Socioeconomic inequalities in hypertension in Kenya: A decomposition analysis of 2015 Kenya STEPwise survey on non-communicable diseases risk factors

Samwel Maina Gatimu 1*, Thomas Wiswa John 2.

Authors affiliation

1 School of Economics, University of Nairobi, Kenya

2 Medical Department, Mkinga District Council, Tanga, Tanzania

*Corresponding Author

Samwel Maina Gatimu, Email: gatimu.maina@gmail.com; ORCID: https://orcid.org/0000-0002-8331-4536
Abstract

Introduction: One in four Kenyans have raised blood pressure. Despite this high prevalence of hypertension and known association between socioeconomic status and hypertension, there is a paucity of evidence on inequality in raised blood pressure in Kenya. Hence, we quantified the socioeconomic inequality in hypertension in Kenya and decomposed the determinants contributing to such inequality.

Methods: We used data from the 2015 Kenya STEPwise survey for non-communicable diseases risk factors. We included 4,398 respondents aged 18–69 years. We estimated the socioeconomic inequality using the concentration index (C) and decomposed the C using Wagstaff decomposition analysis.

Results: The overall concentration index of hypertension in Kenya was $-0.08$ (95% CI: $-0.14$, $-0.02$; $p = 0.007$), showing socioeconomic inequalities in hypertension disfavouring the poor population. Half (52.8%) of the pro-rich inequalities in hypertension was explained by body mass index (52.8%) while 21.1% by socioeconomic factors (paid employment (9.3%), education (7.7%) and poorest wealth quintile (4.1%)) and 17.6% by demographic factors (female gender (11.8%), age (5.2%) and marital status (0.6%)). Regional differences explained 8.1% of the estimated inequality with the Central region alone explaining 6.9% of the observed inequality. Our model explained 98.3% of the estimated socioeconomic inequality in hypertension in Kenya with a small non-explained part of the inequality ($-0.001$).

Conclusion: The present study shows substantial socioeconomic inequalities in hypertension in Kenya, mainly explained by metabolic risk factors (body mass index), individual health behaviours, and socioeconomic factors. Kenya needs gender- and equity-focused interventions to curb the rising burden of hypertension and inequalities in hypertension.

Keywords: Socioeconomic Inequality, Hypertension, Kenya, NCDs, Inequalities, STEPwise, risk factors
Introduction

Low- and middle-income countries (LMICs) including Kenya bear the largest burden of non-communicable diseases (NCDs) [1]. High blood pressure is one of the risk factors of NCDs [2]. It affects about a third of the global population and causes an estimated 7.6 million premature deaths [1]. In Kenya, a quarter of the population is estimated to be hypertensive [3] and a half pre-hypertensive [4]. The prevalence of hypertension is higher among women and urban residents than among men and rural residents [5]. Hypertensive disease is associated with a high burden of out of pocket expenditure to patients and family with an annual cost of US$477 and contributing to 59% of the catastrophic healthcare costs [6].

Hypertension is associated with socioeconomic status. Low socioeconomic status is associated with a high prevalence of hypertension, and untreated and uncontrolled hypertension in LMICs [7-11]. However, this is not a consistent finding. For example, in Kenya, a study among urban adults found a high prevalence of hypertension among the richest individuals [12] while others studies have shown a high prevalence among the poor individuals [10, 11]. Besides, studies on socioeconomic inequalities in hypertension have also shown that both pro-poor and pro-rich inequalities exist in hypertension [9, 13, 14]. However, in Kenya, despite a high prevalence of hypertension, there is paucity of evidence on the socioeconomic inequalities and the factors contributing to these inequalities in hypertension. Understanding inequalities in hypertension is key to inform interventions to prevent hypertension and reduce premature mortality from hypertension by 25% by 2025 in line with the global [2] and national targets [15]. Therefore, this study quantified the socioeconomic inequality in hypertension in Kenya and decomposed the determinants contributing to such socioeconomic inequality.
Methods

Data and study population

The study used data from the nationwide 2015 Kenya STEPwise survey for non-communicable diseases and injury risk factors among adults aged 18–69 years in Kenya [3]. The details of the survey are published elsewhere [3]. Briefly, the survey used a three-stage cluster sample design; selection of 200 equally distributed urban and rural areas clusters, 30 sampled households from the selected clusters and random sampling of one member from all the listed households’ members in each household using a personal digital assistant. The WHO STEPwise approach to chronic disease risk factors surveillance–demographic and behavioural information, anthropometric and biochemical measurements–was adopted [3].

Measures

Hypertension, our main outcome variable was defined as “a systolic blood pressure of ≥140 mmHg and/or diastolic blood pressure of ≥90 mmHg on two separate occasions or self-reported use of blood pressure medication” [16, 17]. A binary variable was generated where 0 was normal while 1 was hypertension.

Socioeconomic measure

Wealth index was used as the measure of socioeconomic position and living standards of the respondents. The wealth index was computed based on data on household assets using principal component analysis and categorised into five quintiles (1 – poorest; 5 – richest) [18].

