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ASSOCIATION BETWEEN RISK FACTORS AND MORTALITY IN PATIENTS WITH NON-COMMUNICABLE DISEASES IN EIGHT KENYAN COUNTIES: AN OBSERVATIONAL COHORT STUDY

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ABSTRACT

Objectives: The risk-factors associated with deaths from Non-Communicable Diseases (NCDs) have not been studied in Kenya. The objective of this study was to identify risk factors for death among patients diagnosed and treated for hypertension, diabetes and asthma.

Design, Setting and Subjects: A total of 639 individuals diagnosed and prescribed treatment for hypertension, diabetes or asthma were identified in a representative sample in eight Kenyan counties in 2016. The individuals were followed via three-monthly phone calls until 2019. Risk factors for mortality were quantified.

Main Outcome Measure: Mortality

Results: Of the 639 individuals studied 445 had hypertension of whom 43 died (9.6%), 69 patients had diabetes of whom 11 died (15.9%) and 113 had asthma of whom 7 died (6.2%). Significant risk factors for death were older age [OR= 1.033 (1.016, 1.050) p=0.0001]. There was a reduced risk by being female [OR= 0.442 (0.260, 0.750) p= 0.0025], having primary or secondary education [OR= 0.611 (0.420, 0.887) p= 0.0097], and belonging to a higher wealth quintile [OR= 0.787 (0.649, 0.953) p= 0.0143]. Risk factors not associated with mortality for all cases included county of residence, marital status, number of NCD patients in the household or numbers of NCDs per patient.

Conclusion: The risk factors of older age, male sex, no education and low wealth have been shown to have significant associations with mortality. Clinicians managing patients with these conditions should recognize that older male patients with no education and from the poorer households have the highest risk of mortality.

INTRODUCTION

Non-communicable diseases (NCDs), as defined by the World Health Organization (WHO) are a diverse group of diseases with prolonged duration and slower disease progression, attributable to a combination of genetic, physiological, environmental and behavioral factors.¹

Cardiovascular diseases (including hypertension and stroke), cancers, chronic respiratory diseases and diabetes are the main types of NCDs.¹ According to WHO, more than three quarters of global NCDs are concentrated in low- and middle-income countries; out of which almost 41 million people die each year, equivalent to 71% of all deaths globally are due to NCDs.¹

Kenya, like other LMICs, is undergoing an epidemiological transition marked by an increase in the burden of non-communicable diseases (NCDs) including diabetes, cancers, cardiovascular diseases and chronic respiratory infections and a decline in morbidity and mortality due to communicable conditions.⁴ In response to the escalating burden of NCD in Kenya, the government established an NCD division within the ministry of health. Kenya also launched a 5-year National NCD strategy in 2015 to guide the implementation of interventions to reduce the mortality from NCDs. To operationalize this strategy, it is important to understand the leading risk factors associated with mortalities related to

NCDs which the findings of this study will provide.⁵

A number of studies have reported prevalence and NCD mortality in urban areas with the focus on negative health behaviors and limited access to healthcare.^{6,7,8}

In describing a national study conducted in 2016, Turpin et al found that the prevalence of reported NCDs varied across eight surveyed counties and suggested that the reasons for this variation might be attributable to a lack of access to diagnostic facilities and/or differences in lifestyle risk factors.⁹

This study utilizes data from the Novartis Access evaluation that was undertaken between 2016 and 2019.^{10,11} This cluster randomized study aimed to evaluate the effect of providing a basket of NCD medicines at a low cost to individuals with common NCDs. In this study, we have analyzed data collected at baseline in 2016 on the cohort of households in eight counties in Kenya in which one or two of the members had been diagnosed with at least one NCD and prescribed an NCD medicine. This was combined with the data on mortality gathered from this cohort through telephone interviews as well as from face-to-face interviews conducted during midline and end line surveys. These calls and surveys identified individuals who were included at baseline who had died during the study.

The objective of this study was to assess the risk factors associated with mortality among patients diagnosed and treated for NCDs in Kenya.

