in population census reports, little to no attention has been paid to detailed inference mortality analysis with respect to the age-sex variation perspective in Namibia. Thus, this paper examined the socio-demographic disparities in mortality in Namibia, as well as the difference in age-sex specific mortality. Findings from this study can provide a better understanding of how aggregating mortality by age and sex can help reveal the implausible mortality distributions from what would normally be expected with links to other socio-demographic factors in Namibia.

2. Methodology

2.1 Data source

The data used in this paper were extracted from the 2016 Civil Registration Vital Systems (CRVS) from the Ministry of Home Affairs and Immigration's Department of Civil Registration which is responsible for death records and issuance of death certificates. The CRVS data is collected by the Ministry of Home Affairs and Immigration (MHAI) as prescribed under the Births, Marriages and Deaths Registration Act 81 of 1963. This Act makes it mandatory for all events (deaths) to be registered in the country, and making an illegal act to bury a lifeless body without a death certificate and burial order. Once death has occurred, the MHAI is notified and the death is recorded on the registry. The information required on the death notification includes the date and place of death (region and constituency), name, and sex, date of birth, marital status and citizenship of the deceased. Further, the death notice indicates whether the death occurred in a hospital (and the name of medical practitioner) or some other places. Where the event happened out of state facilities (hospitals) or unnatural death is involved, the Namibian police ascertain the cause of death and recorded as such. The data are then captured in the system that is integrated with all regional offices. In addition to the CRVS data, data from the Namibia Intercensal Demographic Survey (NIDS) conducted in 2016 by NSA was used to estimate the population size in 2016 as well as for the mortality rates calculation.

2.1 Statistical analysis

In this paper, the socio-demographic differences in mortality were evaluated for four measures of mortality (life expectancy rates, crude death rates, age/sex specific death rates and probability of dying). The Crude Death Rate (CDR) can be defined as the total number of deaths in a year divided by the average total population expressed per a thousand people (Weeks, 2014). That is,

$$CDR = \frac{Total\ Number\ of\ deaths\ in\ a\ year}{Total\ Population} \times 1000$$

The Age/Sex Specific Death Rate (ASDR), used to account for the differences in dying by age and sex, can be defined as the number of deaths of people aged x years divided by the population aged x years expressed per a thousand people (Weeks, 2014). That is,

$$ASDR = \frac{{}_{n}d_x}{{}_{n}P_x} \times 1000$$

where ${}_{n}d_x$ is the number of deaths in a year of people of a particular age group (typically a five year age group) in the interval x to $x + n$, with x being the lower limit of the age interval and n representing the width of the interval, while ${}_{n}P_x$ is the average number of people of that age group in the midyear population. A life table, consisting of ages groups (grouped into five-year categories instead of single years of age), population of each age group and the number of deaths of each age group, estimates the probability of dying and the survivorship of individuals within a given population (Weeks, 2014). To be precise, it estimates the probability that persons at each age group die before their next birthdays and number of years that they are expected to live before dying.

Furthermore, a negative binomial regression model was fitted, in order to estimate the selected socio-demographic variables (age, sex, region and marital status) specific risk of mortality. Negative binomial regression model is a generalization of a Poisson regression model which loosens the restrictive assumption of the Poisson model that the variance is equal to the mean (NCSS, 2021). Both models are similar to the regular multiple regression model (Oyedele & Lubbe, 2018) except, here, the response variable (y) is an observed count with nonnegative integer values (Zwilling, 2013). With the negative binomial modelling, y follows the negative binomial distribution which is defined in terms of the number of trials until the r^{th} success (NCSS, 2021). This is slightly comparable to the binomial distribution, except in this distribution the number of successes is fixed while the number of trials is counted, whereas in the binomial distribution the number of trials is fixed while the number of successes is counted. Generally, the negative binomial regression model is specified as