Social determinants of hypertension

The social determinants of hypertension included demographic (age, sex, marital status), socioeconomic (education, occupation, wealth), anthropometric (body mass index), health
behaviours (physical activity, current smoking use, current alcohol use, and fruits and vegetable intake) and community (region and residence) variables (Table 1).

| Table 1. Social determinants of hypertension |
|-----------------------------|-----------------|-----------------|
| Variable                    | Operational definition | Source |
| Age in years                | 18–29; 30–39; 40–49; 50+ | [19-22] |
| Sex                         | Male or female | [19-22] |
| Marital Status              | In-a-union; Not-in-a-union | [5, 12, 19] |
| Education levels            | No formal; primary incomplete; primary complete; secondary+ | [12, 19, 23] |
| Residence                   | Rural or urban | [5, 19] |
| Region                      | Nairobi, Central, Eastern, Western, Nyanza, Coast, Rift Valley, North Eastern | [19] |
| Occupation                  | Unemployed, self-employed, paid employment | [12, 19, 23] |
| Physical activity levels    | Low, moderate, and high | [5, 12, 19] |
| Current smoker              | Yes, No | [13, 19, 24, 25] |
| Current alcohol use         | Yes, No | [13, 19, 26] |
| Fruits & vegetable intake   | Sufficient; insufficient | [19, 21] |
| Body Mass Index             | Undernutrition (≤18.5 kg/m²), Normal (18.5–24.9 kg/m²), Overweight (≥25–29.9 kg/m²), Obese (≥30 kg/m²) | [19, 22, 27-29] |

Statistical analysis

Sample characteristics and prevalence of hypertension were described using frequencies and percentages. Stata 13.1 was used to perform all statistical analyses that were adjusted for the stratified sampling design of the survey.

Socioeconomic inequalities in hypertension in Kenya was quantified using concentration index (C) and depicted using concentration curves. C is a ‘measure of inequality in the distribution of health outcome across the wealth or income distribution’, reflects the experience of the population as the whole and is sensitive to the change in the distribution of the population across social-economic groups and can be decomposed [30]. C ranges from −1 and +1 and C=0 shows perfect equality while C<0 shows hypertension is disproportionately concentrated among the poor (pro-rich inequality). It was computed based on the proportion of hypertension by the ranked wealth distribution as follows [30]:

\[ C = \frac{2}{n\mu} \sum_{i=1}^{n} h_i R_i - 1 \]  

(1)
where \( n \) is the number of people, \( \mu \) is the overall mean/proportion of \( h \); \( h_i \) is hypertension in \( i^{th} \) person; \( R_i \) is the \( i^{th} \) person ranked by wealth from the poorest to richest [30]. Hypertension is a binary variable, and the C was normalised by dividing the C by \( 1-\mu \) [31, 32].

Wagstaff-type decomposition analysis of the concentration index was used to examine the contribution of social determinants of inequality in hypertension. To decompose, we first considered the linear additive regression model for the outcome variable \( (y) \) of an individual \( i \) as follow:

\[
y_i = \alpha + \sum k \beta_k x_{ki} + \varepsilon_i
\]  

(2)

where the concentration index of health outcome \( (y) \) can be written as:

\[
C_{\text{Normalized}} = \frac{C}{1-\mu} = \frac{\sum k (\beta_k x_{ki}) C_k}{1-\mu} + \frac{G\varepsilon/\mu}{1-\mu}
\]  

(3)

where \( \mu \) is the mean of hypertension, \( \bar{x}_k \) is the mean of \( x_k \), \( C_k \) is the concentration index of \( x_k \), and \( G\varepsilon \) (residual) is the generalized concentration index for the error term \( (\varepsilon) \). C, therefore, is the sum of the two components – the concentration index of the explanatory variables weighted by the elasticity of \( y (\beta_k \bar{x}_k/\mu) \) which is the explained part and residual part \( (G\varepsilon/\mu) \) which is the unexplained part [30]. Hypertension, the outcome variable, is non-linear hence a non-linear Probit model was used to estimate the marginal effects \( (\beta_k) \) of each determinant [30]. The marginal effects were used to calculate the contribution of \( k \) determinants. A negative absolute contribution was interpreted as supporting effect of inequality that favours the rich, to the disadvantage of poor and vice versa.
Results

Sample characteristics

A total of 4398 respondents were included in the study. A majority of them were female (50.2%), aged 18–24 years (45.7%), lived in rural areas (61.5%), in-a-union (65.7%) and unemployed (39.7%). A quarter of the respondents (25.3%) currently used alcohol, 12.7% were current smokers, 10.9% had low physical activity and 11% were obese. Table 2 outlines the respondents’ characteristics and the prevalence of hypertension according to the sociodemographic, socioeconomic, behavioural, and anthropometric characteristics.

Table 2. Respondents’ characteristics and prevalence of hypertension by respondents’ characteristics

Prevalence of hypertension

The overall weighted prevalence of hypertension was 25.8% (95% CI: 23.4–28.4%) with a higher prevalence among men than women (28% vs 23.7%). The prevalence of hypertension was higher among those who were 50+ years (53.4%), paid employment (31.8%), obese (46%) and overweight (33.4%) and from the central region (38.4%). The prevalence of hypertension was also higher among the poorest (28.1%) and poorer (28.8%) compared to the richest (20.2%) but did not show a clear wealth-related gradient (Table 2).

