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Article

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The contribution of trade openness to health outcomes in sub-Saharan African countries: A dynamic panel analysis

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ABSTRACT

This study examines the contribution of trade openness to health outcomes (measured in terms of under-five mortality and life expectancy) in 33 sub-Saharan African countries using a two-step system Generalized Methods of Moments (GMM) estimator over the year 2000–2016, while controlling for endogeneity of variables (i.e. omitted variables bias and reverse causality). The findings show that, trade openness and measles vaccination reduces under-five mortality in the region. The findings reveal that, trade openness, income (GDP per capita), and health financing (total public and private health expenditure) all contribute to a longer life expectancy. Overall, it was found that trade openness is statistically significant and contributes to health improvement (i.e. under-five mortality and life expectancy). This implies that the health sector in sub-Saharan African countries is not at risk as a result of increased trade. However, the study recommends easing and increasing trade to allow governments to obtain more financial resources to improve the welfare of their people, to include health professionals in future trade negotiations and agreements for public health benefits, and take steps to remove import duties on health related products. These findings have significant implications for sub-Saharan Africa, as well as other developing countries.

Introduction

In 2015, the World Health Organization and its member states declared to work on health and trade while maximizing opportunities to promote public health and risks minimization (Smith et al., 2015). Many people around the world travel each year to seek medical care in other countries, contributing to the economy through medical tourism. The movement of people across the border to seek medical care and its associated goods and health services can affect the health system and the health of the population as a whole. Likewise, regional trade agreements and new trade negotiations continue to exist worldwide, including sub-Saharan Africa, and have increased over time. In general, international trade integration has grown in recent decades (Calderón et al., 2020).

Conversely, sub-Saharan Africa continues to struggle with the provision of healthcare services. To reduce the disease burden in the region, significant investments are needed in physical healthcare (i.e. Diabetes, stroke, heart diseases, malaria, HIV and Tuberculosis). Although sub-Saharan Africans face many challenges, their lives have improved. For instance, the average life expectancy in sub-Saharan Africa was 50 years in 2000 and 61 years in 2018 (World Bank Indicators, 2019). The under-

five mortality was 151 deaths per 1000 live births in 2000 and there were 78 deaths per 1000 live births in 2018 (World Bank Indicators, 2019). This remarkable progress in health outcomes and the widening of trade openness motivates the authors to study the links between trade openness and health outcomes in African context.

Free trade has been one of the key determinants of economic development in different countries that create employment, transfer of knowledge, generate foreign exchange, increase competition among firms, increase income and reduce poverty in many countries (Calderón et al., 2020; Were, 2015; Sakyi et al., 2015; Zahonogo, 2016; Nguyen, 2015). It also supports countries to create both imports and exports of goods and services through economic opening of cross-border flows. Trade openness can influence health through different channels either in positive or negative ways. For example, trade policies can impact on nutritional consumption, beverages, and pharmaceutical drugs. Similarly, developing countries like sub-Saharan Africa usually import low-cost manufactured products from China markets. It is also likely that, the consumption of food, beverages and tobacco products via trade agreements between regions (i.e. sub-Saharan Africa, Europe and China) can shape macroeconomic structure that can either create risks or

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benefits to public health. For example, childhood obesity can be linked to trade in terms of food accumulation and consumption formula for infants and food without nutrition. Trade openness can also affect health when business people interact and may spread infectious diseases such as HIV and COVID-19 that can pose a threat to the public health. Similarly, pollution associated with trade has a direct health effects (Barlow et al., 2021). For instance, high income countries export hazardous materials to low income countries such as electronic waste that releases toxicants (Zhang et al., 2017). It has been estimated that >700,000 people have died as a result of pollution associated with import goods in Western Europe from China (Barlow et al., 2017; Schram et al., 2020). In turn, high prevalence of tropical diseases like malaria in developing countries deteriorates trade and health (McArthur and Sachs, 2001). This implies that traders are not preferred in malaria-prone areas as these areas can cause risks to both trade and health sectors. Long term increases in life expectancy are another important channel in trade openness (Alam et al., 2016).

