Trends in Hospital Mortality at Moi Teaching and Referral Hospital, Kenya: A 15-Year Retrospective Analysis (2000–2014)

Betsy C. Rono Cheriro
bcheriro@jkuat.ac.ke
Jomo Kenyatta University of Agriculture and Technology
Henry Mwangi
Mama Ngina University College
Benson Macharia
Moi Teaching and Referral Hospital
Francis Ndiangui
Kenyatta National Hospital
Robert Too
Moi University
Wilson Aruasa
Executive office of the President
John Kibosia
Kabarak University
John Macharia Macharia
University of Pecs
Bence L. Raposa
University of Pecs

Research Article

Keywords: Gross death rate, File retrievability, Referral status, Net death rate

Posted Date: March 19th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-8894053/v1

Additional Declarations: No competing interests reported.

Abstract

Background

Moi Teaching and Referral Hospital (MTRH) is the second largest national hospital in western part of Kenya, serving a population of approximately 20 million people. It is a 1,200-bed hospital with a 24-hour workload of approximately 2,000 inpatients and 1,500 outpatients. As of 2019, Kenya's national mortality rate was 7.8 per 1,000, and life expectancy was 66.1 years. Mortality rate reported was 31.87/1000 and 419.4/1000 for women and men correspondingly in 2021. Currently, infant mortality rate (IMR) stands at 32/1000 live births with under-five mortality rate at 41/1000 live births. Only 39% of all deaths in Kenya are reported and registered as at 2018.

Methods

All mortality case files at MTRH between 2000 and 2014 retrievable from the hospital Records Department archives, were included in the study. Ethical approval was sought from the Institutional Review and Ethical Committee (IREC) of Moi University/ MTRH with approval number 001127. The search strategy was developed starting with the latest deaths for ease of retrieval. Data retrieval process started in January 2014 and ended in December 2016. Data set of all the mortalities' information was de-identified, decoded and entered into the SPSS version 22. Descriptive statistics were employed to describe each cause of mortality, demographic information and time of mortality occurrence.

Results

A total of 32759 deaths occurred, with only 25,420 (77.60%) records retrievable; Over 72.28% were self-referral; More male deaths occurred at 54.04% than females at 45.96%, $p < 0.001$.

Conclusions

Patient care information retrievability and accessibility remains a challenge hindering care continuum with gaps existing in referral systems with more men at higher risk of dying die than women.

Background

Globally, life expectancy at birth remained at 73.3 years in 2019[1], and age- and sex-stratified global estimates indicate that neonatal conditions accounted for up to 55.2% of cause-specific mortality, followed by tuberculosis (50.3%) and lower respiratory infections (46.6%) among males, while neonatal conditions (42.5%), lower respiratory infections (39.3%), human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS) at 35.1% were the leading causes among females[2] [3] [4].

The overall mortality rate in Kenya is 7.8/1000 with a life expectancy at birth of 66.1 [5]. The reported gender specific mortality rate was 31.87/1000 and 419.4/1000 for women and men correspondingly in 2021. Currently, infant mortality rate (IMR) stands at 32/1000 live births with under-five mortality rate at 41/1000 live births[1 6 7]. Only 39% of all deaths in Kenya were reported and registered as at 2018.

Moi Teaching and Referral Hospital (MTRH) is the second largest national hospital, covering approximately 20 million people, in western region of Kenya [8 9 5]. The hospital boasts a 1200-bed capacity with a 24-hour workload of 2000 and 1,500 in and out-patients correspondingly. It was established in 1917 with a bed capacity of 60 to serve the African populations health needs and later elevated to a national referral status in 1998.

While Kenya's national mortality indicators have been widely reported, hospital-level data remains limited. Institutional and net death rates are crucial indicators of quality of care yet rarely documented. Therefore, this manuscript describes mortality patterns and trends at MTRH over a 15-year period.

The primary objective of this study was to characterize mortality patterns and trends among hospital discharges at Moi Teaching and Referral Hospital (MTRH) between 2000 and 2014. Specifically, the study aimed to determine institutional and net death rates and their temporal distribution, to examine age-specific mortality trends over time, and to compare survival time between self-referred patients and those referred from other health facilities.

Methods

Study area

Deaths that occurred in MTRH between 2000 and 2014 inclusive were included to give a fifteen-year mortality. The study adopted a cross-sectional design. Data search strategy commenced with latest deaths for ease of retrievability guided by list of occurrences. Data collection was conducted by six (6) research assistants recruited among the nursing staff who were trained on key study variables to answer the gross and net deaths epidemiological questions in the hospital. The deceased case files were retrieved from the hospital Records Department archives and examined for details during the study period as shown in *(*Fig. 1*)* below. Data retrieval and entry process started in January 2014 and ended in December 2016.

Sampling design

Census sampling procedure was adopted and all mortalities that occurred at MTRH during the study period that were retrieved were included in the analysis.

Inclusion and exclusion criteria

All recorded hospital deaths occurring at Moi Teaching and Referral Hospital between 2000 and 2014 were included in the study. Records that were incomplete or irretrievable, as well as cases involving patients who were discharged alive, were excluded from the analysis.

All gross deaths were included to give the cumulative mortalities that occurred in the hospital. Net deaths were any deaths that occurred within 48 hours of being admitted to the hospital. These deaths were not attributed to the quality-of-care practices within MTRH.

