Disease burden attributable to dietary risks in Africa, 1990–2040: a systematic analysis for the Global Burden of Disease Study 2021

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Abstract

Disease burden linked to sub-optimal diets in Africa remains under-explored. Using data from the Global Burden of Disease 2021 study, we assessed the disease burden attributable to dietary risks across various locations, age groups, years, and sexes in Africa. Deaths attributable to sub-optimal diet increased from 0.35 million in 1990 to 0.64 million in 2021, and projected increased to 1.62 million in 2040. Disability-adjusted life years (DALYs) similarly increased from 9.79 million in 1990 to 18.1 million in 2021, projected to reach 45.6 million by 2040. In 2021, North Africa had the highest proportion of diet-attributable disease burden at 8.52%. The top dietary risk factors for mortality that year included low fruit intake, insufficient vegetable consumption, and inadequate whole grain intake. Cardiovascular diseases were the leading causes of diet-related deaths. The age-standardized rate of death and disability-adjusted life years linked to dietary risk factors were highest in the Central African Republic, Lesotho, and Guinea-Bissau. Furthermore, the disease burden was found to be greater in males compared to females. These findings will highlight the implementation of evidence-based dietary interventions in Africa.

Introduction

The association between dietary patterns and chronic diseases has been intensively explored [1–5]. Poor dietary habits increase the risk of the incidence, prevalence, and disease related mortality and morbidity of type 2 diabetes, chronic renal disease, fatty liver disease, stroke, ischemic heart disease, and certain cancers [6–8]. The health issues linked to dietary habits in Africa are complex and vary significantly across different countries and regions. On one hand, the hot and arid climate, coupled with limited of water resources, renders many areas unsuitable for cultivating crops, vegetables, and fruits. Additionally, natural disasters such as seasonal floods, tropical cyclones, and locust infestations have caused significant agricultural losses in several countries, resulting in overall food supply shortage and a scarcity of fruits and vegetables. According to a recent report by the World Food Programme (2024), seven out of the 14 "Hotspot areas" experiencing deteriorating food security that require urgent attention are located in Africa. These hotspots include the Democratic Republic of the Congo, South Sudan, Ethiopia, Nigeria, Somalia, Sudan, and the Sahel region, where millions of people expect immediate food assistance. The insufficiency of food and fresh produce has contributed to an increased burden of malnutrition-related diseases. On the other hand, dietary habits in Africa are undergoing significant transformations driven by urbanization, economic growth, and changing dietary preferences. In regions with better economic conditions, there has been a rise in diet-related health issues such as obesity, type 2 diabetes, and cardiovascular diseases [9–11]. Furthermore, with a population projected to exceed 2 billion by 2050, the burden of diet-related diseases in Africa is expected to face even greater challenges. Therefore, comprehensive investigating on the disease burden caused by dietary factors in Africa is crucial for government agencies to proactively address this issue.

Importantly, dietary risks are modifiable. Researchers from the Institute for Health Metrics and Evaluation (IHME) found that increasing vegetable consumption from zero to 306–372 grams daily was associated with a significant decline in the risk of various health conditions: 23.2% for ischemic stroke, 22.9% for ischemic heart disease, 15.9% for hemorrhagic stroke, and 28.5% for esophageal cancer [12]. Changing unhealthy dietary habits, such as increasing the intake of vegetables, fruits, and high fiber foods, and reducing the intake of processed foods and red meat, can help mitigate disease risk and its related burden.

The Global Burden of Disease (GBD) study represents the largest and most comprehensive effort to quantify health loss across different regions and times, encompassing 459 health outcomes and risk factors. Those foundation provides powerful insights into global health trends and challenges. The GBD 2021 Risk Factor Collaborators estimated the burden of disease for adults aged 25 and older associated with 15 dietary risk factors: fruits, vegetables, legumes, whole grains, nuts and seeds, fiber, seafood omega-3 fatty acids, omega-6 polyunsaturated fatty acids, calcium, milk, sodium, red meat, processed meat, sugar-sweetened beverages, and trans fats. They also analyzed 84 behavioral, environmental and occupational, and metabolic risks or clusters of risks, estimating that in 2021, these risk factors resulted in 34.09 million deaths and 1.19 billion disability-adjusted life years (DALYs) globally; dietary risks were the fifth leading level 2 risk factors for deaths and DALYs [13], responsible for 10.6% of all deaths worldwide in 2021. Cardiovascular disease was the leading cause of diet-related deaths, accounting for 30% of these fatalities; the top three dietary risk factors for death that year were high sodium intake, low fruit intake, and low whole grain intake. The food supply, storage methods, and dietary habits in Africa differ significantly from those in other regions, potentially leading to considerable variations in the burden of diet-related diseases. However, at present, few studies focus on the burden attributable to dietary factors of African by time, countries, age, and gender. The aim of this study is to estimate the burden of disease related death and DALYs attributable to dietary risks in Africa from 1990 to 2021, and project to 2040. Subgroup analysis is performed based on sex and age. These data will provide essential information for priority setting and precision planning of health services to control disease burden of dietary risks.

Method

Overview

The Global Burden of Disease (GBD) Study 2021 comprehensively assessed the burden of 369 diseases and injuries and 88 risk factors in 204 countries and territories [13]. GBD is regularly updated and uses the latest epidemiological data sources and improved standardized methods, to conduct a comprehensive assessment of risk exposure and health loss worldwide. The information for the entire 1990–2021 time series generated by GBD 2021 replaced all previously released estimates. Some published literature [14] have detailed the methods of GBD 2021 in earlier reports. All data for this study are available at GBD 2021 (http://ghdx.healthdata.org/gbd-results-tool).

Data Adjustment and Statistical Analysis

In our study, we extracted the number of deaths and disability adjusted life years (DALYs), and mortality and DALYs rates attributable to sub-optimal diet in Africa from 1990 to 2021. DALYs, an optimal measure of disease burden, is calculated as the sum of years of life lost(YLL) and years lived with a disability (YLD ）. YLL represents premature deaths due to diet-related diseases, while YLD reflects the survival time with illness. Age-standardized rates （ASR）are used to assess and compare death rates and DALYs rates between countries and regions with different age structures and demographic characteristics. Each Numeric value is presented as counts and age-standardized rates per 100,000 persons with 95% UI (95% uncertainty interval). Final estimates were calculated using the average of 500 bootstrap replicates, where the lower and upper 95% UI bounds were the 2.5th and 97.5th ranked values across the 500 boot strap replicates, respectively. All data processing, analysis, and graphics were performed and created on the R version 4.3.2 platform.