METHODS

Study population and sampling: A description of the Novartis Access evaluation can be found elsewhere.^{10,11} This study occurred in eight counties of Kenya namely Narok, Kwale, Embu, Nyeri, Kakamega, West Pokot, Makueni and Samburu that were randomly allocated to be intervention or control counties. This study is a retrospective cohort study of individuals diagnosed and treated for NCDs who were followed from 2016 to 2019 to identify the etiological risk factors associated with mortality. The data on mortality was collected from 2016 to 2019 through surveys conducted in 2016, 2018 and 2019 and through regular telephone surveillance. The demographic and socio-economic risk factors investigated were age, sex, county of residence, education, marital status, being in the intervention or a control group for the Novartis Access evaluation study, household wealth quintiles with poorer households in the lower quintiles, number of NCD patients in the household and number of NCDs per patient. The household wealth quintiles were allocated based on the data collected on household wealth during the baseline survey. The outcome was a binary variable of death occurring between 2016 and 2019.

Data Analysis: Descriptive and analytical statistics were carried out using SAS Studio.

Frequency and chi-squared test was performed to generate descriptive statistics across baseline variables, and calculated p-values and confidence intervals were used to assess statistical significance. The p-values for mortality rates were calculated assuming equal variances.. Univariate logistic regression analysis was conducted to generate Unadjusted Odds Ratios, with associated 95% CI and p-values.

RESULTS

The total population of individuals at baseline in 2016 was 639, out of whom 62 died by the end of 2019. Those who reported Hypertension (HTN) as their 1st NCD, had a total population of n= 445, out of whom 43 died. The total population with Diabetes (DM) as their first reported NCD was n= 69, out of which 11 died and those with asthma as their first reported NCD had a total population of n= 113 with 7 deaths.

All Cases

The mean age (in years) for the study population was 58.49 ± 16.76 and the mean age of those who died was 66.29 ± 15.56 . This was a statistically significant difference. ($p=0.0001$). (Table 1).

The mortality rates N (%) as well as the corresponding p-values for the baseline descriptive variables are described in Table 1 below.

Table 1
Mortality across baseline descriptive variables for ALL cases (Categorical)

Risk factors	TOTAL POPULATION	INDIVIDUALS WHO DIED	P-VALUES²
	N (%)	N (%)	
All cases	639 (100)	62 (9.7)	-
Age (in years)¹	58.49 (16.76)	66.29 (15.56)	0.0001*
Average No. of family members per household¹	1.17 (0.44)	1.19 (0.44)	0.4849
Sex			
Male	199 (31.14)	30 (15.07)	0.002*
Female	440 (68.86)	32 (7.27)	
Missing	1		
County			
Narok	67 (10.88)	3 (4.48)	0.2623
Kwale	96 (15.58)	9 (9.36)	
Embu	98 (15.91)	6 (6.12)	
Nyeri	101 (16.40)	11 (10.89)	
Kakamega	93 (15.10)	5 (5.38)	
West Pokot	39 (6.33)	3 (7.69)	
Makueni	97 (15.75)	3 (3.09)	
Samburu	25 (4.06)	0	
Missing	24		
Marital status of respondent			
Single	33 (5.16)	3 (9.09)	0.5500
Married or living together	446 (69.80)	39 (8.74)	
Divorced or separated	27 (4.23)	4 (14.81)	
Widowed	133 (20.81)	16 (12.03)	
Missing	1		
Current marital status			
Yes	446 (69.80)	39 (8.74)	0.2135
No	193 (30.20)	23 (11.92)	
Missing	1		
Education			
None	173 (27.03)	27 (15.61)	0.0086*
Primary	302 (47.19)	23 (7.62)	
Secondary & above	165 (25.78)	12 (7.27)	
Intervention¹			
Intervention county	283 (45.94)	26 (9.19)	0.1510
Control county	333 (54.06)	14 (4.20)	
Missing	24		
Wealth quintile			
Quintile 1 (Low)	126 (19.72)	19 (15.08)	0.0605
Quintile 2	129 (20.19)	11 (8.53)	
Quintile 3	129 (20.19)	16 (12.40)	

Quintile 4	128 (20.03)	9 (7.03)	
Quintile 5 (High)	127 (19.87)	7 (5.51)	
Missing	1		
No of NCD patients in household	548 (85.76)	55 (10.04)	0.4842
1 NCD patient	91 (14.24)	7 (7.69)	
2 NCD patients	1		
Missing			
Number of NCDs per patient	539 (84.35)	49 (9.09)	0.4136
1 NCD	95 (14.87)	12 (12.63)	
2 NCDs	5 (0.78)	1 (20)	
Missing	1		

*indicates statistically significant p-values (p<0.05)

¹Mean (STD)

²indicates pooled p-value assuming equal variances

Gender showed statistically significant differences across males and females with the mortality rate being 15% among males as compared to 7.3% among females (p-value=0.002). From figure 1, we can see that males had higher mortality rates for all cases, as well

for HTN, DM and Asthma as compared to females. However, there were statistically significant differences across males and females only for all cases (p=0.002) and hypertension (p=0.0019).