Data management

Statistical analysis

Missing data were handled using single imputation (mean/median substitution). Descriptive and inferential statistical analyses, including proportions and chi-square tests, were performed using IBM SPSS Statistics (version 26.0). Significance was assessed at a p-value < 0.05

Data analysis

Data were collected using a standardized data abstraction form capturing key study variables and initially entered into Microsoft Excel. The datasets were cleaned, merged, de-identified, and prepared for statistical analysis. Descriptive statistics were used to summarize causes of mortality, demographic characteristics, and timing of death, while chi-square tests were applied to assess associations between referral status, time of death, and gross and net death rates.

Results

A total of 32759 deaths occurred versus 471,449 discharges in MTRH during the fifteen-year study period as shown below in *(*Table 1*).* The study findings are based on 25,420 (77.60%) of retrieved cases, while a total of 7339 (22.40%) files were irretrievable and therefore not included in the study analysis. It is with the assumption that the missing files were random (MAR) in all other variables apart from the period (years) which seems not to be random. The files missing at the beginning of the transition were not at random (MNAR) due to storage and retrieval technical challenges. The 2009 calendar year the retrieval rate was below half of the expected figure; therefore, multiple imputation was applied during data analysis to account for the unobserved values.

Table 1
Comparative of deaths and death rate between research findings and Health Record Information System data

YEAR	Discharge	Total files sampled		HRIS registered deaths		Death rates
		deaths	death rates	deaths	death rates	Difference
2000	18,954	1,373	7.24	1,496	7.89	-0.65
2001	22,278	1,517	6.81	1,460	6.55	0.26
2002	21,541	1,401	6.50	1,605	7.45	-0.95
2003	21,885	1,979	9.04	1,775	8.11	0.93
2004	23,994	1,883	7.85	1,606	6.69	1.16
2005	24,172	2,212	9.15	1,921	7.95	1.20
2006	28,997	2,324	8.01	2,110	7.28	0.73
2007	32,288	1,785	5.53	2,297	7.11	-1.58
2008	31,581	1,944	6.16	2,321	7.35	-1.19
2009	34,676	700	2.02	2,360	6.81	-4.79
2010	37,178	1,485	3.99	2,549	6.86	-2.87
2011	40,396	1,933	4.79	2,863	7.09	-2.30
2012	38,460	1,200	3.12	2,431	6.32	-3.20
2013	44,970	1,460	3.25	2,815	6.26	-3.01
2014	50,079	2,224	4.44	3,150	6.29	-1.85
TOTALS	471449	25,420	5.39	32,759	6.95	-1.56

Death rate (DR) = deaths / Total discharges *100; DR difference = HRIS based-retrieval rate

The fifteen-year crude death rate trend average was 6.95/100 patients, with the highest being 8.11/100 and lowest at 6.95/100 patients as shown in *(*Table 2*).* Based on Health Record Information System **(**HRIS) all-years based figures, the study failed to analyze all deceased records and exceeded the expected in some. The discharges were adjusted by the retrieval rate and hence achieved same crude death rate as the one reported by the hospital.

Table 2
Hospital crude and net death rate

Year	Adjusted Discharges	Total deaths	< 48hrs	Net death rate	Gross death rate	% net death
2000	17,370	1373	604	4.59	7.90	58.03
2001	23,132	1517	639	3.90	6.56	59.52
2002	18,790	1401	646	4.16	7.46	55.81
2003	24,400	1979	888	4.64	8.11	57.21
2004	28,118	1883	844	3.81	6.70	56.89
2005	27,821	2212	964	4.65	7.95	58.44
2006	31,938	2324	1009	4.25	7.28	58.43
2007	25,091	1785	763	4.20	7.11	59.05
2008	26,465	1944	752	4.64	7.35	63.11
2009	10,271	700	305	3.96	6.82	58.16
2010	21,615	1485	579	4.31	6.87	62.69
2011	27,246	1933	716	4.59	7.09	64.66
2012	18,969	1200	408	4.27	6.33	67.45
2013	23,212	1460	489	4.27	6.29	67.94
2014	35,151	2224	727	4.35	6.33	68.73
Total	365370	25420	10333	4.25	6.96	61.08

The net death rate trend against total deaths increased over time with an inverse decrease in gross death rate from 2000 through 2014. However, the proportion of net deaths occurring ≤ 48 hours after admission, increased over time from 60% in the year 2000 to close to 70% in the year 2014 but prevalence remained approximately 4% over the entire period under investigation (Fig. 2).

Of the total deaths, 6998 (27.6%) were referrals from various health institutions where 45.9% were referred from district hospitals 19.6% by private institutions and 18.9% by health centers *(*Table 3*).*

Table 3
Mortality by referral facility over time in percentage

YEAR	Self-referred	District Hospital	Private Hospital	Health Centre	Private Clinics	Provincial Hospital	National Hospital
2000	82.96	5.46	2.40	4.22	4.59	0.36	0
2001	79.52	7.13	3.17	5.75	4.10	0.33	0
2002	81.77	8.72	3.50	2.50	3.36	0.14	0
2003	81.20	8.08	3.54	3.69	3.03	0.45	0
2004	78.16	9.72	4.25	4.52	2.98	0.32	0.05
2005	73.89	10.36	4.66	5.75	4.71	0.50	0.14
2006	75.98	10.12	4.95	5.55	2.97	0.30	0.13
2007	73.50	10.70	4.03	7.23	3.64	0.73	0.17
2008	70.82	16.01	4.27	5.15	3.04	0.67	0.05
2009	64.66	15.74	9.01	6.44	2.86	1.29	0
2010	61.24	20.26	7.97	5.74	3.17	1.62	0
2011	62.23	19.07	6.94	6.11	4.15	1.50	0
2012	67.39	15.80	7.19	6.35	2.34	0.92	0
2013	65.21	15.62	8.90	4.52	4.45	1.23	0.07
2014	64.39	17.94	8.54	4.86	2.43	1.71	0.13

Average 72.19 12.72 5.55 5.23 3.45 0.805 0.049

The proportion of self-referrals trends, remained higher over the period under review as the proportion of those referred from other health facilities particularly district hospital increased. There was a decrease in self-referral versus an increase in health facility referral over time as shown below in *(*Fig. 3*)*.

