EXPLAINING THE SOCIO-ECONOMIC INEQUALITIES IN CHILD IMMUNISATION COVERAGE IN ZIMBABWE

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Declaration

I Tariro Chigwenah, declare that the work in this thesis is based on my original work. Where I have used other people's work I have indicated by references. I also acknowledge that this work will not be submitted for another degree I any other institute.

I used Harvard style referencing for the protocol and literature review. Vancouver was used for the journal article.

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Abstract

Socioeconomic inequalities in health have received significant attention globally because of the well-known association between wealth and health. A lot of studies show that poor people are more prone to sickness than their counterparts. Immunisation has been a key antidote to avert deaths for children under the age of 5. This study represents an initial attempt to assess specific variables that contribute to socioeconomic inequalities in immunisation coverage in Zimbabwe.

Data were obtained from the 2015 Zimbabwe Demographic Health Survey, a nationally representative survey. Immunisation coverage was measured using four categories: full immunisation (a child who will have received 10 doses of vaccines), partial immunisation (a child who will have received at least one but not all vaccines), no immunisation (a child who will not have received any immunisation dose from birth) and immunisation intensity (a proportion of doses received to total doses that they should have received). Inequalities in immunisation coverage in Zimbabwe were assessed using concentration curves and indices. A positive (negative) concentration index indicates immunisation coverage concentrated among the rich (poor). The concentration index was decomposed to identify how different variables contribute to the socioeconomic inequality in immunisation coverage in Zimbabwe.

Results indicate that immunisation intensity and full immunisation concentration indices were (0.0154) and (0.0250) respectively, indicating that children from lower socio-economic status are less likely to receive all doses of vaccines. No immunisation and partial immunisation concentration indices were (-0.0778) and (-0.0878) indicating that children from higher socio-economic status are more likely to have their children immunised opposed to their poor counterparts. The main contributors to socioeconomic inequality in immunisation coverage are the mother's education, socioeconomic status and place of residence (rural/urban and province).

While immunisation services are free of charge in the public health sector in Zimbabwe, coverage rates are higher among the wealthy, which shows that there may be barriers to utilising these services that may not be the direct cost of vaccination. There have to be measures by the government to reach people in areas that are not easily accessible. Also, more needs to be done to reduce socioeconomic inequalities in Zimbabwe.

Dedication

I dedicate this work to my family and friends who had faith in my abilities. I also want to thank God for his amazing support

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Abbreviations

BCG	Bacillus Calmette–Guérin
CI	Concentration Index
DHS	Demographic Health Survey
DPT	Diphtheria-Tetanus-Pertussis
EPI	Expanded Program on Immunisation
HIV /AIDS	Human immunodeficiency virus/ Acquired Immune Deficiency Syndrome
IPV	Inactivated Polio Vaccine
LMIC	low and middle-income countries
MCHIP	Maternal and Child Health Integrated Program
MR	Measles and Rubella
OPV	Oral Polio Vaccine
PCV	Pneumococcal Conjugate Vaccine
SES	Socioeconomic status
UNICEF	The United Nations Children’s Emergency Fund
WHO	World Health Organisation
ZIMSTAT	The Zimbabwe National Statistics Agency

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PART A: RESEARCH PROTOCOL

Introduction

Globally, progress has been made to reduce under 5 mortality rates but there are still disparities between countries and regions (Raza et al, 2018). In 1974 the World Health Organization (WHO) introduced the Expanded Program on Immunisation (EPI) to avert childhood diseases such as measles, tuberculosis, pertussis (whooping cough), diphtheria, tetanus and poliomyelitis (Chang et al, 2018). According to Global Alliance for Vaccines and Immunisation child Immunisation is one of the key interventions that has made a significant impact in averting deaths of children under the age of 5 in different countries, and it is also considered a cost-effective intervention for both low and middle-income countries (Ataguba et al, 2016).

An estimated 6.3 million children under the age of 15 years died in 2017, 5.4 million of those were under the age of 5. An estimated 19.9 million children globally did not receive the 3 doses of DPT (WHO, 2017). Although the total number of under-5 deaths worldwide declined from 12.6 million in 1990 to 5.4 million in 2017 (WHO, 2017), sub-Saharan Africa is still the region with the highest mortality rates with children being 14 times more likely to die under the age of 5 compared to the rest of Africa (United Nations, 2015).

Child mortality is an indicator used to assess how well a country's health system is performing (Reidpath & Allotey, 2003). During 2017, about 85% of infants worldwide (116.2 million infants) are fully immunised, receiving the 3 doses of diphtheria-tetanus-pertussis (DTP1-3) vaccine that protect them against infectious diseases that can cause severe illness and disability (UNICEF, 2018).

Low and middle-income countries, compared to high-income countries, have lower immunisation coverage rates with significant disparities between the rich and the poor, even though immunisations services are usually free (UNICEF, 2018). It is crucial to understand the socio-economic disparities between different population groups within and between countries. The Alma Ata declaration of 1978 advocated the need to bridge the gap between the rich and poor in accessing health services (Gillam, 2008). Addressing inequalities in health has been widely recognised as a crucial developmental goal in improving the health system's performance and economic growth (Regidor, 2004a). Overall, analysing health inequalities is important because, in broader economic terms, health economists acknowledge the relationship between improved population health and economic growth (Lauridsen & Pradhan, 2011).

Problem statement

The population of Zimbabwe was estimated at 16.7 million people in 2018. In 2017, the infant mortality rate was estimated at 36 deaths per 1,000 live births and the under-5 mortality rate was estimated at 50 deaths per 1,000 live births (UNICEF, 2018). The leading cause of child mortality is HIV and AIDS, with a prevalence of 13.3% and contributing to 21% of deaths (WHO, 2018). Other major contributors to under-5 mortality are pneumonia, measles, diarrhoea, malnutrition and malaria (WHO, 2008). Figure 1 represents the Zimbabwean government's immunisation schedules, which are in line with that of the WHO.

Figure 1: Immunisation schedule for children under 1 year in Zimbabwe

First contact at birth – BCG

Second contact at 6 weeks – OPV 1, DTP-HepB-Hib1 (Pentavalent), PCV 1, Rotavirus 1

Third contact at 10 weeks – OPV 2, DTP-Hep B-Hib 2 (Pentavalent), PCV 2, Rotavirus 2

Fourth contact e at 14 weeks – OPV 3, DTP-Hep B-Hib 3 (Pentavalent), PCV 3, IPV

Fifth contact at 9 months – Measles and Rubella vaccine

Source: *Ministry of Health and Child Care, 2017*

Zimbabwe is a country in the sub-Saharan Africa region that adopted the EPI in 1982 and attained Universal Child Immunisation in 1990 with a considerable reduction in morbidity and mortality from vaccine-preventable diseases and longer inter-epidemic periods of measles up to 2008 (Mukungwa, 2015). Poor economic performance has, to a large extent, affected immunisation coverage in Zimbabwe, causing it to decline (Sibanda & Doctor, 2013). In 2017 immunisation coverage was 89%, which is 1% short of reaching the WHO's target of 90% (UNICEF, 2018). The region has countries like Nigeria, with about 39% (3 980 000) of children unvaccinated (UNICEF, 2018). Ethiopia is another country with a large number of unvaccinated children pegged at 23% (853000) (UNICEF, 2018).