$$ln(\mu) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_p x_p$$

for a set of predictor variables $x_1, x_2, \dots, x_p$, where μ is the mean of y (Oyedele & Lubbe, 2018), β_0 and $\beta_1, \dots, \beta_p$ are the intercept and unknown parameters that are estimated from a set of data respectively (NCSS, 2021). In this paper, the predictor variables were the individuals' age group in years (under 1, 1-4, 5-14, 15-59 & 60+), sex (male & female), region (!Karas, Erongo, Hardap, Kavango East, Kavango West, Khomas, Kunene, Ohangwena, Omaheke, Omusati, Oshana, Oshikoto, Otjozondjupa & Zambezi) and marital status (single, married, divorced, widowed & unknown), while the response variable was the number of mortality cases. Thus, y_{ijkl} being the number of mortality cases across sex i, region j, marital status k and age group l for $i = 1, 2,$ $j = 1, 2, \dots, 14$, $k = 1, 2, \dots, 5$, and $l = 1, 2, \dots, 5$ can be modelled as

$$\begin{aligned} ln(\mu_{ijkl}) = \beta_0 + \beta_1(Deaths\ by\ sex\ i) \\ + \beta_2(Deaths\ by\ regions\ j) \\ + (Deaths\ by\ marital\ status\ k) \\ + \beta_4(Deaths\ by\ age\ group\ l) \end{aligned}$$

where μ_{ijkl} is the mean of y_{ijkl}.

3.Results

3.1 Mortality distribution in Namibia

In 2016, a total of 19225 deaths were recorded in Namibia, out of which 10475 (54%) deaths were male deaths, while 8750 (46%) were female deaths as shown in Table 1. Looking at the mortality distribution by regions, it can be observed that there were more deaths in the highly populated and urbanised regions of Khomas (22.5%) and Oshana (18.9 %), while the lowest deaths were recorded in the Kavango West region (1.9%). Out of the 19225 recorded deaths, majority were recorded among the individuals who were single (73%), followed by those who were married (15%). In addition, there were more single and married males dying compared to their female counterparts as shown in Table 1. Moreover, the highest mortality recorded in 2016 was among the 15-59 age group (40.4%), followed by the 60+ years old age group (35.7%). In addition, there were slightly more male babies dying (8.8%) compared to female babies (7.9%)) among the infants (under 1 year) category, while the opposite is observed for the 60+ years age group.

Table 1: Mortality distribution across region, marital status, ages and sex in 2016

	Deaths by Sex		Both sexes	Chi-square & P-value
	Female	Male		
Region				
!Karas	258 (1.3%)	406 (2.1%)	664 (3.5%)	
Erongo	416 (2.2%)	598 (3.1%)	1014 (5.3%)	
Hardap	374 (1.9%)	507 (2.6%)	881 (4.6%)	
Kavango East	896 (4.7%)	983 (5.1%)	1879 (9.8%)	
Kavango West	176 (0.9%)	191 (1.0%)	367 (1.9%)	

Khomas	1920 (10.0%)	2403 (12.5%)	4328 (22.5%)	74.811 & <0.001
Kunene	222 (1.2%)	227 (1.2%)	449 (2.3)	
Ohangwena	628 (3.3%)	642 (3.3%)	1270 (6.6%)	
Omaheke	320 (1.7%)	432 (2.2%)	752 (3.9%)	
Omusati	814 (4.2%)	894 (4.7%)	1708 (8.9%)	
Oshana	1717 (8.9%)	1924 (10.0%)	3641 (18.9%)	
Oshikoto	166 (0.9%)	302 (1.6%)	468 (2.4%)	
Otjozondjupa	458 (2.4%)	572 (3.0%)	1031 (5.4%)	
Zambezi	385 (2.0%)	394 (2.0)	779 (4.1%)	
Marital status				
Single	6317 (32.9%)	7653 (39.8%)	13970 (72.7%)	582.896 & <0.001
Married	950 (5.0%)	1936 (10.1%)	2886 (15.0%)	
Divorced	62 (0.3%)	57 (0.3%)	119 (0.6%)	
Widowed	651 (3.4%)	198 (1.0%)	849 (4.4%)	
Unknown	16 (0.1%)	36 (0.2%)	52 (0.3%)	
Ages				
Under 1	1528 (7.9%)	1698 (8.8%)	3226 (16.8%)	551.794 & <0.001
1-4	443 (2.3%)	486 (2.5%)	929 (4.8%)	
5-14	187 (1.0%)	237 (1.2%)	424 (2.2%)	
15-59	3102 (16.1%)	4673 (24.3)	7775 (40.4)	
60+	3490 (18.2%)	3381 (17.6%)	6871 (35.7%)	