The difference in the average patients age between those who were self-referrals and those referred from health facilities was mainly significant $p < 0.001$. Overall, majority 72.28% with 95% CI 71.73–72.84 of the cases were admitted in MTRH as self-referral compared to 27.72% referral from other health facilities. There was dominance of neonatal deaths. The proportion of neonates that were self-referral was significant at 87.5% $p < 0.001$ compared to the overall proportion 72.28% same as the infant proportion at 79.41% $p < 0.001$ as shown below in *(*Table 4*)*.

Table 4
Mortality by age and referral status

Age group	Self-referral n (%)	Referred n(%)	p-value
Neonate (< 28 days)	2,534 (87.50)	362 (12.50)	< 0.001
Infant (> 29 days <1years)	1,415 (79.41)	367 (20.59)	< 0.001
Under-five (1–4 years)	1,085 (72.33)	415 (27.67)	0.963
Pediatric (5–13 years)	753 (58.51)	534 (41.49)	< 0.001
Adolescent (14–23 years)	1,369 (66.49)	690 (33.51)	< 0.001
Adult (24–64 years)	8,707 (71.08)	3,543 (28.92)	< 0.001
Elderly (> 64 years)	2,224 (68.45)	1,025 (31.55)	< 0.001
Total	18,087 (72.28)	6,936 (27.72)	

Among males, as shown in (Table 5) the proportion of self-referral was proportionately higher at 29.0% compared to females 25.9%.

Table 5
Mortality by gender and referral status

Gender	Self	Referred	Total
Male	9,750 (71.0)	3,974 (29.0)	13,724
Female	8,650 (74.1)	3,023 (25.9)	11,673
Total	18,400 (72.4)	6,997 (27.6)	25,397

Deaths in terms of age

124 entries had age indicated as 0 (zero). For the purpose of categorizing age groups 88 who were NBU admission their age was assigned as the mean 14 days (28/2) 0.03836 since they were considered as neonates. The 36 infants were assigned to be 168 days ((365 − 28)/2) translating to 0.46027years. When divided into 5 years' age groups, children under-five years had the highest overall proportion of mortality at > 6000(24.68%) and those between 35–40 years at 2000 deaths, 25–30 years at 1900 deaths and 30–35 at 1900 deaths as shown below in (Fig. 4).

When divided into cohorts, there was higher adult mortality in comparison to children. Adults aged 24–64 years had the highest overall proportion of mortality of 12,261(48.97%) in comparison to children under-five years at > 6000 (24.68%) as shown below in (Table 6).

Table 6
Age groups

Age group	Frequency	Percent
Neonate (< 28 days)	2,897	11.57
Infant (> 29days <1years)	1,784	7.12
Under-five (1–4 years)	1,501	5.99
Pediatric (5–13 years)	1,287	5.14
Adolescent (14–23 years)	2,059	8.22
Adult (24–64 years)	12,261	48.97
Elderly (> 64 years)	3,250	12.98
Total	25,039	100

Mortality in terms of sex and age

There was overall higher male mortality in comparison to females. On average there was non-significant mortality occurring more among neonates and significantly among adolescents 14–23 years mortality and the elderly > 64 years. On average, there were more 13477 (53.84%) male deaths compared to females 11556 (46.16%) apart from the adolescents where more female mortality significantly as shown below in *(*Table 7*)*.

Table 7
Mortality by gender and age

Age group	Male n(%)	Female n (%)	p-value
Neonate (< 28 days)	1,528 (52.85)	1,363 (47.15)	0.259
Infant (> 29days <1years)	920 (51.57)	864 (48.43)	0.046
Under-five (1–4 years)	816 (54.36)	68 5 (45.64	0.673
Pediatric (5–13 years)	712 (55.32)	575 (44.68)	0.272
Adolescent (14–23 years)	1,006 (48.86)	1,053 (51.14)	< 0.001
Adult (24–64 years)	6,678 (54.47)	5,583 (45.53)	0.051
Elderly (> 64 years)	1,817 (55.91)	1,433 (44.09)	0.011
Total	13477 (53.84)	11556 (46.16)	

Mortality among the married was dominant in comparison to unmarried adults and children as shown below in (Table 8).

Table 8
Mortality by marital status

Marital status	Frequency	Percent
Married	12,597	51.28
Single	3,484	14.18
Divorced/separated	191	0.78
Widowed	574	2.34
N/A (child)	7,720	31.43
Total	24,566	100

There was no skewness towards either weekends or weekdays. Patient care standards and management practices remained constant during the weekday and weekends. The average daily deaths trends ranged between 13.62–14.95% as shown below in (Table 9).

Table 9
Mortality versus day of death.

Days of the week	Frequency	Percent
Sunday	3,462	13.62
Monday	3,802	14.95
Tuesday	3,595	14.14
Wednesday	3,662	14.40
Thursday	3,678	14.46
Friday	3,684	14.49
Saturday	3,544	13.94
Total	**25,427**	**100**

There was a high mortality trend demonstrated by a higher number of deaths occurring between at 6am to noon as shown below in (Table 10) compared to other times of the day.