In sub-Saharan Africa, there are few studies that link trade with health outcomes measured in terms of child health and life expectancy. Therefore, this study updates the existing literature and explores the weaknesses of recent studies undertaken in sub-Saharan Africa (for example Nguyen, 2015; Sakyi et al., 2018; Novignon et al., 2018) to examine the links between trade openness and health outcomes. Our study considers sub-Saharan African countries because the regions had become increasingly traded in recent years due to availability of information and technology (i.e. e-health) and wider involvement of private-public sector partnerships in terms of trade negotiations and agreements. In the same vein, both trade and health have given priority in the Sustainable Development Goals by 2030 (United Nations, 2015). This means that policy makers can access and make decision regarding to international trade agreements, as well as their associated health risks and benefits. These highlight the fact that, the recent rise in trade volume between Africa and China can adversely affect the health systems and policy through trade negotiation (See, Smith et al., 2009).

This study differs from existing ones on the links between trade and health outcomes for a number of reasons. First, it focuses in sub-Saharan African countries. Second, understanding the links between trade and health outcomes is important in both research and practice especially in context of recent Sustainable Development Goals (SDGs). Third, the study reveals sub-Saharan Africa trade growth and health outcomes, which can assist decision makers developing new trade negotiations and agreements in the regions. Fourth, endogeneity is addressed in a way that has been overlooked by previous studies in sub-Saharan Africa (See for example, Sakyi et al., 2018; Novignon et al., 2018). Generally, our study contributes to the literatures using a two-step system Generalized Method of Moments (GMM) estimator to deal with endogeneity concerns. In statistical models, the GMM method estimates parameters and controls endogeneity of variables (i.e. reverse causality, omitted variable bias). It is an extension of instrumental variable that uses internal instruments sufficiently to estimate the results. As part of the estimation process, it combines two equations in terms of levels and differences, and uses an instrument count to eliminate endogeneity of variables (Arellano and Bover, 1995; Blundel and Bover, 1998; Roodman, 2009; Kinyondo and Byaro, 2020). We also use the GMM estimators in this case because there is a short time period (i.e. $T < 30$ years) and large cross-section units (N). Likewise the regressors used in this study are not strictly exogenous like those assumed to fixed and random effects models (Byaro, 2021a). Recently published studies in sub-Saharan Africa like (Sakyi et al., 2018; Novignon et al., 2018) had some weaknesses in their use of GMM estimators, and both failed to report the number of instruments count that control endogenous variables (i.e. omitted variables bias, reverse causality), as Byaro & Mpeti, 2021c; Roodman, 2009a,b; Byaro, 2021 have pointed out.

In GMM estimators, reporting the number of instruments and all other specifications (i.e. Hansen Test, autocorrelation test) are essential. In studies like (Sakyi et al., 2018; Novignon et al., 2018), the numbers of

instruments are not included in the estimation results, raising the possibility that either too many instruments were used or the endogenous regressors were over fit. This could bias the overall estimates and lead to erroneous conclusions and policy implications (See Roodman, 2009c; Byaro, 2021a). The dynamic panel data model used in this study is more sensitive to endogenous variables than static panel data models used in other studies like Herzer, 2017; Levine & Rothman, 2006; Owen & Wu, 2007; Razmi & Yavari, 2012. To this end, the current study aims to close this gap by examining the contribution of trade openness to health outcomes using dynamic panel data models with all specification choices in the two-step GMM estimators (See; Kinyondo et al., 2021; Byaro, 2021b Roodman, 2009; Mehrhoff, 2009). Moreover, there is concern that previous studies linking trade and health investments agreements were weak and that very few addressed the problem of unobserved confounding (See, Barlow et al., 2017).

It is against this background, our study applies GMM estimators to a dynamic panel data model and uses Roodman (2009) *collapse* option to ensure that the number of instruments controlling endogenous variables are smaller than the number of countries in order to avoid inconsistency with estimation results (See, Byaro, 2021a). This is particularly important in addressing the limitation of previous studies failed to report instrument counts.

Our results show that trade openness, GDP per capita (income), health financing (total public and private health spending) and measles vaccination all contributed to a decline in the region's under-five mortality from 2000 to 2016. Similarly, the findings reveal that trade openness; health financing and GDP per capita (income) improves life expectancy. In addition to the sensitivity tests, our results are robust due to lags of endogenous variables, Hansen test of over-identifying restriction and Arellano Bond of Second Order Serial-Correlation test (AR-2).