3.2 Mortality rates

Table 2 shows the crude death rate estimated for each region and for the whole country. The Oshana region can be seen to have the highest crude death rate of 19.2 per 1000 people followed by the Kavango East, Khomas, Hardap and Omaheke regions with 12.66, 10.4, 10.1 and 10.08 deaths per 1000 people respectively.

Table 2: Crude Death Rates per region

Regions	Population	Number of deaths	CDR
!Karas	85 759	664	7.74
Erongo	182 402	1014	5.56
Hadarp	87 186	881	10.10
Kavango East	148 466	1879	12.66
Kavango West	89 313	367	4.11
Khomas	415 780	4323	10.40
Kunene	97 865	449	4.59
Ohangwena	255 510	1270	4.97
Omaheke	74 629	752	10.08
Omusati	249 885	1708	6.84
Oshana	189237	3641	19.24
Oshikoto	195 165	468	2.40
Otjozondjupa	154 342	1030	6.67
Zambezi	98 849	779	7.88
Namibia	**2324388**	**19225**	**8.27**

3.3 Age-specific mortality rates

The age specific death rate was calculated for all the age groups and are shown in Table 3. It can be seen that the under 1 year age group had the highest age specific death rate of 47.6% followed by the 60+ years old age group with 47.1%, both of which are the most vulnerable to conditions that are major causes of death. The lowest age specific death rate was for the age group 5-14 years (0.8%), followed by the 1-4 years (3.7%), both of which are the less vulnerable to conditions that are major causes of death.

Table 3: Age Specific Mortality Rates, Namibia, 2016

Age Group	Female Deaths (Population size)	Male Deaths (Population size)	Total Deaths (Population size)	ASDR
Under 1	1528 (33319)	1698 (34417)	3226 (67735)	47.6
1-4	443 (125826)	486 (128365)	929 (254189)	3,7
5-14	187 (260436)	237 (263834)	424 (524270)	0,8
15-59	3102 (688781)	4673 (630687)	7775 (1332331)	5,8
60+	3490 (31964)	3381 (59589)	6871 (145861)	47.1
Namibia	**8750 (1194634)**	**10475 (1129754)**	**19225 (2 324 388)**	**8.27**

3.4 Life Table

The life tables used in this paper were the abridged life tables showing the population of each age group and the number of deaths of each age group. Additionally, the age sex death rate for both females and males in 2016 were computed and shown in column 5 of Annexure 1 and 2, in order to get the probability of dying before reaching the next birthday (shown in column 6 of Annexure 1 and 2). From both Life Tables (Annexure 1 and 2) the probability of dying is slightly higher in the first ages of life compared to the middle-aged children and then progressively rises from young adult ages until the last age group which had the highest probability of dying (1.00). The expectation of life at birth for males in Namibia was 67.9 years while for females it was 70.1 years in 2016. That is, if all persons born in the year 2016 had the same risks of dying throughout their lives as those indicated by the age specific death rates in 2016, then their average age at death would be 69.7 years if males and 70.1 years if females. Furthermore, females were expected to live longer than males by 2.2 years as seen in Annexure 1 and Annexure 2.

3.5 Negative binomial regression results

With a significant p-value at a 5% level of significance, the individuals' age (p-value<0.001), region (p-value<0.001) and marital status (p-value<0.001) can be concluded to have a significant association with their risk of mortality, as shown in Table 1. Hence, all the associated variables were considered in the fitted negative binomial regression model and the resulting results shown in Table 4.