According to Kidia (2018), the government of Zimbabwe allocated 7.7% of the national budget to health, which is a relatively small amount. Zimbabwe, like many other developing countries, is heavily reliant on donor funding and faces challenges which include weak health systems (Olapade-Olaopa et al, 2016). The country also faces epidemics which continue to strain the health system. These include cholera and typhoid outbreaks that highlight the country's poor infrastructure, such as cracked sewer pipes (Mukandavire et al, 2011).

The Zimbabwean government in 2017 removed user fees for vulnerable groups (expecting mothers, children under the age of 5 and elderly citizens over 65 years) as a pro-poor health policy to increase the use of health services by less economically advantaged (Meessen et al, 2011). Removing user fees' intent was to improve health outcomes and offer some financial protection for these groups (James et al, 2006). On the other hand, this policy has put a strain on the workload on health staff, with a doctor-patient ratio of 1:250,000 (Kidia, 2018). The strain put on health staff also includes drug stock-outs when there is high demand of health services including immunisations, and this sometimes frustrates them and affects service delivery which in turn causes a ripple effect to patients not accessing health services (Gilson & McIntyre, 2005).

When comparing child mortality across socioeconomic groups in the country, the poor are the most affected, conforming to the concept of social gradient that is usually present in developing countries (Hämmig & Bauer, 2013). Social gradient refers to inequalities in populations related to the socioeconomic status where morbidity and mortality rise steadily with gradually decreasing social or socioeconomic status (Hämmig & Bauer, 2013). Vaccines are free, but access barriers usually affect service utilisation. Literature suggests that there is a high immunisation coverage, but the poor still face access barriers in accessing health services such a long walking distance to clinics, poor service delivery and in most cases a shortage of staff as has been mentioned particularly in rural areas (Ray & Masuka, 2017).

Religious beliefs in the country contribute to some of the hesitancy towards immunisation that affects coverage (Oleribe et al, 2017). The apostolic faith in Zimbabwe which had a following of 4 million people in 2016 does not believe in getting their children immunised which works against the government's efforts to increase coverage of immunisation in the country (Gerede et al, 2017). With large numbers of children not immunised it could increase the chance of other children being infected with vaccine-preventable diseases (Gerede et al, 2017).

Zimbabwe, a low-income country with great economic potential (Mukungwa, 2015), has an abundance of natural resources that could help the country generate income but is poorly governed (Cain, 2016). This poor governance affects resource allocation, which affects service provision and causes the under-utilisation of state resources. Corruption is one of the major forms of poor governance that the government faces (Mukungwa, 2015).

Rationale of the study

The government of Zimbabwe acknowledges that the use of research evidence in informed decision making is essential to improve health outcomes (Cairney & Oliver, 2017). No known study in Zimbabwe has attempted to decompose health inequalities, especially in immunisation coverage, a significant child health indicator. This makes the study an important study.

Economically disadvantaged households in most cases get caught in a poverty trap when their children fall ill, which can potentially be evaded if it is a vaccine-preventable disease (Carter & Barrett, 2006). These inequalities are also obstacles to the human rights of people having access to health services and needs rectification (London, 2008).

The result of this study is to make policymakers aware of inequalities that the population is facing so that they can address the issues that can allow all social groups to have an equal chance to have good health (Lauridsen & Pradhan, 2011). The results of the study could help inform policymakers on the better allocation of resources in such a way that all socioeconomic groups are adequately reached. Furthermore, the ultimate result is for immunisation coverage to increase, especially among the poor and vulnerable.

Aim

The research aims to explain socioeconomic inequalities in immunisation coverage in Zimbabwe.

Objectives

- To estimate socioeconomic inequality in child immunisation coverage in Zimbabwe
- To explain the factors that contribute to the socioeconomic inequalities in child immunisation in Zimbabwe.

BRIEF LITERATURE REVIEW

Theories of health inequality

Theories of health inequalities are important because a successful identification of causes of any problem is crucial to solving the problem (McCartney et al, 2013). The Black report, a document published in 1980 in the United Kingdom, suggested that there were large differences in mortality and morbidity that favoured higher social classes and were not being redressed by social services (Smith et al, 1990). The document presented four types of explanations of how health inequalities arise: artefacts, selection, behavioural/ cultural and materialistic.

Artefacts theory is more relevant to the measurement of social class. It urges us to look critically at how health and social class are measured and suggests that the apparent relationship between the two variables may be inherent in the measures themselves (Blane, 1985). The health of a population can variously be measured by the rates of morbidity and mortality, and these are seen as indicators. The Black report was unable to explain this theory but showed an important point about the importance of taking note of how social classes impact, to a greater extent, the level and distribution of health (Smith et al, 1990).

Selection theory sees an individual's health as having an important influence on their chances of social mobility. Those in better health than their class peers, it is argued, are more likely to be upwardly mobile, and those in worse health downwardly mobile. This explanation, therefore, accepts a causal connection between health and social class and sees social class as the dependent variable (Blane, 1985).

Behavioural/cultural theory suggests that differences in behaviours adopted by people such as smoking, taking drugs, alcohol consumption, diet and physical activity cause health inequalities (Arcaya et al, 2015). Differences in health behaviour are a consequence of disadvantage, and that unhealthy behaviour may be more culturally acceptable amongst lower socio-economic groups (Skalická et al, 2009). For example, studies have found associations between the low socioeconomic position (SEP) and higher prevalence of biomedical risk factors such as obesity, high blood pressure, glucose intolerance etc. (Skalická et al, 2009).

The materialistic theory is the most favoured explanation and notes that social class differences in health may be seen as an inevitable consequence of the competitive accumulation of capital (Smith et al, 1990). At the intermediate level, health may be linked to factors such as income, poverty and access to education etc. Some studies have found that a wide range of diseases are associated with manual workers exposed to dust and chemicals and noise, and these are usually people of lower socioeconomic standing (Blane, 1985; Khan et al, 2017).

Methodological review

There are several ways to measure health inequality such as the Gini index, pseudo-Lorenz curve, the index of dissimilarity, slope index of inequality but the most commonly used method is the concentration index.

The Gini index is based on the Lorenz curve which plots the cumulative distribution of individuals (on the x-axis), against the cumulative proportion of the health outcome in the population (on the y-axis). The Gini index is derived from the Lorenz curve as two times the area between the Lorenz curve and the line of equality (Regidor, 2004a). The index is used to measure economic inequality and ranges from 0, which represents perfect equality to 1, which represents perfect inequality. If health is equally distributed, the Lorenz curve coincides with the diagonal. The further the Lorenz curve is from the diagonal, the greater the inequality (Wagstaff et al, 1991a).

The pseudo-Lorenz curve uses groups rather than individual data, unlike the Lorenz curve. Groups are occupational classes and not health classes which are ranked by mortality ranked from lowest mortality class to highest mortality (Wagstaff et al, 1991a). The pseudo-Lorenz curve like the true Lorenz curve fails to reflect the relationship between inequalities in health and SES (Sibanda & Doctor, 2013; Wagstaff et al, 1991a).