Linking trade openness and health outcomes

Different studies have shown that trade openness can affect health through various channels. First, trade openness creates high income which contributes to economic growth. Further, higher income supports households to buy foods and nutrition, clean water, health care treatment and prevention, better housing and raise the standard of living (Alam et al., 2016; Levine and Rothman, 2006). In other words, a healthier economy is associated with a healthier lifestyle. A similar situation exists with regard to nutrition-related imports or exports, which can increase a country's economic competitiveness, but can also pose risks to the health sector and, ultimately, health care provision. Technology transfer is among the channels that affect health through pharmaceutical research and development (Xu and Wang, 2000; Owen and Wu, 2007; Smith et al., 2009). This means that public health can benefit from improved technology such as innovation in medical treatment and pharmaceuticals through importation. Therefore, the link between trade openness and health outcomes can operate through income, medical supplies and drugs, immunization rates (vaccines), health expenditures and population (Owen and Wu, 2007; Levine and Rothman, 2006; Byaro and Musonda, 2017). Other benefits of trade is that it can increase interactions between countries and knowledge transfer about disease treatments and standard health practices, which can be used to design public health programs and its administration (Owen and Wu, 2007).

Conversely, a country with better institutional quality and low corruption, the effect of trade on child health becomes much stronger (Dithmer and Abdulai, 2020). Trade openness can also affect child health through governments spending on health care after getting tax revenues from trade activities (Agbeyegbe et al., 2006; Sakyi et al., 2018). This implies that an increase of trade activities in the economy would increase government revenues and later increases health spending on child health. Trade openness is also related to industrialization that cause air pollution in urban settings and affect child health through respiratory diseases (Levine and Rothman, 2006). Free trade is

also bad for health since it promotes economic inequality, insecurity and makes more processed foods available (Stevens et al., 2013). Trade openness may increase life expectancy (Alam et al., 2016) and decreases life expectancy (Qadir and Majeed, 2018). Thus, trade can both promote health and have adverse effects on it. Infectious diseases such as HIV and SAR influenza virus can spread through the open economy (Kawachi and Wamala, 2006). As with the standard of living, trade improves public health by providing quick access to medical supplies (Blouin et al., 2009). Trade can also cause income inequality, environmental pollution and unhealthy products (Blouin et al., 2009; Barlow et al., 2021; Schram et al., 2020; Barlow et al., 2017). Lower infant and child mortality rates in developing countries are linked to greater trade openness; Levine and Rothman, 2006; Papageorgiou et al., 2007). Other studies have concluded that trade openness reduces infant mortality, under-five mortality, and increases life expectancy in developing countries including the following (Owen and Wu, 2007; Sakyi et al., 2018; Novignon et al., 2018; Razmi and Yavari, 2012; Hudak, 2014; Olper et al., 2014 and Herzer, 2017).

Data sources and methodology

Annual panel data (i.e. longitudinal data) were collected in a sample of 33 sub-Saharan African countries between 2000 and 2016. The data set contains observations of various cross sections over time. The countries were chosen based on data availability, and all data was extracted from the World Bank, *World Development Indicators* (2018). Data from the World Bank are available for different countries and indicators over a variety of time period. The variables selected, its units and sources are shown in Table 1. The variable selection was adopted from Levine and Rothman, (2006); Novignon et al (2018) and other theoretical literature.

Model

From the theoretical perspectives, we describe our health production function which includes trade openness and other independent variables, as follows:-

$$Health_{i,t} = \emptyset + \alpha Health_{i,t-1} + \beta trade_{i,t-1} + \gamma Z_{i,t-1} + \epsilon_{i,t} \quad (1)$$

Where, Health represents (life expectancy and under-five mortality), for $i = 1, 2, \dots, N$ (Countries) and $t = 1, 2, \dots, T$ (time).

$\epsilon_{i,t}$ = idiosyncratic error (error term for country i and time t and is calculated by

$$\epsilon_{i,t} = u_{i,t} + Y_t$$

Y_t = time specific fixed effects,

μ_i = is the country specific fixed effects constant in time

$t-1$ = lagged time

Table 1

Variables, units and its sources.