Table 4: Binomial regression output

	Estimate	Standard Error	P-value	Expected count	95% Confidence Interval for Expected count	
					Upper	Lower
(Intercept)	9.721	.0509	<0.001	16658.799	15078.287	18404.981
Sex						
Female	.012	.0148	.407	1.012	.983	1.042
Male	0			1		
Region						
!Karas	-.020	.0530	.706	.980	.884	1.087
Erongo	-.025	.0478	.607	.976	.888	1.072
Hardap	-.019	.0493	.705	.981	.891	1.081
Kavango East	.001	.0427	.989	1.001	.920	1.088
Kavango West	.061	.0634	.334	1.063	.939	1.204
Khomas	.007	.0391	.865	1.007	.932	1.087
Kunene	.010	.0593	.860	1.011	.900	1.135
Ohangwena	-.005	.0456	.919	.995	.910	1.088
Omaheke	-.026	.0512	.614	.975	.881	1.077
Omusati	.041	.0433	.347	1.042	.957	1.134
Oshana	.002	.0395	.962	1.002	.927	1.083
Oshikoto	-.025	.0586	.671	.975	.870	1.094
Otjozondjupa	.021	.0476	.656	1.021	.930	1.121

Zambezi	0			1		
Marital Status						
Divorced	.009	.0983	.927	1.009	.832	1.224
Married	-.033	.0399	.404	.967	.895	1.046
Other	.009	.0443	.837	1.009	.925	1.101
Single	-.128	.0378	.001	.880	.817	.948
Unknown	.098	.1437	.495	1.103	.832	1.462
Widowed	0			1		
Age						
<1 year	-2.221	.0239	<0.001	.109	.104	.114
1-4 years	-1.392	.0365	<0.001	.249	.231	.267
5-14 years	-1.222	.0511	<0.001	.295	.267	.326
15-59 years	-.577	.0183	<0.001	.561	.542	.582
60+ years	0			1		
(Scale)	1					
(Negative binomial)	1					

From Table 4, it can be concluded that the expected death count for individuals who were single (p-value=0.001) was 0.880 less compared to the expected count for the widowed individuals. Furthermore, the expected death count for individuals who were aged 15-59 years (p-value<0.001), 5-14 years (p-value<0.001) and 1-4 years (p-value<0.001) were 0.561, 0.295 and 0.249 respectively less compared to the expected count for the individuals aged 60+ years. In addition, the expected death count for the less than 1-year individuals (p-value<0.001) was 0.109 less compared to the expected count for the individuals aged 60+ years as shown in Table 4. Moreover, from Table 4, the estimate of the fitted negative binomial regression model was 1 which was greater than 0, and therefore suggest a present of over-dispersion (i.e., the variance was greater than the mean).

4. Discussion

From this study, there were more males dying in 2016, compared to the females. This mortality differential is quite usual because according to Weeks (2014) males were more likely to suffer from conditions that were major causes of death such as chronic diseases, car accidents, etc., and another interpretation of the mortality difference was the biological superiority in the ability of females to survive longer than males (Weeks, 2014). Similar patterns of females living longer than males have been observed since the 1991 and 2001 census, which led to females reporting less deaths compared to males (NSA, 2014). In addition, Oshana, Kavango East, Khomas, Hardap and Omaheke regions had high mortality rates, while infants and elderly individuals had a high probability of dying. Khomas and Oshana regions recorded the highest of number of deaths due to the fact that the two regions house the main referral hospitals in the country and patients are transferred from their respective regions for better treatment because some hospitals in most regions lack the adequate medical equipment needed for the treatment of their patients. This situation also explains the results from the Kavango East region because of the Rundu Intermediate State Hospital being the only nearby referral hospital within the surrounding geographical areas. Also, according to NSA (2016), these regions house the highest population percentage, especially the age group 15-59 years, who are reportedly more susceptible to different causes of deaths such as HIV/AIDS, car accidents, suicide, homicide, and etc. Furthermore, the study revealed that individuals who were single and aged 15-59 and 5-14 years had less expected death count. This is not surprising as infants and elderly individuals are the most vulnerable and fragile to different types of illnesses and conditions that are major causes of death.