The index of dissimilarity represents the proportion of total health that would need to be transferred from the healthy to those whose health is below average to achieve a situation of total equity (Regidor, 2004a). It assumes that socio-economic inequalities are derived from the inefficient distribution of resources (Sibanda & Doctor, 2013). The weakness of this method is that it is insensitive to socioeconomic dimension to inequalities in health, meaning it does not pay particular attention to where high morbidity or mortality are located in any socioeconomic group (Sibanda & Doctor, 2013). The slope index of inequality is a linear regression coefficient that shows the relationship between the level of health in each socioeconomic group and the ranking of each socioeconomic category on the social scale (Regidor, 2004b).

The concentration index is based on the concentration curve. Here, the x-axis represents the cumulative proportion of individuals by socioeconomic category ranking them from those with the lowest level up to those with the highest socioeconomic level while the y-axis represents the cumulative proportion of health in these individuals (Regidor, 2004b). The concentration index ranges from -1 to +1. Like the Lorenz curve, if the concentration curve coincides with the diagonal (i.e. the line of equality), all individuals have the same health (Erreygers, 2009). When the curve lies above the line of equality, the concentration index will be negative and health is concentrated more towards the poor, and when it is underneath the line of equity, the concentration index will be positive and health is concentrated more on the rich (O'Donnell et al, 2016). It includes all individuals in a population and is sensitive to changes in the distribution of the population across different socioeconomic categories (Regidor, 2004b; Zhang & Wang, 2007).

Empirical Review

There is consistent evidence globally that individuals with socioeconomic disadvantage suffer a more substantial burden of illness and have higher mortality rates than their better-off counterparts (Gwatkin, 2000a). These socioeconomic inequalities in health are a major challenge for health policy, not only because most of these inequalities can be considered unfair, but also because a reduction in the burden of health problems in disadvantaged groups offers great potential for improving the average health status of the population as a whole (Shaw, 2005).

Also, most studies agree that people in lower socio-economic spectrum utilise less health care services than those on a higher spectrum (Wagstaff & Van Doorslaer, 2000). Mortality and morbidity rates are inversely related to many correlates of socioeconomic status, which include income, education, social class and wealth (Deaton, 2002). The concept was documented in 1820 in Paris by Rene Villerme, who compared poverty and mortality rates. Empirical evidence in developed countries suggests that an additional year of education, which is protective of health reduces mortality rates by about 8% (Deaton, 2002; Merten et al, 2015).

Literature in low- and middle-income countries (LMIC) seeks to identify socioeconomic factors that affect immunisation but do not go further to decompose health inequality (Flatø & Zhang, 2016). Nigeria is the one country that had a study explaining the inequalities and the study reported that full immunisation coverage is to the advantage of the rich and partial and no immunisation leans more towards poor children (Ataguba et al, 2016). Factors such as mother's literacy, region and location of residence, and socioeconomic status significantly explain disparities in immunisation (Ataguba et al, 2016).

Results of a study in Zimbabwe showed that the region of residence was important because immunisation compliances differ by regions with Bulawayo and Mashonaland recording the highest immunisation rates (Mukungwa, 2015). Full vaccination also increased with the mother's level of education. About 71% of children whose mothers had secondary education were fully vaccinated compared to 54% of children whose mothers only had primary education. Religion, media, distance to health facility all were moderately associated with full immunisation (Mukungwa, 2015).

In Kenya and Kampala, studies showed that there were lower immunisation rates among children in urban areas, especially those that live in informal settlements and slums (Asuman et al, 2018). These differences can arise because of development strategies and also depending I how rural and urban areas are defined (Asuman et al, 2018).

The Zimbabwean literature on the topic is sparse, which is one of the reasons why this study is essential. The purpose of the study, therefore, is to fill a gap that is existing in explaining the socio-economic inequalities in the coverage of immunisation in the Zimbabwean context.

METHODS

Data source

Data for this paper was obtained from the Demographic and Health Survey (DHS) that was conducted in 2015 in Zimbabwe. Among other things, the DHS surveys usually provide detailed information on different modules such as fertility, family planning and mortality etc. The DHS is conducted as national surveys in more than 90 developing countries (Boulton et al, 2018). The surveys are conducted to gain more knowledge of current situations which help the government in policy and decision making.

Study population

The sample sizes for the DHS are contained in Table 1.

Table 1: Zimbabwe DHS sampling statistics

Country	Household sample size	Females	Males	Phase
Zimbabwe	11196	9955	8396	VII

***Source**: DHS database 2015*

Households were surveyed and depending on whether they had children who were between the ages of 12 months to 5 years, they would then have the key indicator survey, of the child's health on the mother/father or the caretaker, administered. The surveys took, on average, 18-

20 months for data collection in the field. The survey file used will be the maternal and child health files (ZIMSTAT & ICF International, 2016).

Analytical method

Stata 15 software was used for data analysis. Four immunisation coverage variables will be generated– (a) fully immunised children (children aged 12-59 months that received all of the 10 vaccinations- BCG, Rotavirus 1-2, DTP 1-3, PCV 1-3, OPV 1-3, IPV and MR), (b) partially immunised children (those that received at least 1 but not all the 10 doses, (c) children not immunised (those that did not receive any vaccine from birth). The last category was introduced because partial immunisation ranges from a child receiving 1-9 vaccines. It measures the intensity of immunisation, defined as the proportion of vaccines received over the total number of vaccines that should be received.

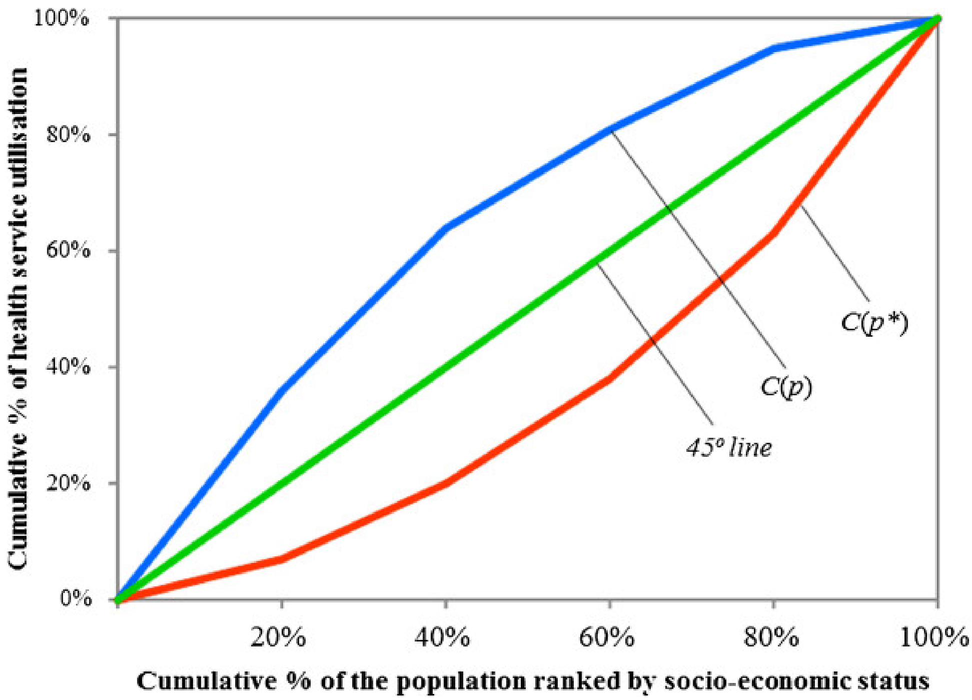
It is important to note that this paper uses 10 vaccines in the analysis as opposed to the 14 shown in Box 1 above. 10 vaccines are used because the rotavirus was introduced in 2014, a year before the survey, which would not have given a good reflection of the number of children who received the dose. Specifically, rotavirus 1 and 2 were dropped. The Inactivated Polio Vaccine (IPV) was also introduced in 2019 which is an obvious exclusion. Measles and Rubella was a supplementary dose introduced in Zimbabwe in 2015 and may not be included in the mainstream vaccine doses or collected in the 2015 DHS data. After removing these 4 doses due to the reasons mentioned above, the remaining 10 doses were used to categorise children into different immunisation coverage indicators.