Significant Definitions

GBD 2021 generates specific risk summary exposure values (SEVs), relative risks (RRs), population attributable fractions (PAFs), estimated values of risk-attributable burdens measured by DALYs and the number of death. The summary exposure value (SEVs) of each risk represents the prevalence of risk-weighted exposure in a specific age group. SEVs are reported on a scale of 0 to 100, and 0 is equivalent to the case the whole population is exposed to the theoretical minimum risk exposure levels (TMREL), and 100 indicates that the entire population is exposed to the maximum risk exposure level. PAFs, risk-attributable burden estimates for 2021, are given as numeric value and age-standardized rates per 100,000 population, using the GBD standard demographic structure data considering the age structure differences among different population groups. Estimated average annual percentage change (EAPC) is applied to calculate the annual percentage change in the incidence rate of cases attributable to dietary risks in Africa from 1990 to 2021. Age-Period-Cohort (APC) is used to predict the burden of diseases attributable to dietary risks in Africa after 2021, projected to 2040.

Analysis of the overall temporal trends in prevalence of diseases attributable to sub-optimal diet in Africa

The number and age-standardized rate from 1990 to 2021 were employed to assess the overall temporal trends in the burden of diseases. For estimating the age-standardized prevalence rate, the direct method for age standardization was utilized, which assumes that the rates are distributed as a weighted sum of independent poisson random variables [15, 16]. Additionally, the relative proportions of disease prevalence stratified by fifteen age groups (25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, 85–89, 90–94, 95 plus) were calculated, and stratified by gender, to illustrate the temporal changes in the age distribution of prevalence.

APC analysis of prevalence attributable to sub-optimal diet in African population

The Age-Period-Cohort (APC) model emphasizes the determination of the contributions of age-related natural histories, contemporary time-related medical technologies and social factors, as well as early-life related health behavior patterns and social exposures to disease trends. It can determine the net drift and local drift of disease burden over time, representing the overall temporal trend and temporal trend within each age group, respectively. Additionally, it can estimate the age, period, and cohort effects, which may help to gain an in-depth understanding of disease epidemiology and identify potential gaps in different aspects of prevention, management, and treatment programs. The methodological details of the APC model have been thoroughly discussed elsewhere [17]. In this study, we used the (APC) model framework to analyze the temporal trends in prevalence by age, period, and birth cohort. When preparing input data for the APC model, we adopted prevalence estimates and population data for each African country or region from the GBD 2021. Typically, age intervals must equal period intervals, meaning that 5-year age groups should be used with 5-year calendar periods.

Result

Trends of death number and mortality rate from 1990 to 2040 attributable to dietary risks in Africa

In 2021, sub-optimal diets contributed to 0.64 million (95% UI, 0.59-0.70 million) deaths, which accounted for 5.76% of all-cause deaths. The death number related to sub-optimal diet has increased greatly over the past 31 years and were projected with a rise from 2021 to 2040 (Fig. 1A). The numbers of deaths attributable to sub-optimal increased from 0.35 million (0.32-0.39 million) in 1990 to 0.64 million in 2021, an increase of 82.9%. There was a projected increased to 1.62 million deaths in 2040 without effective interventions. Between 1990 and 2021, the age-standardized death rate per 100,000 population attributable to sub-optimal diet decreased by 18.8%, from 262.1 to 212.8. The projected age-standardized rate of death was 238.9 in 2040 (Fig. 1A). It is interesting that the age-standardized rate first reaches the peak in 2022 (219.5 (95% UI, 218.9-220.0)) , then decreases smoothly to 2030 (216.3 (95% UI, 215.8-216.7)). After that, it increases slowly until it exceed 2021 again in 2034, and rises smoothly according to prediction (Fig. 1A, S1), perhaps because of population aging and rapid increasing in metabolic diseases related to dietary mode changes.

The numbers of DALYs attributable to sub-optimal increased from 9.79 million (0.96-1.00 million) in 1990 to 18.1 million in 2021, an increase of 84.9%. There was a projected increased to 45.6 million in 2040 without effective interventions. Between 1990 and 2021, the age-standardized DALYs rate per 100,000 population attributable to sub-optimal diet decreased by 20.3%, from 6047 to 4814. The projected age-standardized rate of DALYs was 5753 in 2040 (Fig. 1B). It is interesting that the age-standardized DALY rate first reaches the peak in 2023 (4829 (95% UI, 4831-4826)) , then decreases smoothly to 2030 (4797 (95% UI, 4795-4799)). After that, it increases slowly until it exceeds 2023 again in 2032, and rises smoothly according to prediction (Fig. 1B, S1).

Trends of all cause disease burden attributable to dietary risks by age in Africa

We investigated the age-specific burden of diseases attributable to dietary risks, found that the numbers of deaths peaked between 65 and 74 years of age [Death: females 41.8 (13.6-64.1) thousand, males 44.1 (9.1-68.7) thousand]. The numbers of DALYs peaked between 60 and 64 years of age [DALYs number: female 1.08 (0.31-1.65) million, male 1.29 (0.25-2.01) million] (Figures 2A, 2B). The crude rates of deaths and DALYs peaked over 95 years of age [Death rate: female 3.97 (1.6-5.89) thousand, male 3.81 (0.97-5.94) thousand; DALY rate: female 33.83 (13.92-50.24) thousand, male 32.72 (8.65-50.71) thousand]. (Figures 2C, 2D). A distinct gender disparity was observed between ages 25 and 69, with males bearing a greater disease burden for both deaths and DALYs, which reversed over 70 years of age (Figures 2A, 2B), as the similar trends in the crude rates of deaths and DALYs (Figures 2C, 2D).

The Trend of diet-attributable diseases by Africa region

Across African regions, highest proportional diet-attributable disease burden was in North Africa (8.52% (95% UI: 0.66–13.77%)), following Central Africa (4.79% (95% UI: 1.39–7.17%)), Eastern Africa (4.68% (95% UI: 1.72–6.82%)) and Southern Africa (4.12% (95% UI: 1.74–5.90%)). The lowest proportional diet-attributable burdens of diseases were in Western Africa (3.52% (0.99–5.40%)).