Table 10
Time of death

Time period	Frequency	Percent
06:00–11:59 morning	8,276	32.59
12:00–17:59afternoon	5,227	20.58
18:00–23:59 evening	6,153	24.23
00:00–05:59 night	5,741	22.61
Totals	**25,397**	**100**

Discussion

There was a slight decrease in gross death rate but the proportion of hospital net death rate remained at slightly over 4%. The proportion of net deaths against total deaths increased over time from 60% in the year 2000 to close to 70% in the year 2014. This may be attributed to improved diagnostics, treatment delays, and bed shortages. This is comparable with other studies that indicate that smoking and alcohol deaths explains 60% of social inequality in mortality and 50% increase in mortality inequality[10 11 12 13]. The Kenyan mortality data employs clinical settings and this is different in other countries, it is population-level based mortality in Germany [14]. Given that excess mortality is the difference between expected and observed mortality in a given period and Bayesian model was used to estimate all cause excess mortality[15]. In comparison with global evidence, while MTRH showed a slight decline in gross death rate, similar other institutions in Japan reported an increase in all-cause mortality, illustrating differences in healthcare system maturity [20].

There are higher number of deaths occurring between 6am (32.59%) to noon compared to other times of the day. The average daily death burden being witnessed ranges between 13.62–14.95%. There is no skewness to weekends or weekdays. This is in contrast to excess deaths occurring during summer periods in Europe of 29 deaths per million[16].

On average significant mortality occurred among 13477 (53.84%) males compared to females 11556 (46.16%) $p < 0.001$. This is different from other hospital reporting readmissions and post-discharge all-cause mortality were 10.38 and 4.00 respectively. It has been reported in literature that majority of patients' readmission and mortality occurs within the first 30 days' post-discharge[4].

There was a high overall mortality among under-five children at > 6000 and followed by those between 35–40 years at 2000 deaths, 25–30 years at 1900 deaths and 30–35 at 1900 deaths. This is different from other studies showing a higher probability of dying within the age of 15-24years at 11.2/1000 youth age. Sub-Saharan Africa (SSA) accounts for 37.9 of deaths occurring among the youths globally. The burden of mortality is increasingly concentrated in SSA[6]. Minimal mortality reduction among men within the specified age 15–44 in Scotland. Drug related deaths increased from 1.2 to 44.9/100000 and now leading cause of mortality. Deaths among the youths are increasing due to preventable causes[13]. Excess mortality is driven by older ages and deaths from cardiovascular and mental/nervous diseases. There is need for detailed mortality data with relevant information for policy makers[17].

Overall, majority of the cases, 72.28% (95%CI 71.73–72.84) were admitted in MTRH as self-referrals compared to 27.72% being referred from other health facilities. Neonates were self-referred significantly at 87.5% $p < 0.001$ in comparison to infants at 79.41%, $p < 0.001$ and under-fives overall proportion 72.28%. $p < 0.001$. This may be attributed to delayed presentation or by-passing primary care, this is comparable globally[18 19 2].

The US government has ensured that there are policies in place to support the changing population domains that promote health care and resultant reduction in mortality [21]. Kenya government should support Policy and practice implications influenced by mortality trends. There is need for policy to enhance focused allocation to address subnational variation and inequalities in mortality [22,23]. Health facilities need to adhere and implement policies that will support resource commitment to guarantee health care improvement in kenya[22,24–27].

Conclusion

While comparing survival times at two different admission points, a significant proportion of admissions were self-referred, underscoring gaps in the referral system and highlighting the need for patient education and improved triage protocols.

Increase in institutional net death rates over time from 2000–2014 demonstrates delay in seeking care due to delay in correct diagnosis versus right treatment delays and bed shortages.

Patient care standards and practice remained constant during the weekday and weekends, demonstrating consistency in quality-of-care level which is commendable based on the availability and readiness of care services.

There is a higher likelihood of male mortality in comparison to females.

Recommendations

The study recommends that MTRH develops more focused patient priority setting of care and supervisory vigilance. This will assure uncompromised quality of care delivery to critically ill patients supported with effective cause-specific intervention strategies put in place.

There is need for further research to understand the likelihood of male mortality while focusing on specific preventive measures: early screening for chronic illnesses (diabetes mellitus, hypertension, heart disease, cancers); cessation of alcohol, cigarettes and substance abuse. These needs to be emphasized amongst the population within the MTRH catchment areas to support and mitigate the high mortality.

The high under-five mortality rate is indicative of the quality-of-care readiness and availability in the hospital necessitating revision of policy guidelines and directives to improve care effectiveness to the sensitive and delicate age groups patients.

The Ministry of Health to ensure early hospitalization and universal access to healthcare promotes quality care availability and readiness supported by promoting of public policy on referrals health care system.

Limitations

This study had several limitations. First, irretrievable data reduced the statistical power of the analysis, primarily due to misfiling and limited resources for digitizing and archiving inactive medical records beyond ten years, which constrained their use for research and policy development. Second, the retrospective approach resulted in missing archived records. In addition, incomplete diagnosis coding limited accurate case fatality estimation, as challenges in record retrieval and the absence of real-time ICD coding hindered identification of definitive causes of death and primary diagnoses. Furthermore, potential confounding factors, including age and multiple diagnoses per patient, increased disease burden and limited cause-specific mortality analysis due to incomplete implementation and adherence to international disease classification standards. Finally, residence and proximity to the hospital may have introduced bias in self-referral status, compounded by the absence of a fully functional district hospital within the catchment area.