The study will use concentration indices (CI) and curves to represent the magnitude of socioeconomic-related inequality in immunisation coverage (O'Donnell et al, 2016). As introduced under the methodological review, the concentration curves give rise to concentration indices, which are calculated as two times the area between the concentration curve and line of equality (Clarke et al, 2003).

Each immunisation variable will be indirectly standardised with age and sex as a way to reduce confounding effects.

The blue concentration curve in Figure 2 shows a pro-poor distribution. This is the case where the concentration index will be negative and more immunisation coverage is recorded among the poor. The red concentration curve shows a pro-rich distribution where the concentration index will be positive. The green concentration curve coincides with the line of equity.

Figure 2: Concentration curve for health



Source:(Phiri & Ataguba, 2014a)

Although concentration curves show the extent of socio-economic inequality they do not explain factors that contribute to observed inequalities (Ataguba et al, 2016). Wagstaff proposed a straightforward way of decomposing the degree of inequality into contributions of explanatory factors (Lauridsen & Pradhan, 2011). Wagstaff et al showed that the concentration index (C) can be decomposed and written as:

$$C = \sum_k (\beta_k \bar{x}_k / \mu) C_k + GC_\varepsilon / \mu,$$

C is equal is the concentration index concentration. C_k ($\overline{x}_k$) is the concentration index (mean) of the *k*th contributing factor. β_k is the OLS coefficient on the *k*th contributing factor obtained from a regression of the immunisation variable on the contributing factors whereas $GC\varepsilon$ is the generalised concentration index for the error term (ε). The equation above is used to obtain the contribution of each contributing factor (k) to the concentration index (C).

Ethics

There will be minimal ethical consideration because the data are secondary. As a researcher, permission was granted by the DHS group to download the Zimbabwe DHS dataset. However, ethics approval will be sought from the UCT Human Research Ethics Committee (HREC).

Budget

No cost is directly associated with the study. The NRF supports my education at UCT.

Dissemination of information to stakeholders

Results obtained from the study will be disseminated through access to the published journal article and a policy brief.

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PART B: STRUCTURED LITERATURE REVIEW

Background

This first section will explain theories of health inequalities that originated from the black report. The Black report proposed four theories — artefact, natural or social selection, cultural-behavioural and materialist/structural—to explain the root causes of health inequalities (Gray, 1982). Upon more research there are more theories that have been explained in the text.

Immunisation is a key public health tool in averting child deaths from deadly diseases (Gram et al, 2014). Immunisation continues to be a serious topic globally and with the rollouts of the World Health Organisation's (WHO) Expanded Program on Immunisation (EPI) (Devasenapathy et al, 2016). In developing countries, disparities between the rich and the poor are large, limiting poorer group's potential to contribute to economic growth (Lauridsen & Pradhan, 2011). Socioeconomic disparities in health are a major concern in developing countries because they make it difficult to attain the Sustainable Development Goals (SDGs) set by the United Nations (UN) (Lauridsen & Pradhan, 2011).

Health inequalities have persisted through time and can be mostly found in low- and middle-income countries (de Graaf et al, 2013). Following the WHO EPI schedule, 85% of children who die under the age of 5 are found in developing countries (Gram et al, 2014).

Theories of inequalities in health

It is important to understand what causes health inequalities to identify solutions to reduce them (McCartney et al, 2013). The Black Report published in 1980 identified four theory categories: artefact, health selection, behaviours (including culture) and structural/ materialistic factors as the root cause of inequality in health (Alonge & Peters, 2015). Over the years, there are more theories introduced, such as the intelligence and meritocracy theories that fall under the selection category (Etana & Deressa, 2012). Psychosocial and life perspective are also new theories discussed in this section

Health inequities are avoidable and unjust differences that are spread across a population and occur between specific population groups (Arcaya et al, 2015). According to the WHO, health inequalities are differences in health status or the distribution of health determinants between different population groups (Beenackers, 2018). A distinction between health inequality and equity is important. Equality means everyone has the equal opportunity to attain their full health potential while equity is making sure that equal opportunities are created according to need, and making sure that everyone receives services according to their need (Chang, 2002).

Artefacts theory: It suggests that socioeconomic inequalities do not exist but are a result of methods of measurement and data (Bambra, 2011). Differences in health by socioeconomic status are explained by the differences in measurement, noting that the size of the inequalities identified is because of differences in data measurement tools (Bambra, 2011).

Artefacts theory is more relevant to the measurement of social class. It urges us to look critically at how health and social class are measured and suggests that the apparent relationship between the two variables may be inherent in the measures themselves (Blane, 1985). The health of a population can variously be measured by the rates of morbidity (condition of being unhealthy or ill) and mortality (death). The Black report was unable to explain this theory but showed an important point about the importance of taking note of how social classes impact, to a greater extent, the level and distribution of health (Smith et al, 1990).

Health selection: Selection theory sees an individual's health as having an important influence on their chances of social mobility and not vice versa (Blane, 1985). Individuals who are 'fitter' are more likely to be upwardly-mobile, and those in worse health are downwardly mobile and concentrated within the lower socioeconomic classes (Bambra, 2011). This explanation, therefore, accepts a causal connection between health and social class and sees social class as the dependent variable (Blane, 1985). It suggests reverse causation: that poor health causes a social selection (a social slide) leading to the observed association between ill health and low social status (McCartney et al, 2013).

Intelligence: Health selection was rejected as a major health inequality explanation, but recently, there has been an attempt to reinvigorate the theory by a proposal of the role of intelligence (McCartney et al, 2013). Intelligence is a mental capability involved in the ability to reason, solve problems, among other things, and it reflects a broader and deeper capability for comprehending surroundings and making sense of things (Gottfredson, 2004).

Health and intelligence are closely associated due to intelligence being a genetic endowment and because they are both caused by confounders such as socioeconomic status or early life experiences (Gottfredson, 2004).

Meritocracy: The theory originated in Scandinavian countries which are considered more democratic and meritocratic than other countries (Warikoo, 2018). The more able individuals that are born into lower socioeconomic groups (those with higher intelligence) can rise to higher socioeconomic groups when they are adults. Vice versa, "less able" people born into higher socioeconomic groups can experience a socioeconomic-slide (Manor et al, 2003).

Behavioural/ cultural: The link between behaviour and culture is a result of the differences between socioeconomic class in terms of their health-related behaviours (Bambra, 2011). Certain behaviours like smoking, dietary intake, alcohol consumption, health service usage and physical activity that are different between groups contribute to health inequalities (McCartney et al, 2013).