We identified heterogeneity in attributable burdens of diseases based specific dietary factors at regional levels. Nine specific suboptimal diet modes were estimated to be most prominent in Northern Africa among the five African regions, including diet low in whole grains (3.33% (1.47–5.10%)), low in omega 3 seafood fatty acids (1.18% (0.23–2.07%)), low in polyunsaturated fatty acids (1.26% (-3.99–4.75%)), low in nuts and seeds (1.18% (0.35–1.94%)), low in legumes (0.26% (-0.20–0.70%)), high in red meat (0.23% (0.00–0.38%)), high in trans fatty acids (0.72% (0.07–1.33%)), high in sugar-sweetened beverages (0.15% (0.07–0.24%)), and low in milk (0.08% (0.03–0.13%)). Conversely, the burdens attributable to two specific suboptimal diet modes were lowest in Northern Africa: low in fruits (1.11% (0.75–1.45%)) and low in vegetables (0.60% (0.38–0.88%)) (Fig. 3). Some suboptimal intakes were estimated to be associated with a lower disease burden in Western Africa Compared to other regions, particularly diet low in nuts and seeds (0.28% (0.0077–0.047%)) ; low in fiber (0.065% (0.020–0.11%)) ; low in calcium (0.028% (0.015–0.039%))；low in milk (-0.014% (-0.103–0.060%)) and high in sugar-sweetened beverages (0.29% (0.013–0.045%)). In contrast, excess processed meat consumption was associated with a higher burden in Western Africa than other regions (0.297% (0.069–0.505%)). Insufficient fruits intake was estimated to be associated with disease cases in Southern Africa (1.63% (0.81–2.31%)). Low in vegetables (2.00% (0.98–2.87%)) and fiber (0.27% (0.078–0.46%)) were associated with disease cases in Central Africa. The estimated attributable disease burden from excess sodium was (0.81% (0.053–2.06%)) in Southern Africa, while the burden attributable to low in calcium was 0.083% (0.067–0.099%) in Eastern Africa. Large regional differences were observed in the estimated disease burden of excess trans fatty acids, ranging from 1.26% (-3.99–4.75%) in Northern Africa to 0.0002% (0.00002–0.0004%) in Southern Africa (Fig. 3).

Impact of individual components of diet on death and DALYS in males and females

Figure 4 displays the deaths and DALYs attributable to the 15 dietary risk factors for males and females in Africa for 2021. The top five risks for attributable deaths in males were diet low in fruits (85.6 thousand [95% UI 42.8-121.8] deaths, accounting for 26.1% of all male deaths attributable to dietary risks), low in whole grains (81.5 thousand [35.3-121.3] deaths, or 24.8% of all male deaths attributable to dietary risks in 2021); Diet low in vegetables (75.7 thousand [41.6-108.3] deaths, or 23.1%); Diet low in polyunsaturated fatty acids (38.5 thousand [118.0-141.0] deaths, or 11.7%) Diet high in sodium (36.4 thousand [0.867-125.0] deaths, or 11.1%) (Fig. 4A). For females, the top five risks differed slightly. The leading dietary risk factors for attributable deaths in 2021 was also led by diet low in fruits, which accounted for 94.0 thousand (95% UI 53.9–126.3) deaths (29.7% of all female deaths attributable to dietary risks), followed by diet low in vegetables (84.1 thousand (52.5–114.3) deaths, or 26.6% of all female deaths attributable to dietary risks), diet low in whole grains (59.8 thousand (25.8–92.0) deaths, or 18.9%), diet high in sodium (38.3 thousand (1.39–125.4) deaths, or 12.1%), and diet low in seafood omega-3 fatty acids (32.5 thousand (6.41–56.2) deaths, or 10.3%) (Fig. 4B). When viewed in terms of DALYs (Fig. 4 C, D), the ranking of dietary risk factors reflects the age variations in mortality and the contribution of non-fatal disease burden. Most notably, diet low in fluits was the first leading dietary risk factor for both males and females in 2021, accounting for 27.0% of male DALYs attributable to sub-optimal diet and 29.9% of female DALYs. Diet low in whole grains ranked second for males and third for females in terms of attributable DALYs (2.53 million [1.01–3.84], or 26.2% of all male DALYs attributable to dietary risks in 2021; 17.3 million (6.4–27.0), or 20.6% of all female. Diet low in vegetables ranked third for males and second for females (22.2 million [11.5–32.0], or 23.0% of male DALYs; 21.5 million (12.6–29.7), or 20.6% of all female)(Fig. 4 C, D).

Leading causes of deaths, DALYs and change of disease burden attributable to dietary risks in Africa, 1990–2021

In 2021, dietary risks in Africa accounted for 78.5%, 8.3%, and 6.3% of suboptimal diet-related deaths due to cardiovascular diseases, diabetes mellitus (DM), and cancers, respectively (Fig. 5). From 1990 to 2010, the leading causes of death increased by 46.1% for ischemic heart disease, 25.3% for hypertensive heart disease, 19.7% for stroke, 83.9% for DM, and 72.9% for chronic kidney disease. Notably, the number of death due to DM increased most significantly during this period. From 2010 to 2021, the top five causes continued increase by 28.0% for ischemic heart disease, 27.9% for hypertensive heart disease, 18.7% for stroke, 38.0% for DM, and 43.6% for chronic kidney disease respectively. In terms of DALYs, cardiovascular diseases, DM, and cancer accounted for 74.0%, 12.5% and 6.76% of sub-optimal diet-related DALYs in 2021, respectively (Fig. 5). The leading causes of DALYs remained consistent between both time periods. From 1990 to 2010, the five leading causes increased by 43.1% for ischemic heart diseases, 23.1% for hypertensive heart disease, 19.5% for stroke, 102.0% for DM, and 71.1% for chronic kidney disease. From 2010 to 2021, the top five causes continued to increase by 27.0%, 27.5%, 19.9%, 54.3%, and 43.5% respectively.

Age-standardized rates and estimated annual percentage change for diet-attributable diseases in African countries, 1990 and 2021

There were marked variations of burden of diseases attributable to dietary risks at national level from 2010 to 2021 in Africa. In 2021, the **Age-standardized death rate (**ASDR) per 100,000 people attributable to dietary risk factors was highest in the Central African Republic (193.39 [66.28 to 297.83]), Lesotho (184.89 [78.56 to 273.31]), and Guinea-Bissau（173.92 [43.55 to 264.20]）, while the lowest rates were occurred in Nigeria (77.65 [19.35 to 122.93]), Niger (82.27 [30.17 to 128.71]) and Uganda (82.66 [26.57 to 132.63]). From 1990 to 2021, ASDRs decreased in 37 nations, with the largest decrease in Rwanda (53.0%), and increased in 17 nations, with the largest increase in Lesotho (60.6%) (Table 1). From 2010 to 2021, highest annual percentage change of ASDR attributable to dietary risk in Africa was observed in Lesotho (2.45 [1.95 to 2.96]) and Zimbabwe (1.71 [1.2 to 2.23]), while highest absolute value of lowest negative change was observed in Rwanda (-3.53 [-3.95 to -3.11]) and Ethiopia (-2.57 [-2.73 to -2.4]) (Table 1).