Abbreviations

HRIS
Health Records Information System
ICD
International classification of Disease
IMR
Infant Mortality Rate
MAR
Missing files at random
MNAR
Missing files not at random
MTRH
Moi Teaching and Referral Hospital
SSA
Sub-Saharan Africa
US

United States

Declarations

Ethical approval and consent to participate:

Ethical approval was obtained from the ethical committee in line with the Declaration of Helsinki in 1964 and updated in 2013. Ethical approval was obtained from Institutional Review and Ethical Committee (IREC) of Moi University/ Moi Teaching Referral Hospital (Approval No. 001127). The requirement for informed consent was waived due to the retrospective nature of the study and the use of de-identified archival data.

Consent for publication:

Not applicable.

Competing interests:

We wish to confirm that there are no known competing interests associated with this publication, and there was no significant financial support for this work that could have influenced its outcome.

Funding:

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. The article processing charge (APC) was covered by the University of Pécs (PTE).

Author Contribution

BCRC, WKA and JK designed and oversaw the study implementation. HM, BM, FN, RT, JMM and BLR cleaned the data and analyzed the data and wrote the methodology section. BCRC, wrote the manuscript

Acknowledgement

The authors acknowledge Jofrex Fred Kimng’eno Cheriro, Nova Pioneer School, for his assistance with the literature search.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

References

1. Brault MA, Mwinga K, Kipp AM, et al. Measuring child survival for the Millennium Development Goals in Africa: what have we learned and what more is needed to evaluate the Sustainable Development Goals? Glob Health Action. 2020;13(1). 10.1080/16549716.2020.1732668.
2. Skei NV, Nilsen TIL, Mohus RM, et al. Trends in mortality after a sepsis hospitalization: a nationwide prospective registry study from 2008 to 2021. Infection. 2023;51(6). 10.1007/s15010-023-02082-z.
3. Mensah GA, Wei GS, Sorlie PD, et al. Decline in Cardiovascular Mortality: Possible Causes and Implications. Circ Res. 2017;120(2). 10.1161/CIRCRESAHA.116.309115.
4. Ramzi ZS. Hospital readmissions and post-discharge all-cause mortality in COVID-19 recovered patients; A systematic review and meta-analysis. Am J Emerg Med. 2022;51. 10.1016/j.ajem.2021.10.059.
5. KNBS. Kenya Population and Housing Census Volume 1: Population by County and Sub-County. Vol I.; 2019.
6. Masquelier B, Hug L, Sharrow D, et al. Global, regional, and national mortality trends in youth aged 15–24 years between 1990 and 2019: a systematic analysis. Lancet Glob Heal. 2021;9(4). 10.1016/S2214-109X(21)00023-1.
7. Nyongesa C, Xu X, Hall JJ, Macharia WM, Yego F, Hall B. Factors influencing choice of skilled birth attendance at ANC: Evidence from the Kenya demographic health survey. BMC Pregnancy Childbirth. 2018;18(1). 10.1186/s12884-018-1727-z.
8. Balaton-Chrimes S. Who are Kenya's 42(+) tribes? The census and the political utility of magical uncertainty. J East Afr Stud. 2021;15(1). 10.1080/17531055.2020.1863642.
9. Balaton-Chrimes S, Cooley L. To count or not to count? Insights from Kenya for global debates about enumerating ethnicity in national censuses. Ethnicities. 2022;22(3). 10.1177/14687968211056379.
10. Tetzlaff F, Nowossadeck E, Jansen L, et al. Widening area-based socioeconomic inequalities in cancer mortality in Germany between 2003 and 2019. Sci Rep. 2023;13(1). 10.1038/s41598-023-45254-5.
11. Jensen HAR, Møller SR, Christensen AI, Davidsen M, Juel K, Petersen CB. Trends in social inequality in mortality in Denmark 1995–2019: the contribution of smoking- and alcohol-related deaths. J Epidemiol Community Health. 2023;78(1). 10.1136/jech-2023-220599.
12. Pereyra-Zamora P, Copete JM, Oliva-Arocas A, et al. Changes in socioeconomic inequalities in amenable mortality after the economic crisis in cities of the spanish mediterranean coast. Int J Environ Res Public Health. 2020;17(18). 10.3390/ijerph17186489.
13. Allik M, Brown D, Dundas R, Leyland AH. Deaths of despair: cause-specific mortality and socioeconomic inequalities in cause-specific mortality among young men in Scotland. Int J Equity

Health. 2020;19(1). 10.1186/s12939-020-01329-7.