Socioeconomic inequality in hypertension

Figure 1 and 2 shows that the concentration curve lay above the line of equality indicating a pro-rich inequality in hypertension disfavouring the poor, with an overall concentration index of hypertension of −0.08 (95% CI: −0.14, −0.02; p = 0.007). The social determinants included in our model explained 98.3% of the estimated socioeconomic inequality in hypertension in Kenya with a small non-explained part of the inequality (−0.001).
Table 2. Respondents’ characteristics and prevalence of hypertension by respondents’ characteristics

| Characteristics                        | Sample n | Prevalence of hypertension n | % | [95% CI] |
|----------------------------------------|----------|------------------------------|---|---------|
| **Sociodemographic variables**         |          |                              |---|---------|
| **Sex**                                |          |                              |---|---------|
| Male                                   | 1,768    | 527                          | 28.0 | [24.6, 31.7] |
| Female                                 | 2,630    | 728                          | 23.7 | [21.3, 26.2] |
| **Age, years**                         |          |                              |---|---------|
| 18–29                                  | 1,450    | 222                          | 14.6 | [11.8, 17.8] |
| 30–39                                  | 1,236    | 271                          | 23.1 | [19.0, 27.7] |
| 40–49                                  | 779      | 269                          | 36.6 | [31.1, 42.6] |
| 50+                                    | 933      | 493                          | 53.4 | [48.9, 57.8] |
| **Marital status**                     |          |                              |---|---------|
| Not-in-a-union                         | 1,404    | 411                          | 22.1 | [18.7, 25.9] |
| In-a-union                             | 2,993    | 844                          | 27.7 | [24.8, 30.8] |
| **Socioeconomic variables**            |          |                              |---|---------|
| **Education**                          |          |                              |---|---------|
| No formal                              | 739      | 212                          | 24.6 | [19.3, 30.8] |
| Primary incomplete                     | 1,074    | 282                          | 23.4 | [20.2, 26.9] |
| Primary complete                       | 1,390    | 411                          | 27.8 | [24.1, 31.8] |
| Secondary+                             | 1,195    | 350                          | 26.0 | [21.4, 31.3] |
| **Occupation**                         |          |                              |---|---------|
| Unemployed/Unpaid                      | 1,829    | 486                          | 22.3 | [19.3, 25.6] |
| Self-Employment                        | 1,754    | 516                          | 26.2 | [22.8, 29.9] |
| Paid Employment                        | 815      | 252                          | 31.8 | [26.1, 38.0] |
| **Wealth status, Quintiles**           |          |                              |---|---------|
| 5 – Richest                            | 885      | 291                          | 28.1 | [22.6, 34.3] |
| 4                                      | 877      | 266                          | 28.8 | [24.6, 33.6] |
| 3                                      | 878      | 256                          | 24.4 | [20.3, 29.0] |
| 2                                      | 869      | 232                          | 26.5 | [22.0, 31.4] |
| 1 – Poorest                            | 888      | 210                          | 20.2 | [16.7, 24.3] |
| **Health behaviours**                  |          |                              |---|---------|
| **Current smoking**                    |          |                              |---|---------|
| No                                     | 3,885    | 1103                         | 25.6 | [23.4, 28.0] |
| Yes                                    | 512      | 152                          | 27.0 | [21.0, 33.9] |
| **Current alcohol use**                |          |                              |---|---------|
| No                                     | 3,479    | 950                          | 24.0 | [21.7, 26.4] |
| Yes                                    | 911      | 304                          | 31.3 | [27.0, 36.0] |
| **Fruits & vegetable intake**          |          |                              |---|---------|
| Enough                                 | 576      | 164                          | 25.1 | [20.4, 30.5] |
| Not enough                             | 3,822    | 1091                         | 25.9 | [23.3, 28.7] |
| **Physical activity**                  |          |                              |---|---------|
| High                                   | 3,196    | 904                          | 25.7 | [23.1, 28.5] |
| Moderate                               | 668      | 187                          | 25.0 | [20.1, 30.6] |
| Low                                    | 530      | 164                          | 27.7 | [21.2, 35.3] |
| **Metabolic risk factor**              |          |                              |---|---------|
| **Body mass index**                    |          |                              |---|---------|
| Normal                                 | 2,205    | 556                          | 23.2 | [20.7, 25.9] |
| Undernutrition                         | 675      | 135                          | 16.8 | [13.3, 21.1] |
| Overweight                             | 767      | 284                          | 33.4 | [28.2, 38.9] |
| **Obese**                              | 536      | 257                          | 46.0 | [40.3, 51.8] |
| **Community variables**                |          |                              |---|---------|
| **Residence**                          |          |                              |---|---------|
| Rural                                  | 2,252    | 634                          | 26.5 | [23.8, 29.4] |
| Urban                                  | 2,146    | 621                          | 24.8 | [20.5, 29.6] |
| **Regions**                            |          |                              |---|---------|
| Rift Valley                            | 1,313    | 348                          | 24.7 | [21.0, 28.8] |
| Eastern                                | 772      | 255                          | 30.1 | [25.3, 35.3] |
| Nyanza                                 | 561      | 144                          | 23.9 | [18.8, 29.8] |
| Coast                                  | 515      | 131                          | 20.5 | [14.7, 27.8] |
| Central                                | 514      | 207                          | 38.4 | [30.2, 47.3] |
| Western                                | 411      | 112                          | 26.7 | [23.9, 29.7] |
| North Eastern                          | 249      | 43                           | 16.0 | [9.8, 25.1] |
| Nairobi                                | 63       | 15                           | 19.1 | [11.2, 30.6] |
Figure 1. Concentration curve (C = −0.080, 95% CI: −0.137, −0.022; p = 0.007)