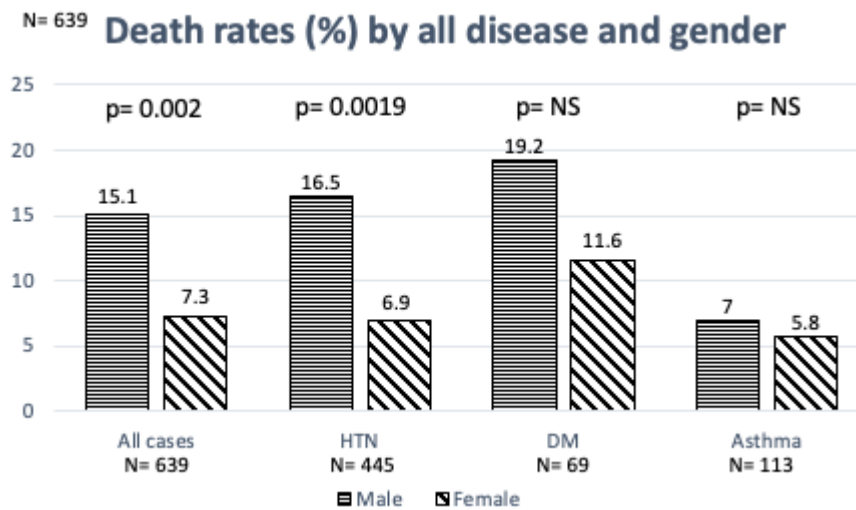


Figure 1: Death rates (%) by all diseases and gender

County of residence did not show statistically significant differences in death rates for all cases though the county of Nyeri reported the most deaths (10.9%), followed by Kwale (9.4%), Makueni (7.7%), Embu (6.1%), Narok (4.5%) and Samburu (3.1%). Marital status did

not show statistically significant results; however, those who were divorced showed the highest mortality rates (14.8%), followed by those who were widowed (12%) and singles (9.1%). Those who were currently married had a lower death rate (8.7%) as

compared to those who were not currently married (11.9%).

Education was found to show statistically significant differences ($p= 0.0086$) with maximal death rates among those with no education (15.6%), followed by those with only primary education (7.6%), followed by those with secondary level education or above (7.2%)

The death rate was 9.2% among those who received the intervention and 4.2% among those who were in the control group, but this was not statistically significant different among the two groups. Wealth quintiles analysis appeared to show higher mortality among the poor though this was not statistically significant. The patients having 3 NCDs showed higher death rates (20%) as compared to those with 2 NCDs (12.6%) and those with 1 NCDs (9.1%).

Hypertension (HTN) Cases

Table S1 shows mortality across baseline descriptive variables among those who had HTN as their first reported NCD. Gender again showed statistically significant differences ($p= 0.0019$) with mortality rate

among hypertensive patients of 16.5% among males as compared to 6.9% among females. An average of 12.3% deaths were associated with HTN were reported from Kwale county, followed by 10% from Nyeri, 7% from Kakamega, 5.9% from Makueni, 5.7% from Narok, 5.2% from Embu and 2.5% from Samburu counties. County of residence did not show statistically significant differences in mortality rates. Single individuals had the highest mortality rates among those with HTN had 15.38% as compared to those who were divorced/ separated had 11.8%, widowed had 9.7%, and those who were married had the mortality rate of 9.3%. Education did not show statistically significant differences in mortality rates among those with HTN, however, those with no education had the highest death rate (14.1%) as compared to those with only primary education (8%) and those with secondary level or above education (7.7%). Those categorized as quintile 1 (poorest) of wealth quintiles had the highest death rate among those with HTN with 14.7% as compared to other wealth categories.