14. Marinetti I, Jdanov D, Grigoriev P, Klüsener S, Janssen F. Effects of the COVID-19 pandemic on life expectancy and premature mortality in the German federal states in 2020 and 2021. PLoS ONE. 2023;18(12 December). 10.1371/journal.pone.0295763.
15. Paglino E, Lundberg DJ, Zhou Z, et al. Monthly excess mortality across counties in the United States during the COVID-19 pandemic, March 2020 to February 2022. Sci Adv. 2023;9(25). 10.1126/sciadv.adf9742.
16. Ballester J, Quijal-Zamorano M, Méndez Turrubiates RF, et al. Heat-related mortality in Europe during the summer of 2022. Nat Med. 2023;29(7). 10.1038/s41591-023-02419-z.
17. Mühlichen M, Sauerberg M, Grigoriev P, Evaluating, Spatial. Cause-Specific and Seasonal Effects of Excess Mortality Associated with the COVID-19 Pandemic: The Case of Germany, 2020. J Epidemiol Glob Health. 2023;13(4). 10.1007/s44197-023-00141-0.
18. Gouvêa E, de CDP, Ribeiro AM, de Aquino EC, Stopa SR. Mortality trend due to chronic kidney disease in Brazil: an ecological study. Epidemiol e Serv Saude. 2023;32(3). 10.1590/S2237-96222023000300010.PT.
19. Lebakula V, Cosby AG. Geographic disparities of cardiovascular and cancer mortality in the USA: 1981–2019. J Public Heal (United Kingdom). 2023;45(4). 10.1093/pubmed/fdad089.
20. Kim SE, Hashizume M, Armstrong B, et al. Mortality Risk of Hot Nights: A Nationwide Population-Based Retrospective Study in Japan. Environ Health Perspect. 2023;131(5). 10.1289/EHP11444.
21. Montez JK, Mehri N, Monnat SM, et al. U.S. state policy contexts and mortality of working-age adults. PLoS ONE. 2022;17(10 October). 10.1371/journal.pone.0275466.
22. Huang T, Chu Y, Shams S, et al. Population stratification enables modeling effects of reopening policies on mortality and hospitalization rates. J Biomed Inf. 2021;119. 10.1016/j.jbi.2021.103818.
23. Macharia PM, Giorgi E, Thuranira PN, et al. Sub national variation and inequalities in under-five mortality in Kenya since 1965. BMC Public Health. 2019;19(1). 10.1186/s12889-019-6474-1.
24. Langat AK, Ofori MA, Mutinda JK, Baranon MD, Amegah AK, Kazembe LN. Spatial Regression Modeling of Child Survival on the Distribution of Births and Deaths in Kenya Based on the Kenya Demographic and Health Survey (KDHS) 2022. Asian J Probab Stat. 2024;26(3). 10.9734/ajpas/2024/v26i3600.
25. Naliaka Watulo E, Kibera Wanjoya A. Survival Analysis of Child Mortality in Kenya: An Analysis of 2014 Kenya Demographic and Health Survey Data. Int J Stat Distrib Appl. 2021;7(2):57. 10.11648/j.ijsd.20210702.14.
26. KNBS & ICF MACRO. *Kenya Demographic and Health Survey 2022. Key Indicators Report. Nairobi, Kenya, and Rockville, Maryland, USA*:; 2023.
27. GSS and ICF. *Kenya Demographic and Health Survey 2022.Key Indicators Report.*; 2024.

Figures

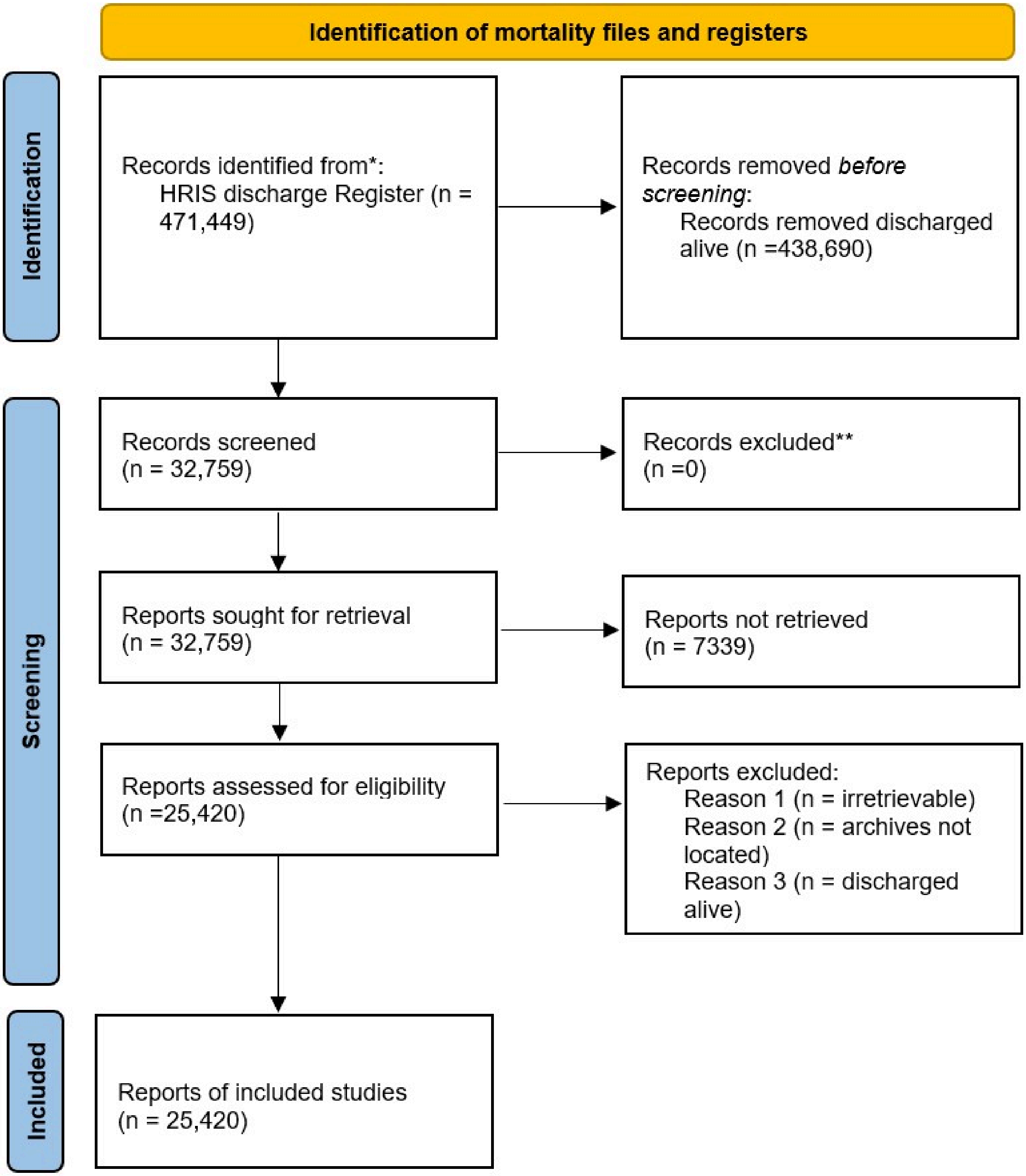

Figure 1

Simplified schematic representation of all the MTRH mortality records retrieved to the study