Figure 2. Concentration curve for male and female population

Table 3 presents results of the decomposition analysis that revealed that half (52.8%) of the pro-rich inequalities in hypertension is explained by the body mass index. About one-fifth (21.1%) of the estimated inequalities in hypertension is explained by socioeconomic factors (paid employment (9.3%), education (7.7%) and poorest wealth quintile (4.1%)) while sociodemographic factors (female gender (11.8%), age (5.2%) and marital status (0.6%)) explained 17.6% of the observed inequality. Lastly, the regions explained 8.1% of the estimated inequality with the Central region alone explaining 6.9% of the observed inequality while individual health behaviour explained only 4.4% (smoking (2.8%) and alcohol use (1.6%)).

Respondents who were middle-aged, unmarried, urban residents, with primary school and higher education, moderately physically active, current alcohol users, overweight and obese and from Nairobi, Western, Central and Eastern regions were mainly concentrated among the poor populations (indicated by the negative concentration indices) and were likely to be hypertensive (indicated by the coefficients) (Table 3).
### Table 3. Summary of decomposition analysis

| Characteristics                      | Coeff. | Elasticity | C    | Cont. to C | %     | Adjusted % |
|--------------------------------------|--------|------------|------|------------|-------|------------|
| **Sociodemographic variables**       |        |            |      |            |       |            |
| Female gender (Ref: male)            | -0.056 | -0.130     | 0.123| -0.016     | 20.3  | 11.8       |
| Married (Ref: unmarried)             | 0.008  | 0.020      | -0.042| -0.001     | 1.1   | 0.6        |
| Age, years (Ref: 18–29 years)        |        |            |      |            |       |            |
| 30–39                                | 0.073  | 0.079      | -0.003| -0.0002    | 0.2   | 0.1        |
| 40–49                                | 0.191  | 0.131      | -0.052| -0.007     | 8.7   | 5.1        |
| 50+                                  | 0.393  | 0.323      | 0.123| 0.040      | -50.6 |            |
| **Socioeconomic variables**          |        |            |      |            |       |            |
| Education (Ref: No formal)           |        |            |      |            |       |            |
| Primary incomplete                   | -0.015 | -0.014     | 0.257| -0.004     | 4.6   | 2.7        |
| Primary complete                     | 0.046  | 0.057      | -0.119| -0.007     | 8.5   | 5.0        |
| Secondary+                           | 0.0002 | 0.0002     | -0.596| -0.0001    | 0.1   | 0.1        |
| Occupation (Ref: Unemployed)         |        |            |      |            |       |            |
| Self-employment                      | -0.001 | -0.002     | -0.035| 0.0001     | -0.1  |            |
| Paid employment                      | 0.037  | 0.026      | -0.475| -0.013     | 15.9  | 9.3        |
| **Wealth (Ref: Richest)**            |        |            |      |            |       |            |
| Richer                               | 0.016  | 0.006      | -1.000| -0.006     | -7.8  | 4.1        |
| Middle                               | -0.009 | 0.023      | -0.497| -0.012     | 0.0   |            |
| Poorer                               | 0.030  | -0.007     | 0.001| 0.000      | 0.0   |            |
| Poorest                              | 0.007  | 0.012      | 0.498| 0.006      | 7.0   | 4.1        |
| **Health behaviours**                |        |            |      |            |       |            |
| Current smokers (Ref: No)            | -0.030 | -0.014     | 0.279| -0.004     | 2.8   |            |
| Current alcohol use (Ref: No)        | 0.071  | 0.057      | -0.038| -0.002     | 2.7   | 1.6        |
| Insufficient fruits/vegetable intake | 0.022  | 0.076      | 0.022| 0.002      | -2.1  |            |
| Physical activity (Ref: High)        |        |            |      |            |       |            |
| Moderate                             | -0.009 | -0.005     | -0.156| 0.001      | -1.0  |            |
| Low                                  | 0.032  | 0.015      | 0.084| 0.001      | -1.6  |            |
| **Metabolic risk factor**            |        |            |      |            |       |            |
| Body mass index (Ref: Normal)        |        |            |      |            |       |            |
| Undernutrition                       | -0.088 | -0.055     | 0.386| -0.021     | 27.0  | 15.8       |
| Overweight                           | 0.090  | 0.064      | -0.228| -0.015     | 18.5  | 10.8       |
| Obese                                | 0.198  | 0.098      | -0.360| -0.035     | 44.8  | 26.2       |
| **Geographical factors**             |        |            |      |            |       |            |
| Urban residence (Ref: rural)         | -0.013 | -0.025     | -0.388| 0.010      | -12.2 |            |
| Regions (Ref: Rift Valley)           |        |            |      |            |       |            |
| Eastern                              | 0.016  | 0.011      | -0.010| -0.0001    | 0.1   | 0.1        |
| Nyanza                               | -0.017 | -0.008     | 0.065| -0.001     | 0.7   | 0.4        |
| Coast                                | -0.052 | -0.024     | 0.019| -0.001     | 0.6   | 0.3        |
| Central                              | 0.063  | 0.029      | -0.325| -0.009     | 11.8  | 6.9        |
| Western                              | -0.009 | -0.003     | -0.044| 0.0001     | -0.2  |            |
| North Eastern                        | -0.004 | -0.001     | 0.653| -0.001     | 0.7   | 0.4        |
| Nairobi                              | -0.058 | -0.003     | -0.541| 0.002      | -2.2  |            |
| Concentration index                  | -0.080 |           |      |            |       | 0.07       |
| Standard error                       |         | 0.029      |      |            |       |            |
| Residuals                            | -0.001 |           |      |            |       |            |
| 95% CI                               | -0.137 to -0.022 | |   |            |       |            |