Variables	Unit	Source
GDP per capita (income)	Constant 2010 US dollars	World Development Indicators (2018)
Life expectancy at birth	Total years	World Development Indicators (2018)
Under-five mortality rate	Death per 1000 live births	World Development Indicators (2018)
Trade openness	Import + export ratio to GDP	World Development Indicators (2018)
Measles immunization rate	% of children ages (12–23 months)	World Development Indicators (2018)
Vitamin A supplement coverage rate	% of children ages (6–59 months)	World Development Indicators (2018)
Total health expenditures	% of GDP	World Development Indicators (2018)

Source: World Development Indicators (2018).

$\emptyset, \alpha, \beta, \gamma$ are coefficients of estimated parameters and Z' = Vector of other explanatory variables which includes total health expenditure, GDP per capita, measles vaccination (i.e. immunization rates) and vitamin A supplement. For easy estimation and interpretation of parameters in terms of elasticity, all variables indicated in Eq. (1 & 2) were transformed to logarithmic form in Table 3.

Model estimation

Our variable of interest in the model illustrated in Eq. (1) is trade openness, which is shown by coefficient (β). Since the endogeneity exist between trade openness and other explanatory variables, the actual estimates of β is biased. This is due to reverse causality between trade openness, GDP per capita (income) and health measures (under-five mortality and life expectancy). Similarly ($Health_{i,t-1}$) and ($trade_{i,t-1}$) may be correlated with other unobservable characteristics such as cultural factors and other independent variables such as total health expenditures, which are captured in the error term. To address this endogeneity problem, an instrumental variable approach such as Generalized Methods of Moments (GMM) should be used. The two-step system GMM instruments described by Arellano and Bover (1995); Blundell and Bond (1998), and Roodman (2009) are appropriate for dealing with this endogeneity (i.e. omitted variable bias and reverse causality). We use the system GMM estimators because it is characterized by the lags of the dependent variable, specific country fixed effects, and endogenous independent variables (See Byaro & Mpeta, 2021c; Roodman, 2009a,b; Yameogo, Omojolaibi, & Dauda, 2020). Furthermore, our data contains both large ($N = 33$ countries) and small ($T = 17$ years) samples that are compatibles with the system GMM.

In estimation process, the system GMM eliminates unobservable individual country specific fixed effects and its omitted variable bias by differencing Eq. (1) as follows:-

$$\Delta Health_{i,t} = \emptyset + \alpha \Delta Health_{i,t-1} + \beta \Delta trade_{i,t-1} + \gamma \Delta Z'_{i,t-1} + \Delta \epsilon_{i,t} \quad (2)$$

Moreover, the two step system GMM estimator jointly combines the differenced Eq. (2) and level Eq. (1) and applies a lag in level and differenced variables as an internal instrument to estimate the coefficient of parameters. The instruments in the level Eq. (1) for independent variables are lagged differences, and the instruments in the differenced Eq. (2) are lagged level variables. We used the Roodman (2009) estimator *xtabond2* in the estimation procedure and introduced the *collapse* options to ensure that the number of instrument counts used is less than the number of groups/countries. Both the Arellano Bond test second order correlation test and the Hansen test for over-identifying restrictions are used to assess the validity of internal instruments.

The Hansen test (p -value > 0.10) indicates instrument validity, and Arellano Bond test of second order serial correlation (AR-2, p -value > 0.10) specifies variable stationarity in the model. The lags of

Table 2

Summary Statistics.

Variables	Observation	Mean	Minimum	Maximum	Standard deviations
GDP per capita	561	2035.5	194.87	20,512.9	3217.9
Under- five mortality	561	105.05	38.5	233.1	39.10
Immunization rate	561	72	21	99	16.54
Total health expenditure	500	5.77	0.84	19.73	2.43
Vitamin A	403	70.35	1	99	29.39
Trade openness	538	67.19	19.1	311.35	32.84
Life expectancy	561	56.12	38.7	67.15	5.32

Table 3
Results of GMM estimation for life expectancy and under-five mortality.