In 2021, the DALYs per 100,000 people attributable to dietary risk factors were highest in the Central African Republic (4669.73 [1489.12 to 7180.58]), Lesotho (4374.94 [1774.61 to 6507.19]), and Guinea-Bissau (4222.43 [1070.22 to 6327.93]), with the lowest rates observed in Nigeria (1732.17 [414.75 to 2736.71]), Kenya (1788.11 [701.03 to 2714.30]), and Uganda (1846.38 [526.82 to 2961.25]). From 1990 to 2021, the DALY rates decreased in 39 nations, with the largest decrease also in Rwanda (60.0%), and increased in 15 nations, with the largest increase in Lesotho (73.7%) (Table 1). From 2010 to 2021, the highest annual percentage change of DALY rates attributable to dietary risks in Africa was observed in Lesotho (2.67 [2.14 to 3.20]) and Zimbabwe (1.98 [1.41 to 2.55]), while the highest absolute value for negative change was seen in Rwanda (-4.01 [-4.47 to -3.55]) and Ethiopia (-2.84 [-3.01 to -2.66]) (Table 1).

African age-standardized SEVs and annualized rate of change over 1990–2021, by dietary risk factor

Summary exposure values (SEVs) quantify risk exposure by accounting for both the severity and proportion of the population exposed. These values are comparable across different risk factors with varying exposure patterns. In 2021, sub-optimal diet risk exposure was highest for low intake of polyunsaturated fatty acids (SEV 75.64 [95% UI: 44.04–87.26] on a 0–100 scale), followed by low intake of milk (64.88 [62.89–73.76]), low intake of whole grains (43.75 [36.13–49.23]), low intake of fruits (40.90 [34.85–42.89]), and high intake of sodium (39.97 [11.73–8.99]) (Table 2).

Among the 15 specific dietary risk factors, over exposure of sugar-sweetened beverages increased considerably between 1990 and 2021, with an estimated annual change rate of 1.17% (1.15-1.2%). Among these dietary risks, exposure to high in trans fatty acids experienced the largest annual declines between 1990 and 2021, at -2.7% (-3.13 to -2.27%), followed by low in seafood omega-3 fatty acids (an annual decline of -1.19% [-1.27 to -1.11]), low in fiber (-1.1% [-1.19 to -1.01]), and low in nuts and seeds (-1.03% [-1.07 to -0.99%]) (table 2).

Age-standardized rates and estimated annual percentage change for diet-attributable diseases in Africa and Globe, 1990 and 2021

The age-standardized rates per 100,000 population for Africa and Globe in 1990 and 2021 are listed in table 3. In 1990, the estimated age-standardized rates per 100,000 population of death, DALY and YLL in

Africa were 145.47 (48.53 to 213.19), 3343.19 (1042.69 to 4878.22), and 3200.69 (988.04 to 4658.11), respectively. These rates were all higher than those of the Globe, which were 134.11(38.78 to 198.33), 3047.99 (889.68 to 4408.01), and 2884.26 (834.28 to 4153.29), respectively. The estimated annual percentage change (EAPC) from 1990 to 2021 indicated that both Africa and Globe experienced a decrease in the mortality rate (Africa, -0.74% [95% UI -0.79% to -0.7%]; Globe, -1.54% [-1.59% to -1.49]), DALY (Africa, -0.82% [-0.87% to -0.78%]; Globe, -1.39% [-1.44% to -1.34]) and YLL (Africa, -0.93% [-0.98% to -0.89%]; Globe, -1.57% [-1.62% to -1.51]). While the age-standardized YLD rates per 100,000 population of YLD attributable to dietary risks in Africa was lower than those of the Globe in 1990, the YLD rate of Africa has increased from 1990 to 2021, with an average annual growth rate exceeding that of the Globe (Africa, 1.04% [1.0% to 1.08%]; Globally, 0.85% [0.83% to 0.88]). Despite this increase, the YLD rate in Africa (197.19 [53.91 to 334.89]) remained lower than that of the Globe (214.41 [64.55 to 349.89]) (Table 3).

Discussion

This study comprehensively demonstrated the trend of disease burden attributable to dietary risk factors across African regions and countries from 1990 to 2021, utilizing measurements of mortality and DALYs. The absolute numbers of deaths and DALYs attributable to sub-optimal diet increased from 1990 to 2021, with projections indicating further increased by 2040. The top there dietary risk factors for mortality in 2021 were low fruit intake, insufficient vegetable consumption, and inadequate whole grain intake. Cardiovascular diseases emerged as the leading causes of diet-related deaths. Additionally, significant disparities by gender and location remain evident. North Africa exhibited the highest proportion of diet-attributable disease burden, followed by Central Africa. The age-standardized rate of death and disability-adjusted life years linked to dietary risk factors were highest in the Central African Republic, Lesotho, and Guinea-Bissau. Furthermore, males had a greater disease burden compared to females. These findings highlight the critical need for targeted interventions and policies to address dietary risk factors, mitigate disparities, and ultimately reduce the disease burden across different regions in Africa.

Our analysis revealed that from 1990 to 2021, the African death and DALY number attributable to dietary risk factors exhibited an increasing trends. There was a projected increasing to 1.62 million deaths in 2040 without effective interventions, an increase of 153% compared to 2021. There was a projected increasing to 45.6 million DALYs in 2040 without effective interventions, an increase of 152% compared to 2021. Although death rate and DALY rate decline slightly in the initial stage after 2021, they exhibite prominent increasing after 2030 and exceede the peak rate in our prediction. This trends brings a heavy burden to Africa. The more substantial burden is partially ascribed to population growth and aging in Africa [18], partially to the augmented burden of non-communicable diseases engendered by variations in dietary patterns, and conceivably also to inadequacies in health policies and healthcare services, and even involves economic instability factors. The intensification of the burden of diet-related diseases will exert greater stress on Africa.

After analyzing 15 dietary risk factors in Africa, we identified three principal dietary risk factors contributing to the majority of the corresponding burden of disease, namely low fruit intake, low vegetable intake, and low whole grain intake. A previous study [19] demonstrated that the top three causes of death attributed to low fruit intake were ischemic heart disease, stroke, diabetes and kidney disease. This study discovered a close association between cardiovascular metabolic deaths and insufficient dietary intake. The proportion of diet-related cardiovascular metabolic deaths was the highest, with 7.5% attributed to low fruit intake. The reason might be intimately linked to the functions of various vitamins, minerals, and other nutrients abundant in fruits [20, 21]. It is hypothesized that individuals in low-income and lower-middle-income countries might lack awareness of the health benefits of fruits, and due to transportation limitations, fruits cannot access the fresh food market [22]. Long-term prospective observational studies and some short-term trials have furnished supporting evidence for the potential causal relationship between vegetables and chronic non-communicable diseases [23–24]. Between 2000 and 2012, the average fruit intake of South African adults (≥ 25 years old) declined by 7%, from 48.5 grams per day to 45.2 grams. Vegetable intake dropped by 25%, from 146.9 grams per day to 110.5 grams [25]. The low consumption level of fruits and vegetables is part of a more "westernized" diet, which was evident among participants in the PURE study [26–27]. Low fruit intake and low whole grain intake are also the two of the top three unhealthy diet modes worldwide. Over the past decade, there has been a mounting body of evidence suggesting that transitioning diets from unhealthy animal-based foods (such as red meat and processed meat) to healthy plant-based foods (such as fruits, vegetables, and whole grains) might be associated with reduced greenhouse gas emissions and, consequently, might be more environmentally sustainable [28–31].