Table S1

Mortality across baseline descriptive variables among those who had Hypertension (HTN) as 1st reported NCD (Categorical)

Risk factors	1ST REPORTED NCD WAS HTN N (%)	INDIVIDUALS WHO DIED N (%)	P-VALUES
All cases	445 (100)	43 (9.67)	-
Sex			
Male	127 (28.54)	21 (16.54)	0.0019*
Female	318 (71.46)	22 (6.92)	
County			
Narok	35 (8.16)	2 (5.71)	0.3652
Kwale	57 (13.29)	7 (12.29)	
Embu	77 (17.95)	4 (5.19)	
Nyeri	80 (18.65)	8 (10)	
Kakamega	71 (16.55)	5 (7.04)	
West Pokot	17 (3.96)	1 (5.89)	
Makueni	81 (18.88)	2 (2.47)	
Samburu	11 (2.56)	0	
Missing	16	14 (87.5)	
Marital status of respondent			
Single	13 (2.92)	2 (15.38)	0.8902
Married or living together	302 (67.87)	28 (9.27)	
Divorced or separated	17(3.82)	2 (11.76)	
Widowed	113 (25.39)	11 (9.73)	
Current marital status			
Yes	302 (67.87)	28 (9.27)	0.6847
No	143 (32.13)	15 (10.49)	
Education			
None	128 (28.76)	18 (14.06)	0.1359
Primary	200 (44.94)	16 (8)	
Secondary & above	117 (26.29)	9 (7.69)	
Intervention¹			
Intervention	235 (54.78)	18 (7.66)	0.4140
Control	194 (45.22)	11 (5.67)	
Missing	16		
Wealth quintile			
Quintile 1	75 (16.85)	11 (14.67)	0.1807
Quintile 2	84 (18.88)	1 (1.19)	
Quintile 3	96 (21.57)	11 (11.46)	
Quintile 4	88 (19.78)	5 (5.68)	
Quintile 5	102 (22.92)	6 (5.89)	
No of NCD patients in household			
1 NCD patient	384 (86.29)	38 (9.90)	0.6765
2 NCD patients	61 (13.71)	5 (8.20)	

Number of NCDs per patient			
1 NCD	347 (77.98)	30 (8.65)	0.3426
2 NCDs	93 (20.90)	12 (12.90)	
3 NCDs	5 (1.12)	1 (20)	

¹Whether the county/patient belongs to an intervention county or control county

* indicates statistically significant p-values (p<0.05)

Diabetes (DM) Cases

Table S2 shows mortality across baseline descriptive variables among those who had DM as first reported NCD. The mortality rates among those with DM was 19.2% in males and 11.6% in females. Although the differences across levels of education, did not reach statistical significance, the highest death

rates were seen in those with no education (36.4%) followed by those with primary education (10.8%), followed by secondary level or above education (9.5%). Most of the other risk factors had very small numbers across the categories and hence we could not detect statistically significant results.

Table S2

Mortality across baseline descriptive variables among those who had Diabetes Mellitus (DM) as 1st reported NCD (Categorical)

Risk factors	1ST REPORTED NCD WAS DM N (%)	INDIVIDUALS WHO DIED N (%)	P-VALUES
All cases	69 (100)	11 (15.94)	
Sex			0.3847
Male	26 (37.68)	5 (19.23)	
Female	43 (62.32)	5 (11.63)	
Missing	1	1	
County			0.5575
Narok	15 (23.44)	-	
Kwale	7 (10.94)	-	
Embu	11 (17.19)	2 (18.18)	
Nyeri	9 (14.06)	1 (11.11)	
Kakamega	5 (7.81)	-	
West Pokot	8 (12.50)	1 (12.5)	
Makueni	5 (7.81)	1 (20)	
Samburu	4 (6.25)	-	
Missing	6	6	
Marital status of respondent			0.1704
Single	6 (8.70)	1 (16.66)	
Married or living together	55 (79.71)	6 (10.91)	
Divorced or separated	4 (5.80)	1 (25)	
Widowed	4 (5.80)	2 (50)	
Current marital status			0.0937
Yes	55 (79.71)	6 (10.91)	
No	14 (20.29)	4 (28.57)	

Education			
None	11 (15.94)	4 (36.36)	0.0793
Primary	37 (53.62)	4 (10.81)	
Secondary & above	21 (30.43)	2 (9.52)	
Intervention¹			
Intervention	29 (45.31)	3 (10.34)	0.4920
Control	35 (54.69)	2 (5.71)	
Missing	5	5	
Wealth quintile			
Quintile 1	14 (20.29)	3 (21.43)	0.1705
Quintile 2	15 (21.74)	-	
Quintile 3	9 (13.04)	3 (33.33)	
Quintile 4	17 (24.64)	3 (17.65)	
Quintile 5	14 (20.29)	1 (7.14)	
No of NCD patients in household			
1 NCD patient	59 (85.51)	8 (13.56)	0.5926
2 NCD patients	10 (14.49)	2 (20)	
Number of NCDs per patient			
1 NCD	68 (98.55)	10 (14.71)	0.6784
2 NCDs	1 (1.45)	-	
3 NCDs	-	-	

¹Whether the county/patient belongs to an intervention county or control county * indicates statistically significant p-values ($p < 0.05$)

Asthma Cases

Table S3 includes mortality across baseline descriptive variables among those who had asthma as first reported NCD had even more missing information and none of the risk factors showed significant results. For this disease, 7% of males and 5.8% of females died

due to asthma. The death rates were higher among those with no education (13.8%) as compared to those with secondary level or more education (4%) and those with primary education (3.5%).