Variables	Coefficient estimates	
	Dependent variable = ln Health	
	Life expectancy	Under-five mortality
ln Health t-1	0.911*** (0.018)	0.946*** (0.024)
ln GDP per capita	0.007** (0.003)	-0.004 (0.009)
ln Total health expenditures	0.015* (0.003)	-0.002 (0.016)
ln Trade openness	0.007** (0.008)	-0.025** (0.013)
ln Measles immunization	0.006 (0.010)	-0.041* (0.023)
ln Vitamin A supplement	0.004 (0.01)	-
Second Order Serial Correlation Test	[0.18]	[0.25]
Hansen Test	[0.76]	[0.27]
Number of observation	336	326
Number of instruments	25	20
Number of groups/countries	32	32
Number of lag applied	3	3
Constant	0.215 *** (0.076)	0.516** (0.240)

Note: * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$; Robust standard error in parenthesis.

ln = Natural logarithm.

The p -value for Hansen Test and Second Order Serial correlation test in parenthesis []

endogenous variables and independent variables were limited to one and three periods, respectively. *Stata version 14* was used to analyze the data. Following all the two-step system GMM specifications, the results are ready for interpretation as shown in [Table 3](#)

Results

[Table 2](#) summarizes the descriptive statistics for all variables chosen for the study. Our analysis was based on an unbalanced panel due to the unavailability of data from other countries. The results show that, the average life expectancy and under-five mortality rate in 33 sub-Saharan African countries were 56 years and 105 deaths per 1000 live births, respectively. The average total health expenditures (private and public as a ratio of GDP) were 5.77 percent. The average gross domestic product (GDP per capita) was 2035 US dollars. The average trade openness (import + export ratio to GDP) in sub-Saharan Africa was 67 percent. The average childhood measles immunization rate and Vitamin A supplement coverage were 72 percent and 70 percent, respectively.

[Table 3](#) shows the model estimation results for life expectancy and under-five mortality. The results show that higher GDP per capita, health financing (total health expenditure as a ratio of GDP) and trade openness are associated with an increase in life expectancy. A 10 percent increase in trade openness corresponds to a 0.07 percent increase in life expectancy. Similarly, a 10 percent increase in GDP per capita is associated with a 0.07 percent increase in life expectancy. Further, a 10 percent increase in total health expenditures (public and private) is associated with a 0.15 percent increase in life expectancy. All of these coefficients are statistically significant at 1% and 5% levels as shown in ([Table 3](#)).

The findings also show that a 10 percent increase in trade openness is associated with a 0.25 percent decrease in under-five mortality. Similarly, a 10 percent increase in measles immunization coverage is linked to a 0.41 percent decrease in under-five mortality. These findings are also significant at the 5% and 10% levels. Other variables are not significant, but their coefficient estimates have expected sign in the coefficient estimates. All findings are robust in terms of the second order serial correlation test and the Hansen test (i.e. p -value > 0.10). In our estimation, these tests imply the validity of instrument count (i.e. Hansen test) and no second order serial correlation test (AR).

Discussion of the results

The WTO (World Trade Organization) under the General Agreement

on Trade in service (GATS) advises countries to consider their trading position according to health services ([Adlung and Carzaniga, 2001](#)). In the last two decades, there was a massive health investment in both public and private sectors. This increase of health investment involves trade in health services delivery through export and import of goods and services (i.e. diagnostic tools, drugs). Similarly, an advance in e-health through information and communication technologies has enabled strong partnership between private and public sectors in health services delivery (i.e. interaction between service providers and patients). These highlight show the fact that trade openness and health system delivery exist in interdependent form.

Our study showed that trade openness plays a significant factor in improving life expectancy and reducing under-five mortality in sub-Saharan Africa over the years 2000–2016. The findings reported in this study are consistent with previous literature on the same theme (i.e. [Razmi and Yavari, 2012](#); [Levine and Rothman, 2006](#); [Owen and Wu, 2007](#); [Sakyi et al., 2018](#); [Herzer, 2017](#); [Olper et al., 2014](#)). The main pathways trade openness can influence health outcomes are through medical technology especially importing pharmaceutical products and processed food. Importing pharmaceutical products requires inspection and consultation of good practices for health products manufacturers. This requires a continuous improvement in border control, as well as the quality and safety of pharmaceutical products. For instance, ventilators and personal protective equipment (PPE) are in high demand as a result of the COVID-19 pandemic making health care providers and governments scrambling to obtain supplies. This means that trade can affect health through this mechanism by ensuring that, all countries including those in sub-Saharan Africa, developed countries and other developing countries have access to life saving materials, as well as vaccine and treatment that are both effective and cost-effective respectively.