Our study found that there were age and gender related disparities in the overall number of deaths and disability-adjusted life years (DALYs) attributed to dietary risk factors. Among individuals aged 25 to 69, it was observed that men bear a heavier disease burden in terms of death and DALY. The death number of male reached its peak at ages 65–69, while female peaked at ages 70–74, with the peak in male occurring 5 years earlier than that of female. This might be associated with the protective effect of female estrogen. Generally speaking, regardless of genetic ancestry, geographical location and age, cancers occur in XY individuals are more prevalent than those in XX individuals [32]. Gender differences are also manifested in energy and metabolic balance, as well as the onset and progression of diabetes complications [33].

In all five regions of Africa, the proportion of diet-related disease burden in North Africa was the highest (8.52%), with nine specific sub-optimal dietary patterns being most prominent in Africa, including low intake of whole grains, low intake of omega-3 seafood fatty acids, low intake of polyunsaturated fatty acids, low intake of nuts and seeds, low intake of legumes, high intake of red meat, high intake of trans-fatty acids, high intake of sugar-sweetened beverages, and low intake of milk. At the same time, the burden of two specific sub-optimal dietary patterns was the lowest in North Africa: low intake of fruits and low intake of vegetables. These characteristics could be explained by the geographical location, climate, economy, and cultural traits of North African. The people in this nation ought to be encouraged to consume a considerable amount of sea food, nuts and seeds, whole grains, legumes and seafood, in the meanwhile, reduce the intake of trans-fatty acids and sugar-sweetened beverages.

Our research shows that in Africa, based on age-standardized summary exposure values (SEVs), the sub-optimal diet risk exposure with low intake of polyunsaturated fatty acids was the highest in 2021, followed by low intake of milk, low intake of whole grains, low intake of fruits, and high intake of sodium. Notably, among the 15 specific dietary risk factors, the excessive exposure to sugar-sweetened beverages increased significantly from 1990 to 2021, with an estimated annual growth rate of 1.17% (1.15–1.2%). Sugar-sweetened beverage intake is associated with weight gain, diabetes, and metabolic syndrome [34–35]. Fortunately, among these dietary risks, the high exposure to trans-fatty acids experienced the largest annual decrease rate between 1990 and 2021 (-2.7% (-3.13 to -2.27%)). The significant decrease in the standardized exposure value of trans-fats highlights the effectiveness of the increasing implementation of trans-fat bans in various regions, and existing effective actions should be maintained. Taxing sugar-sweetened beverages is a strategy to reduce the associated burden, but other policies, such as public health awareness campaigns to enhance the awareness of health risks, may also be appropriate [36–37].

In 1990 and 2021, Africa had a higher mortality rate, disability-adjusted life years (DALYs), and years of life lost (YLL) due to diet-related risks per 100,000 population than the global. From 1990 to 2021, estimated annual percentage change (EAPC) decreased in both Africa and the global, but decline was relatively slower in Africa. In 1990, the age-standardized rate of years lived with disability (YLD) per 100,000 population due to diet-related risks in Africa was lower than the global. From 1990 to 2021, the estimated annual growth rate of YLD in Africa exceeded the global, but YLD of Africa was still lower than the global in 2021. These differences are related to dietary modes in Africa, as well as the differences in food supply, storage methods, and eating habits in Africa compared to other regions. It cannot be ignored that the deficiencies in Africa's economy, healthcare, and social security may lead to more differences. To improve the burden of diseases caused by sub-optimal diet in Africa, the required actions should be multi-faceted and multi-level. The priority of policy actions should be adjusted based on all the results paired with risk factors and the potential rate of YLD for related outcomes.

In conclusion, our study estimated the burdens of disease attributable to dietary risk both in mortality and DALYs in Africa. The overall trends in mortality and DALY numbers and rates decreased from 1990 to 2021; however, projections indicate a potential increasing from 2021 to 2040. This highlights the urgent need for systematic strategies to address the disease burden associated with sub-optimal diets, particularly in the context of urbanization and an aging population in Africa. Importantly, three of the top risk factors for mortality, namely low fruit intake, low vegetable intake, and low whole grain intake, differ from global trends, underscoring the crucial need to enhance fruit and vegetable consumption. Furthermore, significant disparities by gender and location remain evident. Our study could raise public awareness regarding the dietary-related disease burden and provides evidence to support the implementation of region and gender specific health policies in Africa.

Limitation

Global disease burden studies offer policymakers, researchers and planners qualitative, comprehensive and latest evidence regarding global, regional and national disease burdens. This research has performed a significant and precious role, especially for Africa. Nevertheless, the main constraint of this study lies in the quality of data sources. For instance, the epidemiological evidence of the causal relationship between dietary risks and disease endpoints primarily stems from observational studies. Dietary data come from diverse sources and are not applicable to all nations. Deaths resulting from certain dietary risk factors may not be mutually exclusive, which could potentially lead to an over estimation of the disease burden attributed to diet risks. Considering the complexity of dietary behaviors and their extensive influence on diet risks, it demands active cooperation from various actors throughout the entire food system, along with policies targeting numerous sectors of the food system, to improve diet modes.

Declarations

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Authors Contributions

PF.S and HY.H conceived the study. HY.H performed the literature and figures. PF.S and HY.H contributed to data acquisition, performed data analysis, wrote this manuscript. PF.S conceived the study, secured funding, and was responsible for overall study direction. All authors contributed to the manuscript preparation and approved the final version for submission.