It is not accurate to say certain behaviours are linked to poorer people only because rich people can also eat the 'wrong' foods and may smoke and smoke as much as poor people. (McCartney et al, 2013).

Structural/materialistic: Highlights levels of wealth and income. The materialistic theory is the most favoured explanation and notes that social class differences in health may be seen as an inevitable consequence of the competitive accumulation of capital (Smith et al, 1990). At the intermediate level, health may be linked to factors such as income, poverty and access to education etc. Some studies have found that a wide range of diseases are associated with manual workers that are exposed to dust and chemicals and noise, and these are usually people of lower socioeconomic standing (Blane, 1985; Clougherty et al, 2010; Johansson et al, 2019).

Life-course perspective: It combines aspects of other theories, allowing different causal mechanisms and processes to explain the social gradient in different diseases (Bambra, 2011). Health at adult ages is partly determined by experiences in early life: social, psychological and biological advantages and disadvantages over time (Mackenbach, 2012). There are critical development periods that affect health and may not be reversed. An example is poor nutrition in adolescence (a critical period for bone development) which can put an individual at risk for bone fracture when older (Arcaya et al, 2015).

Psychosocial: Focuses on how social inequality makes people feel and how this affects their health and biological makeup (Bambra, 2011). Social inequality can have long term effects on people, making them feel inferior which can stimulate chronic stress with profound consequences for mental and physical health (Mackenbach, 2012). The socioeconomic class gradient is, therefore explained by the unequal social and economic distribution of psychosocial risk factors (Bambra, 2011). Psychological stress can lead directly to ill health by triggering a specific chain of events that can lead to specific diseases, or indirectly through its effect on behaviour and lifestyle that are damaging to heath (Alonge & Peters, 2015).

METHODOLOGICAL REVIEW

This section will give an overview of the methods used to measure socioeconomic inequalities in health.

A relative inequality index has a value that remains constant for any proportional change of the variable of interest (health and health care). An absolute inequality index is a character translation-invariant: adding the same amount of health services to everyone changes the inequality index. (Erreygers & Van Ourti, 2011).

Overview of common measures of health inequalities

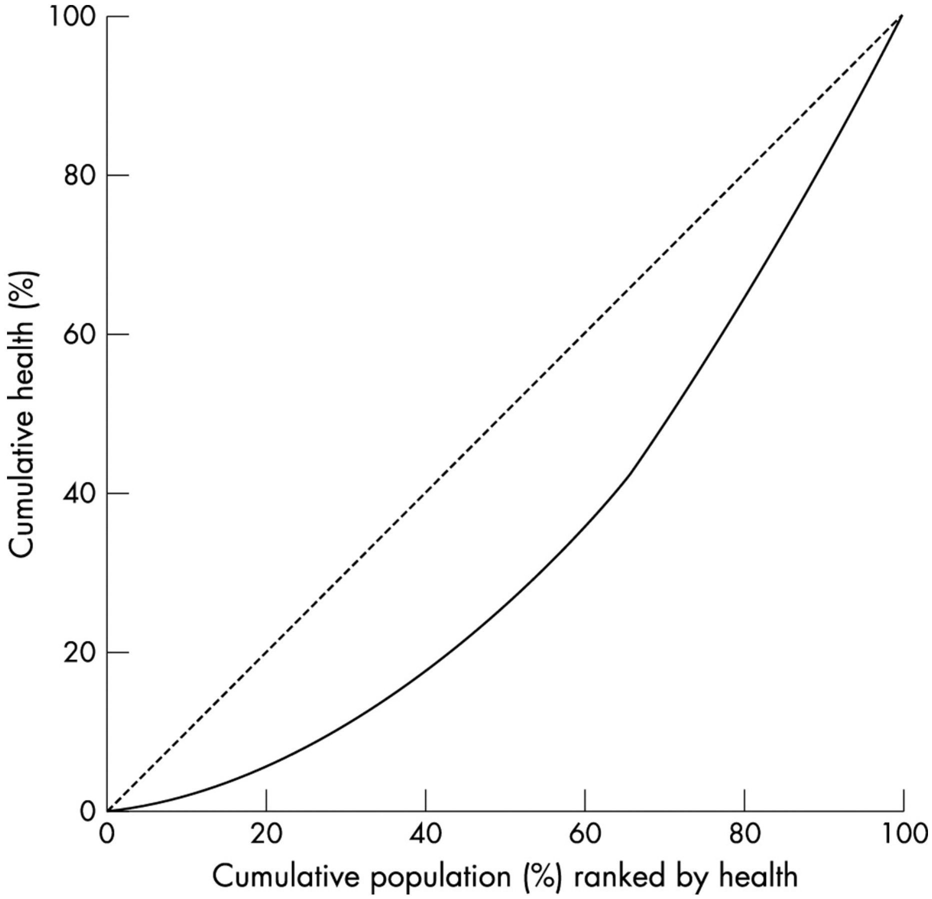
Methods to measure inequality

Wagstaff et al (1991b) outline six measures of inequality that have been used to date in the literature on inequalities in health. These measures include the Gini coefficient (and the associated Lorenz curve), a pseudo-Gini coefficient (and an associated pseudo-Lorenz curve), the index of dissimilarity, the slope index of inequality (and the associated relative index of inequality) and the concentration index (and the associated concentration curve). The range is another measure that has been added with time that has become very popular in the literature (Alonge & Peters, 2015).

Gini index/ Lorenz curve

The Gini index is derived from the Lorenz curve, where the x-axis is the cumulative proportion of individuals by the level of health, ranked in ascending order, from the sickest persons ending with those that are healthy (Regidor, 2004a). The Gini index is derived from the Lorenz curve as two times the area between the Lorenz curve and the line of equality. The y-axis represents the cumulative health of these people. The Lorenz curve is diagonal when health is equally distributed among individuals; otherwise, it lies underneath the line (Wagstaff et al, 1991b). The more it deviates from the diagonal the greater the health inequality. The magnitude of the index ranges from 0- where curve coincides with the diagonal line to 1- when all the health of the population is concentrated in a single person (Wagstaff et al, 1991b).

Figure 1: Lorenz curve



Source: (Regidor, 2004a)

Advantages of the Lorenz curve includes how it represents the experiences of all persons and not just those in social classes, and it does not involve stratifying the population. By not stratifying the population by social class it allows one to side-step the issues associated with classifying people by social class (Dardanoni & Forcina, 1999). The disadvantage of the approach The Lorenz curve may understate the actual amount of inequality if the situation is that richer households are able to use income more wisely than lower income households (Jann, 2016).

Pseudo Lorenz curve

Because the population is assigned to groups according to their social class rather than their health (though the classes are ordered according to health)

$$G = \frac{\sum_{i=1}^{n-1} |p_i - q_i|}{\sum_{i=1}^{n-1} p_i}$$

The formula above is used to calculate the Gini index. Where p_i and q_i represent, respectively, the proportion of individuals by health level and the cumulative total proportion of health of these individuals (Alonge & Peters, 2015). The pseudo-Lorenz curve uses groups rather than individual data, unlike the Lorenz curve. Groups are occupational classes and not health classes which are ranked by mortality ranked from lowest mortality class to highest mortality (Wagstaff et al, 1991a). The pseudo-Lorenz curve, like the true Lorenz curve, fails to reflect the relationship between inequalities in health and SES (Sibanda & Doctor, 2013; Wagstaff et al, 1991a).