**Bold**: p <0.05. Coeff.: coefficient; C: concentration index; Cont. to C: contribution to concentration index; %: percentage contribution; Ref: reference category; SE: standard error
Discussion

Our study revealed a pro-rich inequality in hypertension in Kenya, disfavouring poor individuals. The inequality is explained by body mass index, socioeconomic (wealth status, occupation, and education), sociodemographic (gender, age, and marital status) factors, regions and individual health behaviours (current history of alcohol use and smoking). These aspects need to be given high priority in developing efficient intervention to prevent and control hypertension in Kenya. The prevalence of hypertension reported in the current study is similar to previous studies conducted in Kenya [12, 33-36]. Similarly, the high prevalence of hypertension among men and older adults compared to women and younger adults have also been established.

Similar to other studies in LMICs [8, 23, 37, 38], our findings indicate the presence of inequalities in hypertension disfavouring the poor population. The magnitude of the inequalities in our study (C: –0.08) is lower compared to that of Iran (C: –0.15) [23, 38] and among rural residents in Bangladesh (C: –0.20) [23, 38] despite an almost similar hypertension prevalence reflecting the varying levels of inequalities. However, our findings differ from the pro-poor inequality in high blood pressure reported in a study among women of reproductive age in sub-Saharan Africa [13]. The study reported cumulative inequality for sub-Saharan Africa and did not compute country-specific inequalities which could explain the difference. Though, our study also shows the size of inequality to be lower among women than men (C: –0.05 vs –0.09). Nevertheless, our findings show the hazardous effect of hypertension on underprivileged populations who are poor.

Body mass index was the largest independent contributor to the inequality in hypertension explaining more than half of the inequality. Our study shows that almost one in three individuals were overweight or obese and had some of the highest prevalence of hypertension
(33.4% and 46%, respectively). Obesity and overweight are known risk factors for hypertension [22, 27-29] and independently contributed to 26.2% and 10.8% of the observed inequality. Being obese/overweight increases an individual risk of hypertension especially among individual belonging to the poorest group [12, 28, 33].

Surprisingly, undernutrition independently contributed 16% of the observed inequality, which could reflect the high prevalence of hypertension (17%) among the 16% of our study population who were undernourished. High prevalence of hypertension has previously been reported among undernourished individuals [39]. We hypothesise that the life course approach showing the relationship between childhood/adulthood malnutrition and hypertension could help explain this finding. Malnutrition limits renal development resulting in kidney malfunction in adulthood and eventually hypertension [40, 41]. However, we studied adult individuals some of whom were already malnourished and could not ascertain the timing of the occurrence of malnutrition and any causal linkage to their hypertension. This calls for further evaluation to establish the causal relationship between adult undernutrition and hypertension with a focus on the poor populations.

Occupation, education, and wealth are the socioeconomic factors contributing to about one-fifth of the observed inequalities in hypertension. Similarly, these factors also explained inequality in hypertension in Iran [23]. In this study, individuals in formal paid employment were more concentrated among the poor and had a relatively high prevalence of hypertension compared to the unemployed and self-employed individuals. In Kenya, studies have shown that casual workers and individuals on formal employment have increased odds of hypertension [12]. Our findings also revealed that individuals with low education level (incomplete or complete primary educations) were more likely to be hypertensive and poor. Low education level is associated with the risk of developing hypertension [21, 22, 33]. Educated individuals have a better awareness of hypertension and its preventive strategies compared to the
uneducated [10, 11]. Independently, the poorest wealth inequalities contributed four percent of the inequality in hypertension. Inconsistent with previous studies [12, 13], our study shows a high prevalence of hypertension among individuals in the poorest wealth quintile. We hypothesize those poorest individuals face several financial barriers, which hinder access to health services for control and treatment of hypertension due to huge out of pocket expenditure [6].