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Tables

Tables 1 to 3 are available in the Supplementary Files section

Figures

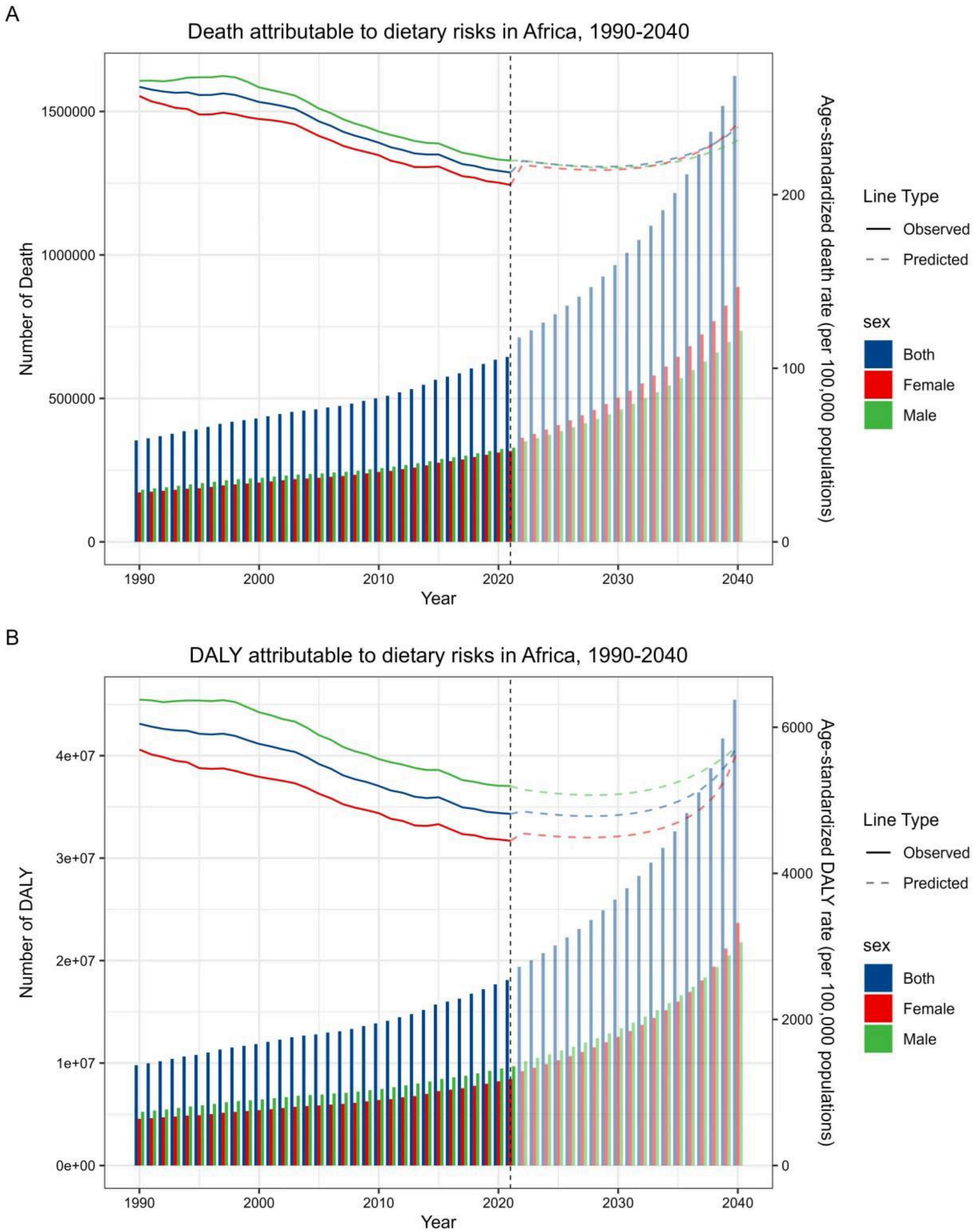

Figure 1

Disease burden attributable to dietary risks from 1990 to 2040 in Africa.

A shows the prediction of death number and age-standardized death rate of diseases attributable to dietary risks. B shows the prediction of death number and age-standardized DALY rate of diseases attributable to dietary risks. DALYs, disability-adjusted life-years.

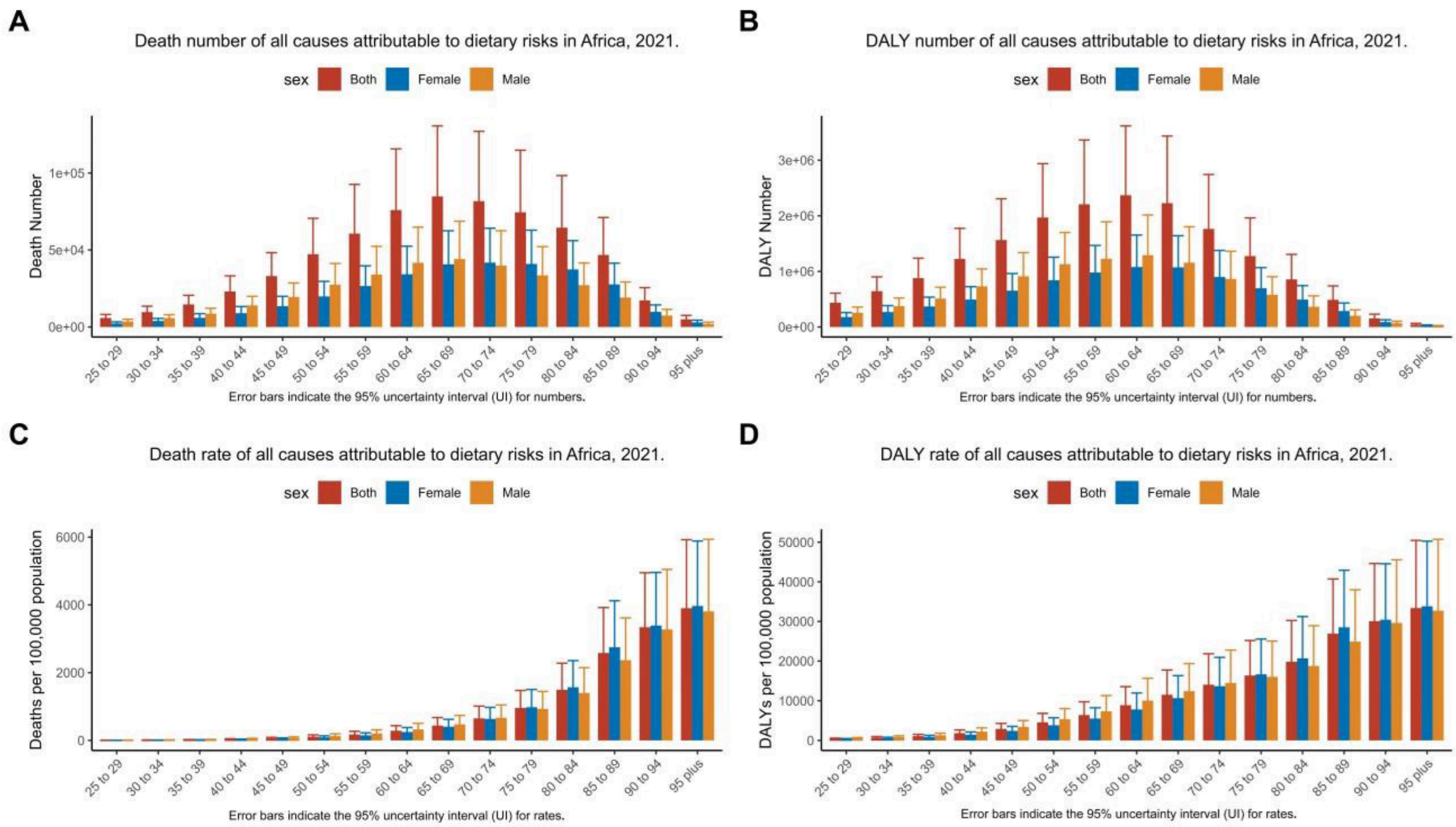

Figure 2

The burden of diseases attributable to dietary risks in Africa by age in 2021.