Index of dissimilarity

The index of dissimilarity represents the proportion of total health that would need to be transferred from the healthy to those whose health is below average to achieve a situation of total equity (Regidor, 2004a). It assumes that socioeconomic inequalities are derived from the inefficient distribution of resources (Sibanda & Doctor, 2013). The weakness of this method is that it is insensitive to socioeconomic dimension to inequalities in health, meaning it does not pay particular attention to where high morbidity or mortality are located in any socioeconomic group (Sibanda & Doctor, 2013).

The slope index of inequality

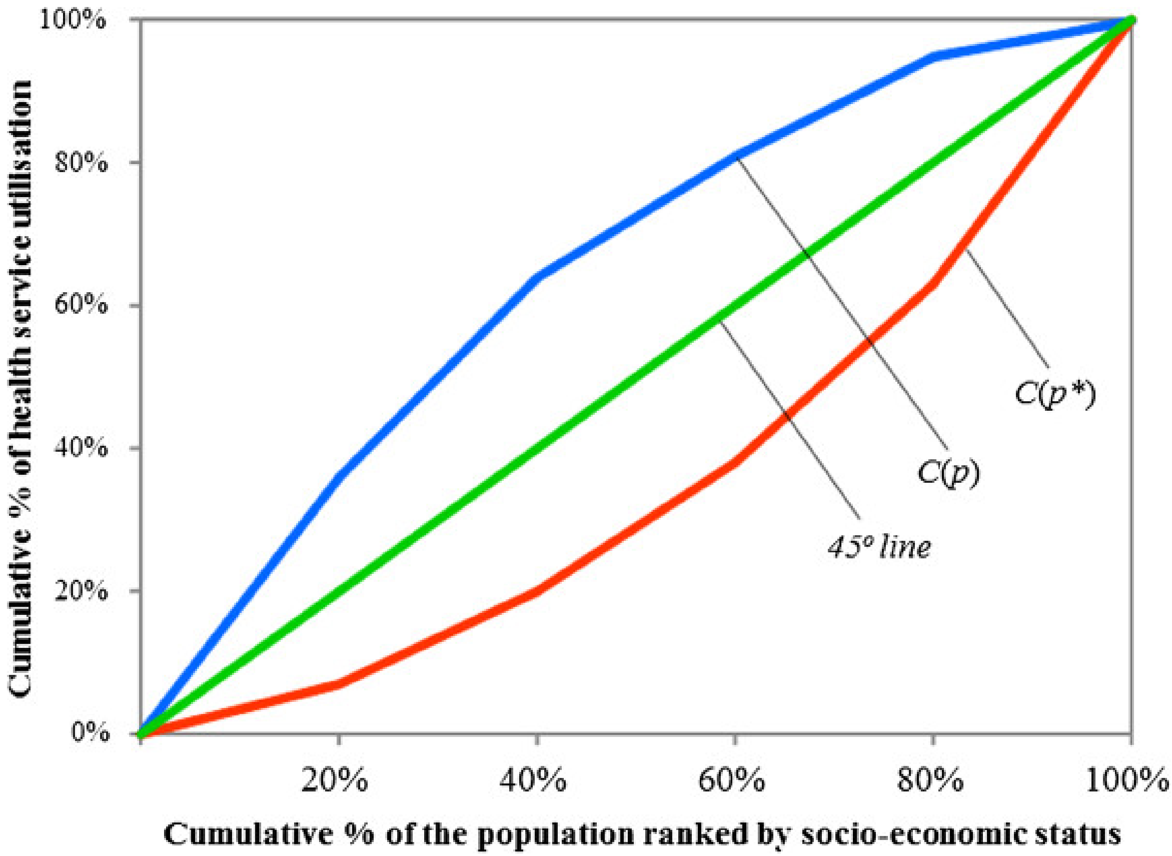
The slope index of inequality is a linear regression coefficient that shows the relationship between the level of health in each socioeconomic group and the ranking of each socioeconomic category on the social scale (Regidor, 2004b). It is sensitive to local population characteristics (e.g. location of care homes, accuracy of local population data for small areas). In some cases, this can lead to inconclusive results.

The range

Typically involves comparing the experiences of the top and bottom socioeconomic groups (Munoz-Arroyo, 2007). Comparison is presented as absolute range but more often as the ratio of one extreme value to the other (relative range) (Munoz-Arroyo, 2007).

An advantage of the relative range concept is that inequality can be compared for rates of the outcome on different scales (Alonge & Peters, 2015). A disadvantage of this approach is that it overlooks what is happening in the intermediate groups. It does not consider the sizes of the groups being compared and this can distort results when making comparisons over a long period and across countries (Munoz-Arroyo, 2007).

Concentration curve



Source: (Phiri & Ataguba, 2014a)

The concentration index is based on the concentration curve. Here, the x-axis represents the cumulative proportion of individuals by socioeconomic category ranking them from those with the lowest level up to those with the highest socioeconomic level while the y-axis represents the cumulative proportion of health in these individuals (Regidor, 2004b). The concentration index ranges from -1 to +1 and is calculated as twice the area between the concentration curve and the line of equity (O'Donnell et al, 2008). Like the Lorenz curve, if the concentration curve coincides with the diagonal (i.e. the line of equality), all individuals have the same health (Erreygers, 2009). When the curve lies above the line of equality, health is concentrated more towards the poor, and when it is underneath the line of equity health is concentrated more on the rich (O'Donnell et al, 2016). It includes all individuals in a population and is sensitive to changes in the distribution of the population across different socioeconomic categories (Regidor, 2004b; Zhang & Wang, 2007). (Rustein, 2004)

Standardisation of the concentration index

The concentration index is standardised by sex and age as a way to reduce confounding effects of demographics on a health variable (Ataguba et al, 2011). Widely denoted as the age-sex standardised distribution because these confounding variables are correlated with measures of socioeconomic status and affect health (Kakwani et al, 1997). It is, therefore, an alteration procedure that is utilised to:

i reflect differences in the population demographic structure

ii establish a refined and validated description of the association between health and socioeconomic status

iii compare estimates over time and across populations or sub-populations (O'Donnell et al, 2016)

There are two methods used to standardise: direct and indirect method (Kakwani et al, 1997; Nicholl et al, 2013). Direct standardisation determines the distribution of health or ill-health across income or SES groups that would be observed if all groups were identical age/sex structure but group-specific intercepts and age effects. The method makes use of grouped data, requiring individuals to be divided into random groups of living standards (Kakwani et al, 1997). Some scientists have criticised the method on the basis that created groups alter the numerical values of inequality measure, claiming that the method exhibits a greater reliance on the number of selected SES groups (Ataguba et al, 2011; Kakwani et al, 1997).

The indirect method uses individual-level data and attempts to correct the actual age/sex distribution by comparing to the distribution that would be experienced is individuals had their own age but the same mean age/sex effects as the entire population (O'Donnell, 2008). The method involves substituting an individual degree of illness with a degree of illness suffered on average by a person of the same age and sex (Gravelle, 2003). The indirect method is the more favoured approach because it has greater accuracy when dealing with individual-level survey data (van Doorslaer et al, 2004).