More than a quarter of the observed inequality was explained by socio-demographic factors. Specifically, gender had a substantial contribution to the inequality with men having a significantly higher prevalence of inequalities in hypertension than women. Previous studies have observed gender disparities in hypertension [20-22], which have been attributed to biological [42] and health behavioural factors [43]. In this study, a further gender-specific decomposition shows that the differences in body mass index, education, employment, and the region could explain the gender disparities in hypertension [Supplementary Table 1]. Age, especially 40–49 years also contributed to the observed inequality in hypertension. Adults aged 35 years and above have been shown to have increased the risk of hypertension in Kenya [12]. The current study shows substantial inequality in hypertension for the older and poor population. These findings call for gender-focused approaches in prevention, treatment, and control of hypertension in Kenya.

Regional differences mainly attributed to Central region contributed to 8.1% of the observed inequalities in hypertension. The central region had the highest prevalence of hypertension. Its main inhabitants, the Kikuyu ethnic groups, has high prevalence hypertension [44] and cardiometabolic markers [45]. It is also one of the most unequal regions in Kenya [46].

Behavioural risk factors contributing to the inequalities in hypertension were current history of smoking and alcohol use. Alcohol use and smoking are associated with increased risk of
hypertension [21, 27, 47, 48]. The prevalence of smoking [13, 24, 25] and alcohol use [13, 26] is high among individuals in the poorest wealth quintile group. These poor individuals are also likely to be hypertensive hence contribute to hypertension inequality in Kenya.

**Strengths and limitations**

To our knowledge, this is the first study in Kenya quantifying and explaining the inequalities in hypertension. One of the strengths is the study uses data collected using the standardised WHO STEPwise approach from a large nationally representative sample making our finding generalisation to Kenya and easily comparable. The study variables included also explain the observed inequalities with minimal residual. However, the data used is cross-sectional and hence causal inference could not be made. Also, the blood measurements were taken in one visit which could have resulted in an overestimation of the prevalence.

**Conclusion**

The present study shows pro-rich inequality in hypertension, which is mainly explained by individual health behaviour, socioeconomic and sociodemographic factors. These findings are particularly important considering that more than half of the Kenyan population is pre-hypertensive [36, 49]. We call for gender- and equity-focused interventions, as proposed in the national strategy for non-communicable diseases to curb the rising burden of hypertension and address the inequalities in hypertension. Importantly, the study findings highlight the significant contribution of obesity/overweight in hypertension inequalities, which calls for further research and investments in measures to curb obesity such as taxes on highly processed foods, sweetened beverages and promoting physical activity.

**List of abbreviations**

C: Concentration index; NCDs: Non-communicable diseases; US: United States; WHO: World Health Organization; SE: Standard error
Declaration

Ethics approval and consent to participate

The study used secondary data from the Kenya STEPwise survey for non-communicable disease risk factors 2015 that was approved by the UoN/KNH Ethical Committee and the respondents provided written consents before the survey.

Consent for publication

Not applicable

Availability of data and materials

Data used in this study can be accessed based on the Kenya National Bureau of Statistics data access agreement on http://statistics.knbs.or.ke/nada/index.php/catalog/90

Competing interests

The authors declare that they have no competing interest.

Funding

This work did not receive any funding.

Author contributions

SMG conceptualized the study and performed data analysis. SMG and JWT wrote, reviewed, and approved the manuscript.

Acknowledgement

We are grateful to the Kenya National Bureau of Statistics for access to the dataset and Mary Wairimu Gatimu for preparation of the initial draft.
Authors information