(A, B) shows the numbers of deaths and DALYs of diseases attributable to dietary risks. (A) Deaths; (B) DALYs; (C, D) shows the age-standardized rates of deaths and DALYs of diseases attributable to dietary risks. (C) Deaths; (D) DALYs; DALYs, disability-adjusted life-years

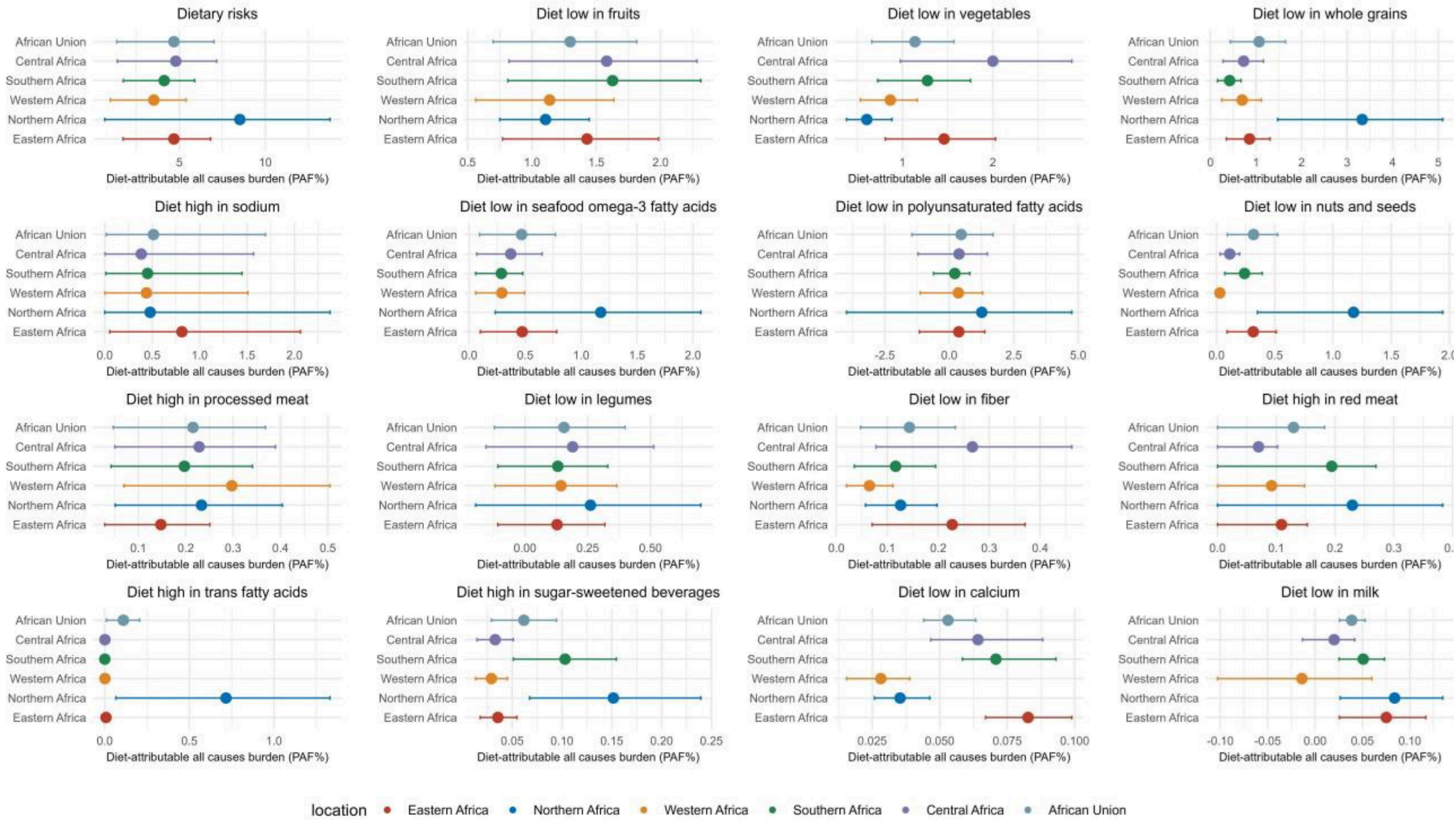

Figure 3

The proportional burden of diseases attributable to sub-optimal intake of individual risk factors by Africa region in 2021. Bars represent the estimated percentage of all diseases incidence due to sub-optimal intake of overall dietary risks and fifteen individual dietary factors separately. Geographically, Africa is customarily divided into Eastern Africa, Western Africa, Southern Africa, Northern Africa, and Central Africa. Data are presented as the central estimate (median) and the corresponding 95% UI, derived from the 2.5th and 97.5th percentiles of 500 multi-way probabilistic Monte Carlo model simulations.