Correction of the concentration index

The concentration index has been widely used and has shown desirable requirements of health inequality indices, though it needs to applied with caution as it is reliant upon the nature of the dependent variable (Van Doorslaer et al, 1997) In theory, CI requires unbounded or continuous variables measured on a ratio scale. In practice, however, many measures of health outcomes tend to be bounded (0, 1) or binary and measured on an ordinal or cardinal scale, such as self-assessed health (Erreygers, 2009). When the health variable is binary, scientists have highlighted the following shortcomings of the CI:

i The bounds of the standard CI depend upon the mean of the health (ill-health) indicator and hence a comparison across populations with different mean levels is not suitable. In large samples, the lower and upper bounds of the computed CI are not necessarily –1 and +1, respectively, but rather between $\mu - 1$ and $1 - \mu$ (O'Donnell, 2008).

ii "Different rankings are obtained when one compares 'inequalities in health with inequalities in poor health33. This is also referred to as "a mirror problem (Clarke et al, 2003).

iii The value of the index becomes "arbitrary" if health variables are qualitative in nature (Clarke et al, 2003).

Both Wagstaff (2005) and Erreygers (2009) propose different normalisation and correction techniques of these shortcomings. Wagstaff (2005) suggests a normalisation process that involves dividing the concentration index by $(1-\mu)$. Both Wagstaff's normalised index (W) and Erreygers' corrected index (E) belong to the same "family of rank-dependent measures of socioeconomic inequality" and satisfy the mirror condition as well as the scale-invariant for cardinal outcomes (Erreygers, 2009; Wagstaff, 2005). Erreygers declares that his index (E) is superior and more appropriate than the traditional CI and W. This is partly because the E satisfies the four desirable properties discussed below and has the maximum bounds of -1 and +1.

In his criticism of the Wagstaff's normalisation of CI index Erreygers (2009 p. 523) points out:

i "Wagastaff's index(W) does not possess the mirror property";

ii W "blow(s) up the levels of measured inequality for the distributions with either high or low means" whereas Erreygers (2009) proposes an index that avoids this situation.

Wagstaff (2009) argues in return that Erreygers's corrected CI is an index of absolute inequality and that Wagstaff' s index was never intentionally created to measure absolute inequality. The magnitude of measured inequality may change, there is little variation between the normalised index, as suggested by Wagstaff, and the standard CI. The ordering of inequality remains the same for both correcting measures, and produce identical results. Erreygers' index could be derived by scaling Wagstaff's normalised index if a binary health variable is used (Ataguba et al., 2011).

EMPIRICAL REVIEW

Search strategy

Literature was sourced from Google scholar, EBSCOHost, PubMed, Medline and Cochrane. Further, the search was manually done from cited literature in other articles. Key search terms used included immunisation/ vaccinations, socioeconomic, inequality in health, disparities in health, assessing/explaining. Boolean operators (AND and OR) were used to combine searches.

Inclusion and exclusion criteria: Excluded papers that had children who were below 12 months of age because full immunisation is achieved at 12 months. Included papers that explained or identified socioeconomic inequalities and were able to identify inequalities found among the 12-59 months age group when it came to immunisation coverage.

Main inclusion criteria were studies that sought to explain socioeconomic inequality in immunisation coverage, and written in English.

Objective: The objective of the empirical review is to analyse literature to understand more of socioeconomic inequalities associated with children being immunised all around the world. Sub-Saharan African has significant inequalities but there is a dearth of research to explain why these disparities persist. The purpose of the review is to identify gaps in the literature that can situate this study.

The empirical section aims to compare literature among different countries to see if there is a common use of certain methods of measuring socioeconomic inequality in child immunisation coverage. Comparison of the results would shed light on the things that are truly contributing to inequalities in most counties and how best these issues could be solved.

Table 1 Summary of empirical studies of socioeconomic inequalities in developing and developed countries

Author	**Type of study /country/ countries and year of analysis**	**Objectives of the study**	**Measure of SES**	**Health outcome**	**Analytical method for inequality analysis**	**Variables**	**Findings and explanations (conclusion).**
(Ataguba et al, 2016)	Nigeria CWIQ core welfare indicators Survey	Assess the inequalities in full and partial immunisation coverage Assess inequality in the intensity of immunisation coverage Explains factors that account for disparities	Principal components analysis (20 variables used to construct the SES index)	Improved immunisation coverage	CI Decomposition	Mothers literacy Region & Location of child SES Geopolitical zone	Mother's literacy played a crucial role in immunisation. It was generally just important to educate mothers on the importance of getting their children vaccinated Disparities exist in immunisation coverage to the advantage of the rich Inequality in partial and no immunisation is

							more towards poor children People who resided in rural areas had lower immunisation coverage as well as those situated in certain geopolitical regions
Yu Hu, Ying Wang, (Hu et al, 2017)	China Zhejiang provincial vaccination coverage survey 2014	Evaluate the socioeconomic inequality in UTDFI coverage among the children aged 24–35 months in Zhejiang province	Household income	Increase immunisation coverage	CI – Decomposition	Birth order Employment status Ethnicity Mother's education	Immunisation favoured children from higher SES Mothers education is the biggest contributor to low immunisation coverage Children in rural areas were more advantaged to receive full immunisation due to a rise in urbanisation that created a weak connection

							between patients and clinic staff and the difference in public health delivery in the rural and urban
Yiengprugsawan, Vasoontara et al 2008	Thailand 2007 The Health and Welfare Survey 2003	Assessing the socioeconomic Inequalities in immunisation coverage	Adult equivalent monthly income	Increase immunisation coverage	Concentration index Decomposing	Demographic SES Geographic Population groups	Low socioeconomic status, education and work status contributed to low self-rated health Residence in rural (Northeast) resulted in low immunisation due to barriers though Thailand has achieved Universal Health Coverage

Asuman, D et al 2018	Ghana 6th wave of DHS conducted in 2008 & 2014 DHS 2 waves 2008 (pro-urban) and 2014 (pro-rural)	Examine rural-urban inequalities in child immunisation coverage. Decompose the difference in the probability of full immunisation coverage between rural and urban areas	Wealth index (Household ownership, housing conditions, access to water, sanitation facilitation	Increase immunisation coverage	Logit model Decomposition (non-linear technique)	Region (rural or urban) Mothers employment Place of delivery (home vs health facility) Religion (traditional church attendees were more likely to have their children fully immunised) Child order	Children in rural areas are more likely to be fully immunised Due to high urbanisation, there should be a policy that looks at the vulnerable children that live in slums Mothers with health insurance were at a better advantage to get children immunisation because they were able to visit the health facilities more often even for their health, which could allow nurses to check on their children Younger mothers were believed to have lower rates of getting children immunised because they

							would need to seek permission from someone else which in most cases delayed immunisation schedules
Mukungwa, T 2015	Zimbabwe DHS data	Factors hindering full Immunisation of children in Zimbabwe	Wealth index	Increase immunisation coverage	Multivariate binary logistic regression analysis	Mothers education Birth order Region	Children with mothers with secondary educated were more likely to be vaccinated. Firstborn children more likely to be fully vaccinated than, say, the sixth child
Egondi, T et al 2015	Kenya Nairobi Cross-sectional Slum Survey of 2012	Tease out factors that might potentially explain inequality in FIC in informal urban	Wealth index Wealth score was grouped into tertiles (the first tertile representing the poorest group and the	Increase immunisation coverage	Concentration index Decomposing	Sex of child Mother's education Occupation of mother Ethnic group	There is immunisation among the urban poor (pro-poor) Immunisation practice was less among the poorest families

		settlements of Kenya	last tertile representing the least poor)			Marital status (not significant) Age of mother	Mothers level of education was a major contributor Followed by birth order &income generating activity (employment status Coverage rates among the urban poor are large among those living in informal settlements compared to the overall urban
Edel Doherty et al 2014	Ireland GUI (Growing Up in Ireland)	Measure and decompose socioeconomic inequalities in childhood vaccination in the Republic of Ireland	Income	Increase immunisatio n coverage	Multivariate analysis Concentration index Decomposition	SES Household structure Income Nationality	Pro-rich gradient Vaccination less likely in lower-income households Access to public-funded services was an important factor