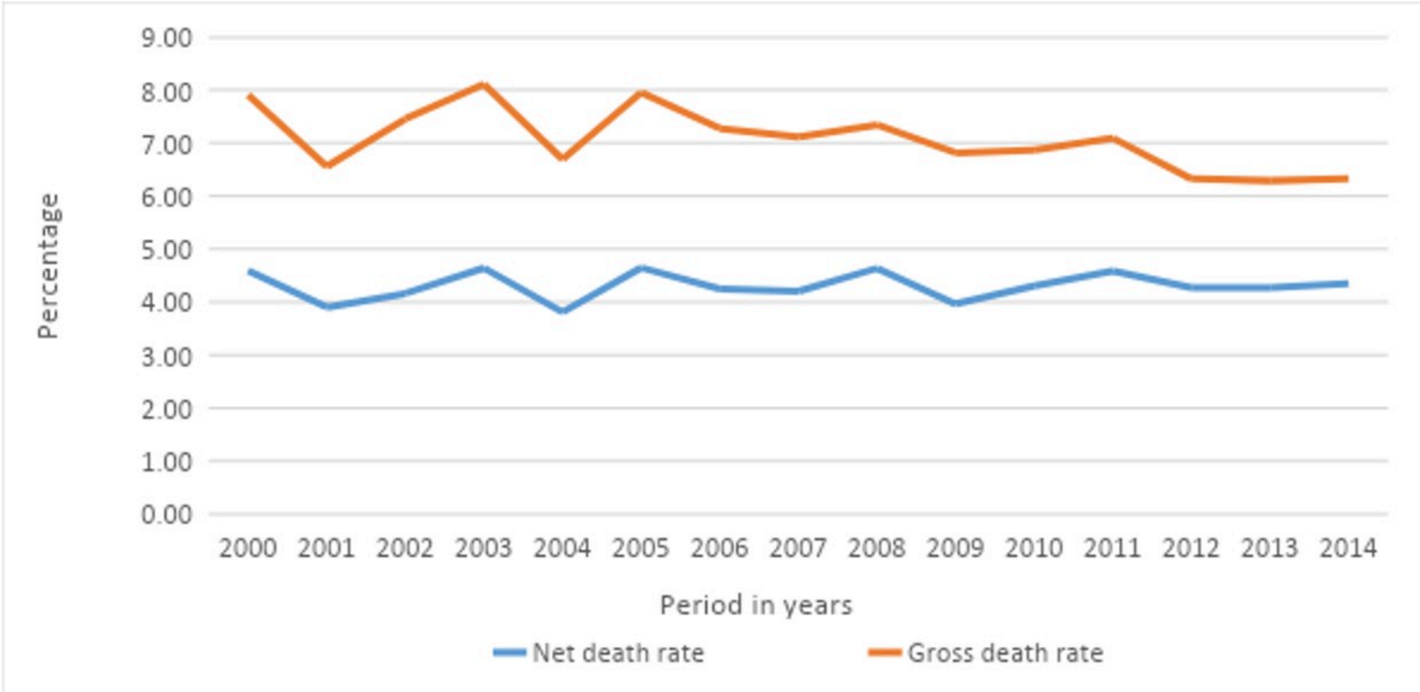

Figure 2

Net versus gross hospital deaths, 2000–2014

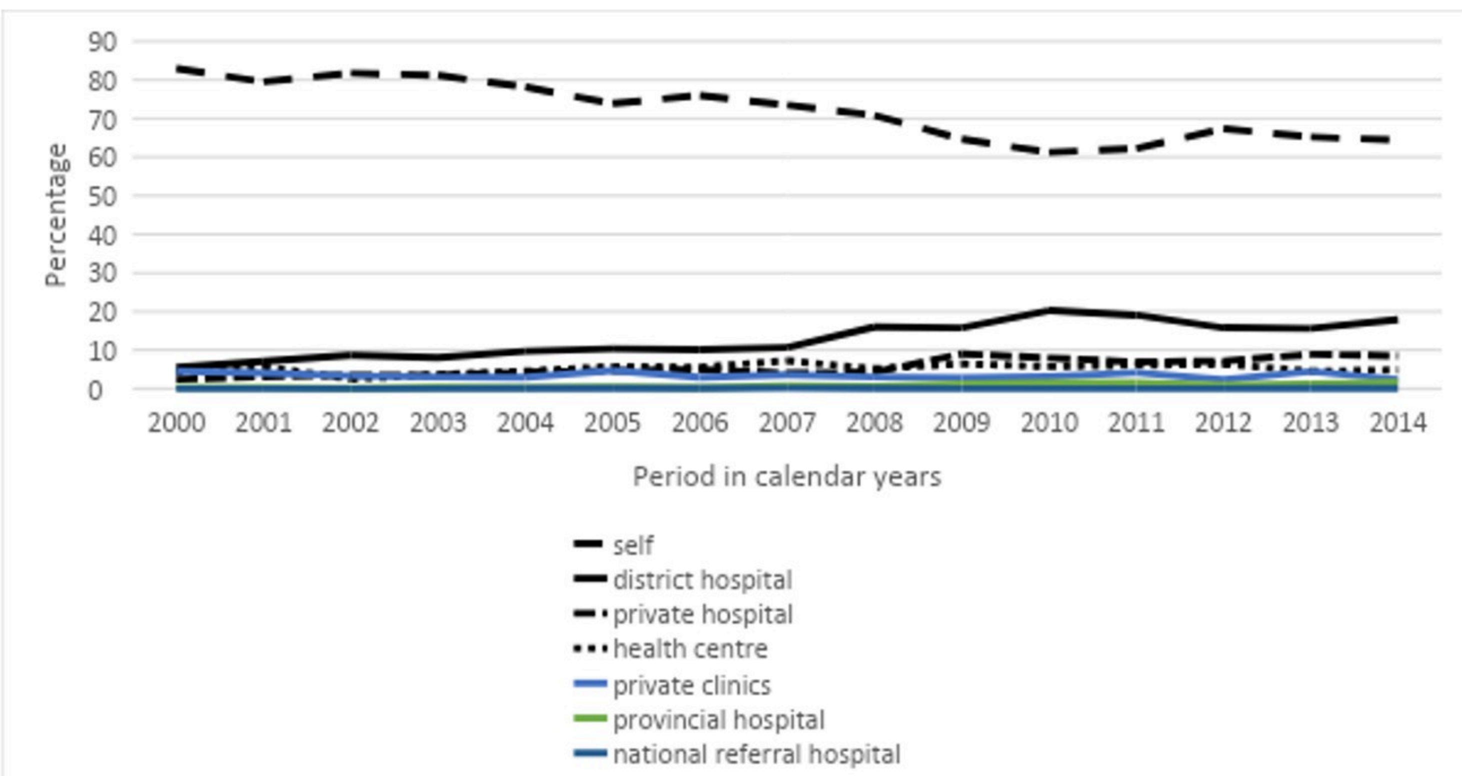