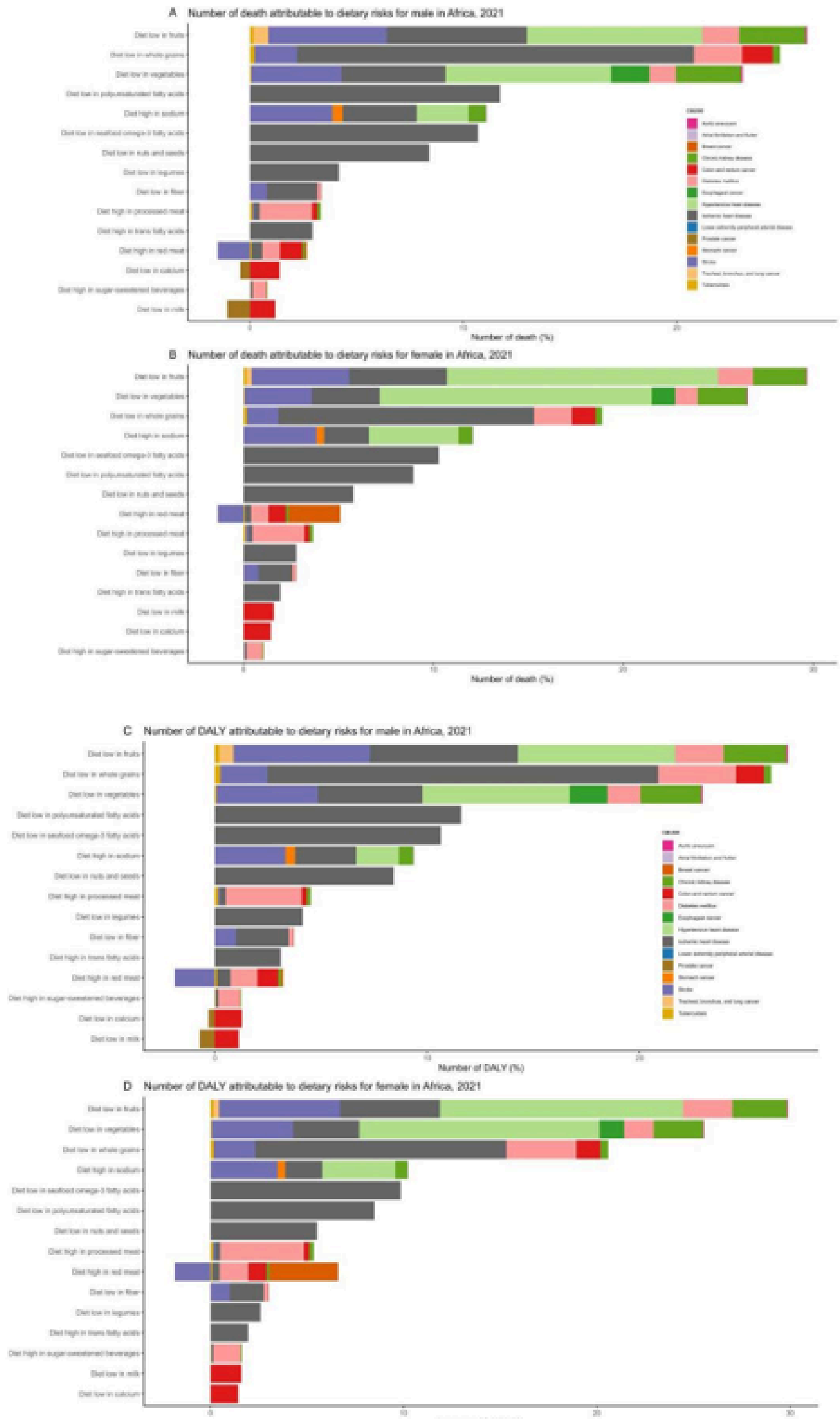

Figure 4

The proportional burden of individual disease attributable to dietary risk by Africa region in Africa. (A, B) Death number; (C, D) DALY number. DALY=disability-adjusted life-year.

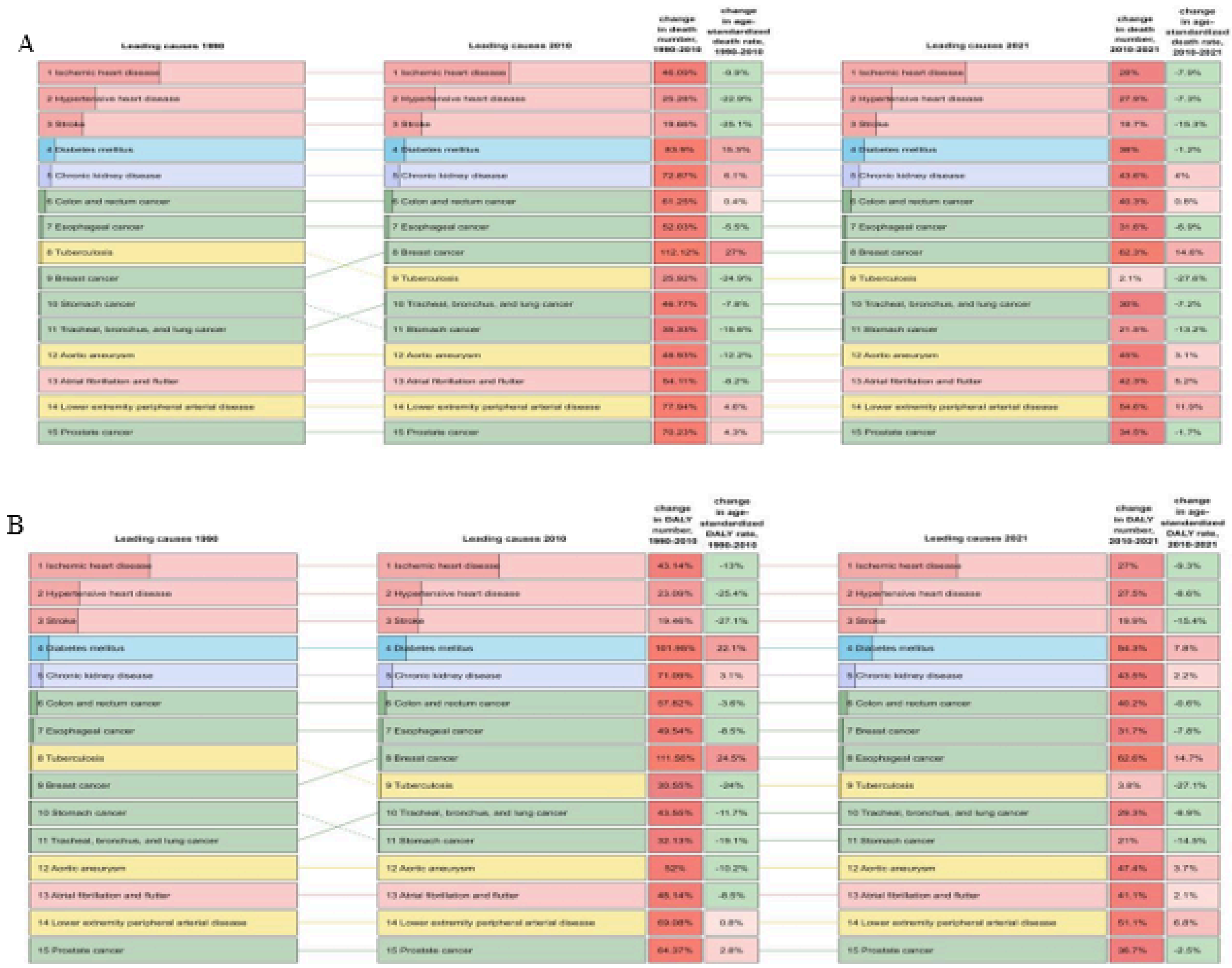

Figure 5

Leading causes of deaths and DALYs attributable to dietary risks in 1990, 2010, and 2021 with percentage change of number and age-standardized rates in African. A: Death number; B: DALY number. Solid lines indicate increases and dashed lines indicate decreases in rank between periods. The darker part in each column represents the proportion of corresponding causes.

Supplementary Files

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- Fig.S1.docx
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