SMG: 0000-0002-8331-4536 ; TWJ: 0000-0003-3514-1666

References

1. Mills KT, Stefanescu A, He J: The global epidemiology of hypertension. Nature Reviews Nephrology 2020, 16:223-237.
2. World Health Organization: Global action plan for the prevention and control of noncommunicable diseases 2013-2020. Geneva, Switzerland: World Health Organization; 2013.
3. Kenya National Bureau of Statistics, World health Organisation, Ministry of Health: Kenya STEPwise Survey for Non-communicable Diseases Risk Factors 2015 Report. Nairobi: Kenya National Bureau of Statistics; 2015.
4. Ogola E, Okello FO, Macgregor-skinner E, Jimenez J, Yonga G: [OP.3C.03] Blood pressure screening results from Healthy Heart Africa: Screening locations, participant characteristics, and hypertension classification in Kenya. J Hypertens 2017, 35:e30-e31.
5. van de Vijver SJ, Oti SO, Agyemang C, Gomez GB, Kyobutungi C: Prevalence, awareness, treatment and control of hypertension among slum dwellers in Nairobi, Kenya. J Hypertens 2013, 31:1018-1024.
6. Oyando R, Njoroge M, Nguhiu P, Kirui F, Mbui J, Sigilai A, Bukania Z, Obala A, Munge K, Etyang A, Barasa E: Patient costs of hypertension care in public health care facilities in Kenya. Int J Health Plann Manage 2019, 34:e1166-e1178.
7. Cha SH, Park HS, Cho HJ: Socioeconomic disparities in prevalence, treatment, and control of hypertension in middle-aged Koreans. J Epidemiol 2012;JE20110132.
8. Palafox B, Mckee M, Balabanova D, Alhabib KF, Avezum AJ, Bahonar A, Ismail N, Chifamba J, Chow CK, Corsi DJ, et al: Wealth and cardiovascular health : a cross-sectional study of wealth-related inequalities in the awareness , treatment and control of hypertension in high-, middle- and low-income countries. International Journal for Equity in Health 2016, 15:15-17.
9. Vellakkal S, Millett C, Basu S, Khan Z, Aitsi-Selmi A, Stuckler D, Ebrahim S: Are estimates of socioeconomic inequalities in chronic disease artefactually narrowed by self-reported measures of prevalence in low-income and middle-income countries? Findings from the WHO-SAGE survey. J Epidemiol Community Health 2015, 69:218-225.
10. Leng B, Jin Y, Li G, Chen L, Jin N: Socioeconomic status and hypertension: a meta-analysis. J Hypertens 2015, 33:221-229.
11. Grotto I, Huerta M, Sharabi Y: Hypertension and socioeconomic status. Curr Opin Cardiol 2008, 23:335-339.
12. Olack B, Wabwire-Mangen F, Smeeth L, Montgomery JM, Kiwanuka N, Breiman RF: Risk factors of hypertension among adults aged 35-64 years living in an urban slum Nairobi, Kenya. BMC Public Health 2015, 15:1251.
13. Yaya S, Uthman OA, Ekholuenetale M, Bishwajit G: Socioeconomic Inequalities in the Risk Factors of Noncommunicable Diseases Among Women of Reproductive Age in Sub-saharan Africa: A Multi-Country Analysis of Survey Data. *Front Public Health* 2018, 6:307.

14. Fateh M, Emamian MH, Asgari F, Alami A, Fotouhi A: Socioeconomic inequality in hypertension in Iran. *J Hypertens* 2014, 32:1782-1788.

15. MoH: Kenya National Strategy for the Prevention and Control of Non-Communicable Diseases (NCDs) 2015 - 2020. Nairobi, Kenya: Ministry of Health, Kenya; 2015.

16. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, Jr., Jones DW, Materson BJ, Oparil S, Wright JT, Jr., et al: The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *JAMA* 2003, 289:2560-2572.

17. Ministry of Health: Kenya National Guidelines for Cardiovascular Diseases Management. Nairobi: Ministry of Health, Division of Non-Communicable Diseases; 2018.

18. Howe LD, Hargreaves JR, Huttly SR: Issues in the construction of wealth indices for the measurement of socio-economic position in low-income countries. *Emerg Themes Epidemiol* 2008, 5:3.

19. Mohamed SF, Mutua MK, Wamai R, Wekesah F, Haregu T, Juma P, Nyanjau L, Kyobutungi C, Ogola E: Prevalence, awareness, treatment and control of hypertension and their determinants: results from a national survey in Kenya. *BMC Public Health* 2018, 18:1219.

20. Ba HO, Camara Y, Menta I, Sangare I, Sidibe N, Diall IB, Coulibaly S, Keita MA, Millogo GRC: Hypertension and Associated Factors in Rural and Urban Areas Mali: Data from the STEP 2013 Survey. *Int J Hypertens* 2018, 2018:6959165.

21. Bosu WK, Aheto JMK, Zucchelli E, Reilly ST: Determinants of systemic hypertension in older adults in Africa: a systematic review. *BMC Cardiovasc Disord* 2019, 19:173.

22. Sarki AM, Nduka CU, Stranges S, Kandala NB, Uthman OA: Prevalence of Hypertension in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis. *Medicine (Baltimore)* 2015, 94:e1959.

23. Veisani Y, Jenabi E, Nematollahi S, Delpisheh A, Khazaei S: The role of socioeconomic inequality in the prevalence of hypertension in adults. *Tabriz University of Medical Sciences* 2019, 11:116-120.

24. Dickson KS, Ahinkorah BO: Understanding tobacco use and socioeconomic inequalities among men in. *BMC Archives of Public Health* 2017:1-8.

25. Irazola V, Santero M, Melendi S, Herna A: Socio-economic inequalities in smoking prevalence and involuntary exposure to tobacco smoke in Argentina: Analysis of three cross-sectional nationally representative surveys in 2005, 2009 and 2013. *PLoS One* 2019:1-16.

26. Lawana N: Decomposing socioeconomic inequalities in alcohol use by men living in South African urban informal settlements. *BMC Public Health* 2018, 18:1-9.
27. Ondimu DO, Kikuvi GM, Otieno WN: Risk factors for hypertension among young adults (18-35) years attending in Tenwek Mission Hospital, Bomet County, Kenya in 2018. *Pan Afr Med J* 2019, 33:210.

28. Akpa OM, Made F, Ojo A, Ovbiagele B, Adu D, Motala AA, Mayosi BM, Adebamowo SN, Engel ME, Tayo B, et al: Epidemiology / Population Science Regional Patterns and Association Between Obesity and Hypertension in Africa Evidence From the H3Africa CHAIR Study. *Obesity and Hypertension in Africa* 2020:1167-1178.