Figure 3

Referral status in hospital deaths, 2000–2014

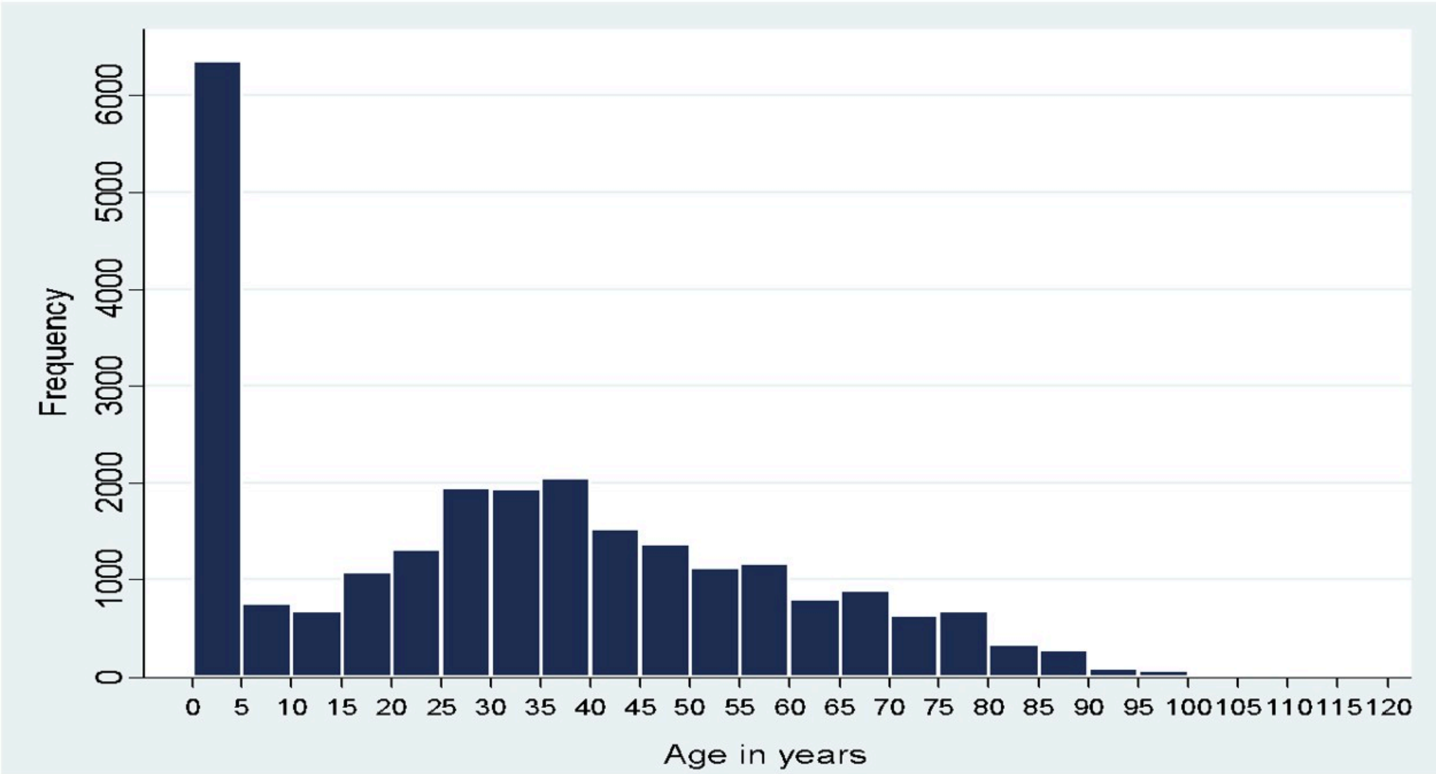

Figure 4

Age in hospital deaths, 2000–2014