Table S3*Mortality across baseline descriptive variables among those who had Asthma as 1st reported NCD*

Risk factors	1ST REPORTED NCD WAS ASTHMA N (%)	INDIVIDUALS WHO DIED N (%)	P-VALUES
All cases	113 (100)	6 (19)	
Sex			
Male	43 (38.39)	3 (6.98)	0.8019
Female	69 (61.61)	4 (5.78)	
Missing	1		
County			
Narok	15 (13.64)	-	0.3192
Kwale	30 (27.27)	2 (6.67)	
Embu	9 (8.18)	-	
Nyeri	11 (10)	2 (18.18)	
Kakamega	14 (12.73)	-	
West Pokot	12 (10.91)	1 (8.33)	
Makueni	9 (8.18)	-	
Samburu	10 (9.09)	-	
Missing	2	2 (100)	
Marital status of respondent			
Single	13 (11.61)	-	0.0055
Married or living together	79 (70.54)	3 (3.80)	
Divorced or separated	6 (5.36)	1 (16.67)	
Widowed	14 (12.50)	3 (21.43)	
Missing	1		
Current marital status			
Yes	79 (70.54)	3 (3.80)	0.0971
No	33 (29.46)	4 (12.12)	
Education			
None	29 (25.89)	4 (13.79)	0.1660
Primary	58 (51.79)	2 (3.45)	
Secondary & above	25 (22.32)	1 (4)	
Intervention¹			
Intervention	62 (56.36)	5 (8.06)	0.0682
Control	48 (43.64)	-	
Missing	2	2 (100)	
Wealth quintile			
Quintile 1	32 (28.57)	3 (9.38)	0.7385
Quintile 2	29 (25.89)	1 (3.45)	
Quintile 3	21 (18.75)	2 (9.52)	
Quintile 4	21 (18.75)	1 (4.76)	
Quintile 5	9 (8.04)	-	
No of NCD patients in household			
1 NCD patient	93 (83.04)	7 (7.53)	0.2168
	19 (16.96)	-	

2 NCD patients			
Number of NCDs per patient			
1 NCD	112 (100)	7 (6.25)	
2 NCDs	-	-	-
3 NCDs	-	-	-

¹Whether the county/patient belongs to an intervention county or control county

* indicates statistically significant p-values (p<0.05)

Regression Analysis

Table 2 shows the results of univariate logistic regression analysis for mortality rates all cases. We can see statistically significant results for age (p-value= 0.0001), sex (p-value= 0.0025), education (p-value= 0.0097) and wealth quintiles (p-value= 0.0143).

Older aged individuals have greater odds of death as compared to younger aged

individuals (OR= 1.03, 95% CI= 1.01-1.05). Females have lower odds of death than males (OR= 0.44, 95% CI= 0.26-0.75). Patients with primary or secondary education have lower odds of death as compared to those having no education (OR= 0.61, 95% CI= 0.42-0.89). Greater wealth also showed an association with lower mortality rates (OR= 0.79, 95% CI= 0.65-0.95).

Table 2

Univariate logistic regression analysis for all cases (n=639)

Risk factors	Odds Ratio ¹	95% CI	p-value
Age	1.033	1.016, 1.050	0.0001*
No. of family members per household	1.115	0.634, 1.962	0.7049
Sex	0.442	0.260, 0.750	0.0025*
County	0.891	0.758, 1.048	0.1630
Marital status of respondent	1.189	0.894, 1.580	0.2348
Education	0.611	0.420, 0.887	0.0097*
Intervention county	1.627	0.833, 3.180	0.1544
Wealth quintiles	0.787	0.649, 0.953	0.0143*
No. of NCD patients in household	0.747	0.329, 1.696	0.4859
No. of NCDs per patient	1.478	0.818, 2.673	0.1958

*indicates statistically significant p-values (p<0.05)

¹Unadjusted Odds Ratios

Table S4 shows the results of univariate logistic regression analysis for mortality among the 445 patients originally diagnosed with HTN.