29. Oladimeji AM, Fawole O, Nguku P, Nsubuga P: Prevalence and factors associated with hypertension and obesity among civil servants in Kaduna, Kaduna State, June 2012. *PanAfrican Medical Journal* 2014, 18:1-5.

30. O'Donnell O, Van Doorslaer E, Wagstaff A, Lindelow M: Analyzing health equity using household survey data: a guide to techniques and their implementation. 2008. *Washington, DC: The World Bank* 2008, 220.

31. Wagstaff A: The concentration index of a binary outcome revisited. *Health Econ* 2011, 20:1155-1160.

32. Wagstaff A: Correcting the concentration index: a comment. *J Health Econ* 2009, 28:516-520, author reply 521-514.

33. Joshi MD, Ayah R, Njau EK, Wanjur R, Kayima JK, Njeru EK, Mutai KK: Prevalence of hypertension and associated cardiovascular risk factors in an urban slum in Nairobi, Kenya: a population-based survey. *BMC Public Health* 2014, 14:1177.

34. Vusirikala A, Wekesah F, Kyobutungi C, Oyebode O: Assessment of cardiovascular risk in a slum population in Kenya: use of World Health Organisation/International Society of Hypertension (WHO/ISH) risk prediction charts - secondary analyses of a household survey. *BMJ Open* 2019, 9:e029304.

35. Gomez-Olive FX, Ali SA, Made F, Kyobutungi C, Nonterah E, Miclesfield L, Alberts M, Boua R, Hazelhurst S, Debuur C, et al: Regional and Sex Differences in the Prevalence and Awareness of Hypertension: An H3Africa AWI-Gen Study Across 6 Sites in Sub-Saharan Africa. *Glob Heart* 2017, 12:81-90.

36. Onyango MJ, Kombe I, Nyamongo DS, Mwangi M: A study to determine the prevalence and factors associated with hypertension among employees working at a call centre Nairobi Kenya. *Pan Afr Med J* 2017, 27:178.

37. Price AJ, Crampin AC, Amberbir A, Kayuni-chihana N, Musicha C, Tafatatha T, Branson K, Lawlor DA, Mwaiyeghele E, Nkhwazi L, et al: Prevalence of obesity, hypertension, and diabetes, and cascade of care in sub-Saharan Africa: a cross-sectional, population-based study in rural and urban Malawi. *The Lancet Diabetes Endocrinology* 2018, 6:208 -222.

38. Biswas T, Islam MS, Linton N, Rawal LB: Socio-Economic Inequality of Chronic Non-Communicable Diseases in Bangladesh. *PLoS One* 2016, 11:e0167140.

39. Wang Z, Li C, Yang Z, Zou Z, Ma J: Infant exposure to Chinese famine increased the risk of hypertension in adulthood: results from the China Health and Retirement Longitudinal Study. *BMC Public Health* 2016:1-11.

40. Mackenzie HS, Uk M, Brenner BM: Fewer Nephrons at Birth: A Missing Link in the Etiology of Essential Hypertension? *American Journal of Kidney Diseaseas* 1995, 26:91-96.
41. Gurusinghe S, Brown RD, Cai X, Samuel CS, Ricardo SD, Thomas MC, Kett MM: Does a Nephron Deficit Exacerbate the Renal and Cardiovascular Effects of Obesity? *PLoS One* 2013, 8.

42. Song J-J, Ma Z, Wang J, Chen L-X, Zhong J-C: Gender Differences in Hypertension. *J Cardiovasc Transl Res* 2020, 13:47-54.

43. Everett B, Zajacova A: Gender differences in hypertension and hypertension awareness among young adults. *Biodemography Soc Biol* 2015, 61:1-17.

44. Mathenge W, Foster A, Kuper H: Urbanization, ethnicity and cardiovascular risk in a population in transition in Nakuru, Kenya: a population-based survey. *BMC Public Health* 2010, 10:569.

45. Wekesah FM, Nyanjau L, Kibachio J, Mutua MK, Mohamed SF, Grobbee DE, Klipstein-Grobusch K, Ngaruiya C, Haregu TN, Asiki G, Kyobutungi CK: Individual and household level factors associated with presence of multiple non-communicable disease risk factors in Kenyan adults. *BMC Public Health* 2018, 18:1220.

46. Friedrich Ebert Stiftung: Regional Disparities and Marginalization in Kenya. *Elite PrePress Nairobi, Kenya* 2012.

47. Belue R, Okoror TA, Iwelunmor J, Taylor KD, Degboe AN, Agyemang C, Ogedegbe G: Globalization and Health An overview of cardiovascular risk factor burden in sub-Saharan African countries: a socio-cultural perspective. *BMC Globalization and Health* 2009, 12:1-12.

48. Hulzebosch A, van de Vijver S, Oti SO, Egondi T, Kyobutungi C: Profile of people with hypertension in Nairobi’s slums: a descriptive study. *Global Health* 2015, 11:26.

49. Mecha JO, Kubo EN, Odhiambo CO, Kinoti FG, Njau K, Yonga G, Ogola EN: Burden of prehypertension among adults in Kenya: a retrospective analysis of findings from the Healthy Heart Africa (HHA) Programme. *BMC Public Health* 2020, 20:281.