5. Conclusions and recommendations

In conclusion, mortality variation was examined by the socio-demographic factors such as age, sex, marital status and region, with the number of deaths differing for each sex and males having reported more deaths compared to females. Mortality also differed for each age group and regions, with high percentages among infants (<1 year), and older ages (60+ years), as well as in the Oshana, Kavango East, Khomas, Hardap and Omaheke regions. Furthermore, the study revealed that individuals who were single and aged 15-59 and 5-14 years had less expected death count. Hence, it is recommended that interventions (such as affordable and proper health care and well-being services) targeted at the (most) vulnerable age groups, marital group and regions be immediately made available, in order to meet the third goal under the health-related sustainable development goals of the United Nations. In addition, further research is needed focusing on the specific cause of death in the population and the quality of health care in Namibia.

Annexes

Annex 1 Abridged Life Table of males for Namibia 2016

Age x	Number of males	Number of deaths	Size of cohort	Death rate	Probability of dying	Number of survivors to age x	Number of deaths at age x	Number of years lived between lx-0 and lx	Total years lived between 0 & x	Life Expectancy
under 1	34417	1698	1	0.0493	0.0474	100 000	4735	95975	6787333	67.9
0 - 4	128363	486	4	0.0038	0.0150	95 265	1430	377628	6691357	70.2
5 -9	143495	132	5	0.0009	0.0046	93 835	431	468100	6313729	67.3
10-14	120339	105	5	0.0009	0.0044	93 405	407	466007	5845629	62.6
15-19	120327	148	5	0.0012	0.0061	92 998	570	463565	5379623	57.8
20-24	114754	357	5	0.0031	0.0154	92 428	1427	458573	4916058	53.2
25-29	102474	453	5	0.0044	0.0219	91 001	1989	450032	4457486	49.0
30-34	81978	595	5	0.0073	0.0356	89 012	3173	437127	4007453	45.0
35-39	68080	690	5	0.0101	0.0494	85 839	4242	418589	3570326	41.6
40-44	55781	705	5	0.0126	0.0613	81 597	4998	395487	3151737	38.6
45-49	42449	631	5	0.0149	0.0717	76 598	5489	369268	2756250	36.0
50-54	33595	531	5	0.0158	0.0760	71 109	5406	342030	2386982	33.6
55-59	24109	563	5	0.0234	0.1103	65 703	7248	310394	2044952	31.1
60+	59589	3381		0.0567	1.0000	58 455	58455	1030242	1734558	29.7

Annex 2 Abridged Life Table of Females for Namibia 2016

Age x	No. of females	No. of death s	Size of cohort	Death rate	Probabil ity of dying	No. of survivors to age x	No. of deaths at age x	No. of years lived between lx-0 and lx	Total years lived between 0 & x	Life Expectancy
under 1	33319	1528	1	0.0459	0.0441	100 000	4414	96248	7013012	70.1
1--4	125826	443	4	0.0035	0.0140	95 586	1335	379141	6916764	72.4
5--9	141152	97	5	0.0007	0.0034	94 251	323	470448	6537623	69.4
10--14	119284	90	5	0.0008	0.0038	93 928	354	468756	6067175	64.6
15-19	122491	140	5	0.0011	0.0057	93 574	533	466538	5598420	59.8
20-24	119344	231	5	0.0019	0.0096	93 041	896	462965	5131881	55.2
25-29	106322	302	5	0.0028	0.0141	92 145	1299	457476	4668916	50.7
30-34	86875	441	5	0.0051	0.0251	90 846	2277	448535	4211440	46.4
35-39	72053	421	5	0.0058	0.0288	88 569	2550	436467	3762905	42.5
40-44	60720	385	5	0.0063	0.0312	86 018	2684	423381	3326438	38.7
45-49	48349	412	5	0.0085	0.0417	83 334	3477	407978	2903057	34.8
50-54	40663	366	5	0.0090	0.0440	79 857	3515	390500	2495079	31.2
55-59	31964	404	5	0.0126	0.0613	76 343	4677	370021	2104579	27.6
60+	84470	3490		0.0413	1.0000	71 666	71666	1734558	1734558.116	24.2

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