Another pathway that trade openness impact health outcomes in sub-Saharan Africa operates through higher income. Trade may improve health conditions by increasing government tax revenues, allowing the government to increase health expenditures and improving social welfare ([Agbeyegbe et al., 2006](#); [Sakyi et al., 2018](#)). Trade taxes are major sources of revenues for countries with low incomes, such as those in sub-Saharan Africa. For instance, when other tax sources are unavailable in low and middle income countries, trade revenues provide more fiscal space to fund health systems ([Barlow et al., 2021](#); [Reeves et al., 2015](#)). As a result, any budget shortfall caused by the collapse of trade in sub-Saharan countries can put the health system in danger. Similarly, reductions in trade activities can also affect social protection services, such as water and education, which protect health. This implies that a decline in revenues and spending on social protection is expected to have a negative effect on health (See, [Barlow et al., 2021](#); [Cyrus, 2018](#)). [Owen and Wu \(2007\)](#), for example, found that trade openness is associated with good economic policies that result in better health outcomes in developing countries. In other words, trade can influence economic growth, thereby improving living standards, education, access to healthy foods and medical treatment and prevention, as well as providing clean water and sanitation ([Cyrus, 2018](#)). It also improves regional economic integration and provides the health sector with grants and ODA assistance in sub-Saharan Africa ([Novignon et al., 2018](#)). In this view, it is argued that regional trade agreements should be linked to an increase in the importation of goods and health services, including the consumption of processed foods and some beverages. For health protection, the World Trade Organization (WTO) noted the importance of linking trade and health outcomes ([WTO, 2014](#)). [Herzer \(2017\)](#) found that international trade has a positive long run effect on health in both developed and developing countries like sub-Saharan Africa. This effect is larger in countries with lower development levels and less restrictive business regulations. Similarly, [Ditchmer and Abdulai \(2020\)](#) found that, trade reduces child mortality rates significantly in long run. Their findings also suggest that the impact of trade on child health is stronger in countries with better institutional quality, lower corruption, good governance, political stability and sound policies

that promote private sector.

Another solid argument to illustrate how trade can affect public health outcomes is through the ongoing COVID-19 crisis in the world. To combat the COVID-19 crisis, health related firms (i.e. pharmaceutical companies) produce a range of medical supplies including soap, gloves, drugs, disinfectants, surgical instruments, ventilators, face masks, vaccines and x-ray machines. Without trade openness through the global market, all medical technology and vaccine innovations cannot be produced from one country. One country's efforts would be insufficient to guarantee universal access to essential COVID-19 products across in the world. This means some essential medicines and medical technology would not exist without global trade market. Reduced trade opportunities can lower access to health-related products. Thus, the ongoing COVID-crisis requires trade openness across the border while ensuring safety and cost efficient supply of medicines and other medical supplies. These examples show that trade openness can fight the COVID-19 pandemic and contribute to long term health prospects of people around the world. Sub-Saharan Africa, developed countries, and other developing countries should take note of the COVID-19 pandemic and engage in trade while considering the removal of other trade barriers. This will address the sustainability of the open border system to be in place after the COVID-19 crisis (Ikotun et al., 2021). In this context, the Sustainable Development Goals will be achieved by improving trade openness and business connectivity between countries, which in turn reduce poverty (See, Becker et al., 2021).