Table S4
Univariate logistic regression analysis for patients with HTN (n=445)

Risk factors	Odds Ratio ¹	95% CI	p-value
Age	1.027	1.005, 1.049	0.0170*
No. of family members per household	1.246	0.657, 2.364	0.5006
Sex	0.375	0.198, 0.710	0.0026*
County	0.838	0.684, 1.027	0.0887
Marital status of respondent	0.993	0.700, 1.408	0.9682
Current marital status	0.872	0.450, 1.689	0.6848
Education	0.685	0.443, 1.058	0.0881
Intervention	1.380	0.635, 2.996	0.4157
Wealth quintiles	0.760	0.604, 0.958	0.0199*
No. of NCD patients in household	0.813	0.307, 2.154	0.6771
No. of NCDs per patient	1.581	0.847, 2.953	0.1505

* indicates statistically significant p-values ($p < 0.05$)

¹Unadjusted Odds Ratios

In this sub analysis, there were statistically significant results for age (p-value= 0.0170), sex (p-value= 0.0026) and wealth quintiles (p-value= 0.0199).

Older aged individuals with HTN had greater risk of death as compared to younger aged individuals (OR= 1.03, 95% CI= 1.01-1.05). Females had lower risk of death than males (OR= 0.38, 95% CI= 0.20-0.71). Patients with primary or secondary education had lower odds of death as compared to those having no education (OR= 0.61, 95% CI= 0.42-0.89). Risk factors not associated with mortality due to hypertension included county of residence, education, marital status, number of NCD patients in the household or numbers of NCDs per patient.

DISCUSSION

Among NCDs in Kenya, cardiovascular diseases and cancers have been the most common attributable risk factors for death; out of which deaths due to CVDs were the

second most common cause (29%).¹³ The Kenya Non-Communicable Diseases & Injuries Poverty Commission Report of 2018, recorded that NCDs were responsible for a large share of morbidity and mortality in Kenya, resulting in 37% of the overall burden of disease and 35% of all deaths.¹² Cardiovascular related mortality in Kenya ranges from 6.1% to 8%, while recent verbal autopsy studies suggest that more than 13% of cause-specific deaths among adults could be due to CVD.¹³ In our study, the majority of deaths were associated with hypertension followed by DM which is consistent with the literature from the Kenya STEPS survey report of 2015 which indicated that HTN is the leading cause of mortality in Kenya and a verbal autopsy study conducted in Kenya suggested that more than 13% of cause-specific deaths among adults could be due to CVDs.¹²

In our study, we found that mortality rates due to NCDs were higher among males as compared to females. This is consistent with a

similar study conducted among slum dwellers in Kenya that observed that comparatively, trends in NCD mortality among males and females had remained stable over time but showed a declining trend among females.¹⁴

Poverty is also linked with NCD mortality in LMICs. People with low socio-economic status and poor education have higher prevalence of acquiring and dying of NCDs.⁷ In our study, we found statistically significant results showing an association between low education, lower wealth and mortality. These findings also confirm the findings by The Kenya Non-Communicable Diseases & Injuries Poverty Commission Report of 2018 that reported that the poor suffer disproportionately from NCDs and that the proportion of deaths due to NCD is higher among the poorest as compared to wealthiest quintiles. Crude death rates among the poor were more than double those of the rich for NCDs.¹²

The strength of the study was that we could identify some of the risk factors for mortality due to NCDs which are in line with the literature. Further investigation and information need to be gathered to confirm the results across other Kenyan counties. Another limitation is that this study focused on sociodemographic risk factors for the three NCDs (HTN, DM and Asthma) and did not look at the behavioral, metabolic, physiological and physical risk factors for these NCDs during this study.

CONCLUSION

The risk factors of older age, male sex, no/poor education, and low wealth have been shown to have significant associations with mortality due to all NCDs and hypertension in Kenya. Clinicians managing patients with

these conditions need to be aware of these results and should recognize that older male patients with no education and from the poorer households have the highest risk of mortality. This could be attributable to the fact that with higher education the individual is more likely to be formally employed which would result in higher income and a higher probability of having health insurance coverage which consequently increases access to higher quality health care services. Poor households are at greater risk of NCD related deaths more than the affluent households which could be attributed to low access to healthcare services and healthcare information on NCD prevention and treatment. Addressing the risk factors associated with these diseases at the public health level may be a lower cost and better long-term solution to the problem of NCDs deaths in Kenya. Analysis and understanding of NCD risk factors by clinicians may present an entry point for policy solutions aimed at addressing these diseases.

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