A global COVID outbreak, for example, has led to an increase in the demand for a wide range of medical supplies. A total of 77 nations have reduced import barriers for medicines and medical supplies since COVID-19 was declared as a pandemic on 12 March 2020 (Barlow et al., 2021). Before the pandemic, access to these products was restricted by trade barriers. During the pandemic, we have learned that eliminating tariffs on medicines and medical supplies can help save lives. To end this, the supply chains are open to all existing trade restrictions on essential goods related to health (Barlow et al., 2021). In this regard, sub-Saharan Africa governments must do more to ensure that the existing trade policy also contributes to the fight against COVID-19 and protects public health. For instance, in the recent pandemic, the agriculture-related trade policy is vital to the survival of sub-Saharan African population and inclusive growth (Osabohien et al., 2021). A decline in agriculture trade can threaten food security at risk, resulting in acute hunger for a number of people. This means that African countries should also focus on increasing international trade flows and building resilient supply chains (Ujunwa et al., 2021). In turn, reducing trade in unhealthy commodities like alcohol, tobacco and sugar-sweetened soft drinks or increasing taxes on unhealthy commodities, could improve population health in sub-Saharan Africa (See for example, Escobar et al., 2013; World Health Organization, 2016; Sassi et al., 2013).

Employment is another important mechanism in which trade affects health outcomes. In sub-Saharan Africa, anyone whose job is dependent on international trade supply chains or whose production is exported heavily is at risk when trade collapses. They become poor, lose their jobs and became ill as a result of financial insecurities. This means, good health and access to goods and services are strongly linked to employment and income (Barlow et al., 2021; Klug et al., 2019).

On the other hand, our study also shows that health financing (total health expenditure) and GDP per capita (income) improves life expectancy. An increase of one percentage point in trade share results in a 2 percent increase in income per person (Frankel and Romer, 1999). Higher incomes make it easier for parents to enroll their children in schools, fund their education and pay out of pocket healthcare expenditures if a family member becomes ill. This implies that income and health outcomes are strongly linked (See, Byaro and Musonda, 2017; Summers and Pritchett, 1996). Chew and Hangoma (2020) as well as Novignon et al. (2018) found that higher incomes and total health expenditures attract health investments that can lead to improvements in

healthcare outcomes measures in sub-Saharan Africa (i.e. child health and life expectancy). Interestingly, our study also found that increasing the immunization rate for measles reduced under-five mortality. According to Levine and Rothman (2006), greater trade openness is associated with higher income, immunization rates and public health expenditures. Trade openness in a developing country like sub-Saharan Africa can imports skilled goods (i.e. raw material inputs, computers) and increase returns on skill in poor nations (Levine and Rothman, 2006; Edwards, 2004). Overall, our study shows that trade openness in sub-Saharan African countries poses no risks to the health sector.

Conclusion

This study examined the contribution of trade openness on health outcomes in sub-Saharan African countries between 2000 and 2016. Endogeneity issues were addressed using the generalized method of moments (GMM) estimator. The main result showed that trade openness is statistically significant and has a positive impact on improving health outcomes (i.e. reduce under-five mortality and elongate life expectancy). The results also showed that vaccination against measles reduces under-five mortality in the region. The findings reveal that, income (GDP per capita) and health financing (total public and private health expenditures) improve life expectancy in sub-Saharan African countries. The contribution of trade on health outcomes in the region has been studied through a variety of mechanisms. Trade, for example, can improve health outcomes by increasing access to medical supplies. Similarly, a COVID-19 outbreak is a good example of how trade can improve health. Our recommendations for sub-Saharan Africa and other developing countries are three folds. First, it is important to note that easing and increasing trade would allow governments to obtain more financial resources to improve the welfare of their people (i.e. child health, life expectancy). Second, health professionals should be included in future trade negotiations and agreements in order to benefit the public health. Third, all countries should take steps to remove import duties on health-related products. The goal of removing trade barriers on health-related goods is to save the lives of patients, not to protect domestic industry. The overall policy implication is that, in order to benefit public health, sub-Saharan African and other developing countries should adopt these three recommendations.

CRediT authorship contribution statement

Mwoya Byaro: Conceptualization, Methodology, Software, Writing - review & editing, Data curation, Writing - original draft. **Juvenali Nkonoki:** Visualization, Visualization, Writing - review & editing. **Hozen Mayaya:** Supervision, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendices: List of countries included in the analysis

Angola, Botswana, Benin, Burkina Faso, Burundi, Cameroon, Congo Dem. Rep, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leon, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe.

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