Lauridsen, J & Pradhan, Jalandhar 2011	India National Family Health Survey 2005-6	Quantify socioeconomic distribution of not fully immunised children -decompose the inequalities	Wealth index	Improve immunisation coverage	Concentration index Decomposition	Household economic status Mothers literacy State lived Per capita	Immunisation practice is pro-rich About 56% are not immunised 47% of the 56% belong to poor HH economic status and mothers who are illiterate Majority of these children come from the rural area (74%).
Branco et al 2014	Brazil Consensus record of Public Health Unit 2010	Assess vaccine coverage in children between 12 to 59 months of age in a small town located in a remote area	Wealth index	Increase immunisation coverage	Logit regression model	Maternal education Possession of HH Income	Children in urban areas had better rates of vaccines as health facilities were also a bit closer to people's homes

		of the Amazon region				Type of residence outside an urban area	Mothers with less education usually did not complete vaccines Higher incomplete vaccinations in children belonging to low-income countries. Distance was a barrier for low-income homes because of the indirect cost associated with transportation and food
Hajizadeh, M 2018	46 low/ middle income countries MEASURE DHS 2010-2015	Measure and identify factors associated with socioeconomic inequalities in full immunisation	Wealth index	Increase immunisation coverage	Concentration index Meta-regression	Mothers education Birth order ANC visits	Immunisation was pro-rich in the majority of the country except for Gambia, Namibia, Kyrgyz Republic Togo and Togo had pro-poor distribution in rural areas

							Educated mothers had better immunisation rates as well as those who had at least 4 ANC visits Socioeconomic inequalities were higher in Nigeria, Pakistan, Yemen, Cambodia, Cameroon and Indonesia compared to other countries
Hosseinpoor et al 2006	Iran DHS 2000	Quantify the determinants contributions of socioeconomic inequality	Principal component analysis (Possession pf car, bicycle, fridge, TV, telephone, heating	Improved mortality	Concentration index Decomposition analysis	Mothers education Residency Risky birth interval	Children with a lower SES were less likely to be fully immunised Mothers education is a major contributor Residency (rural/urban), birth interval and hygiene

			device, rooms per capita)				People from a lower Socioeconomic status are more likely to die in their first year. Infant mortality is greater among the poor
Vasudevan, L et al 2014	Rural Bangladesh household interviews 2011	Identify maternal characteristics associated with timely vaccinations	Principal Component analysis (land ownership, productive assets, dwelling characteristic and durable assets	Improve timely vaccination status	Multivariable logistic regression	Mothers age at pregnancy Mother's education Mother's employment	Mothers from a higher SES status and employed mothers are more likely to have their children vaccinated on time
Lernout, T et al 2014	Belgium Flanders 3 cross sectional EPI	Assess the timeliness of measles-mumps-rubella (MMR) and	Household income	Improve timely vaccinations	Cox regression analysis	Mother's age Mother's origin	Mothers who originated from outside the European Union were more likely to delay

	survey 2005, 2008 & 2012	diphtheria-tetanus-pertussis (DTP) vaccination in infants in Flanders			Multiple regression model	Infants ranking in the family family income level (SES)	vaccinating their children SES was also a major contributor as well as the size of the family
Haider et al 2019	South-east Scotland Scottish Immunisation Recall System	Identifying inequalities in vaccination uptake and timeliness & deprivation	Income	Improve immunisation uptake and timeliness	Chi-squared tests and cox proportional hazards models	Mother's education Deprived groups Education status Rural / urban residence	Most deprived groups were more likely to delay in getting their children vaccinated

Findings of the review

Literature search results have mainly presented papers from developing countries, possibly because they usually have intervention related papers. A total of fourteen papers were reviewed in this paper; four papers from developed countries and ten from developing countries under the United Nations categorisation. Five studies were from sub-Saharan Africa (Kenya, Ghana, Zimbabwe, including Togo and Gambia that were part of a multi-country analysis paper). Four studies from Asia (China, Thailand, Bangladesh and India). One study was from South America (Brazil) and three from Europe (Ireland, Belgium & Scotland). A multi-country study was also included.

The use of the concentration index and decomposition analysis was observed in seven of the papers. The logit regression was used in two papers, one paper used the bivariate and multiple regression model. One paper used the cox regression analysis and chi-squared analysis. The last method that was used was the multivariate binary regression analysis that was used in two studies. The main health outcome that was observed in the papers was to improve immunisation coverage

Studies have shown that in low- and middle-income countries, health outcomes and access to keys services are unevenly distributed across different subgroups in a population and across countries (Skaftun et al, 2014). There is a trend of a social gradient in the majority of the papers that have been reviewed under the notion that health outcomes improve the higher the socioeconomic status a person (Hämmig & Bauer, 2013). Socioeconomic status was a key element in all 11 papers reviewed and there has been a consensus in the findings that immunisation coverage is higher among higher socioeconomic groups. In the Gambia, Namibia and the Kyrgyz Republic (Hajizedah et al, 2018), children who belonged to higher socioeconomic groups received fewer immunisation.

Maternal effects on child immunisation coverage are an important aspect (Mohamud et al, 2014; Vasudevan et al, 2014). Having identified this, it is important to realise that many policies would be tailored to help women become independent and able to provide for their children. Mother's education was the highest-ranked variable in the majority of the papers (Ataguba et al, 2016; Egondi et al, 2015; Hu et al, 2017; Lauridsen & Pradhan, 2011; Mukungwa, 2015). The only study where the education of the mother was not equally as important was Ireland, where income and household structure were very important (Doherty et al, 2014). Negative experiences in health facilities also played a major role in determining vaccination delays in Scotland (Haider et al, 2019). Delays in children being vaccinated contributes to outbreaks that are still observed (Tiley et al, 2018)

Most immunisation interventions are pro-rich meaning they are in favour of the rich. Urban areas usually present with higher coverages but in this review, there were two studies where rural areas had higher coverage—in China and Ghana (Asuman et al, 2018; Hu et al, 2017). These countries have governments that came up with many health interventions that included increasing health facilities and increasing interventions such as nurses visiting homes and carrying out vaccinations within communities (Saeterdal et al, 2014). These studies also managed to have high coverage in rural areas because of the engagement between health workers and mothers and they were able to educate them more on the importance of vaccinating their children, which was not the case in urban areas where there is high urbanisation which increases demand for health workers there limiting tome they have per patient (Hu et al, 2017). Zimbabwe on the other had no difference between the rural and urban areas (Mukungwa, 2015)

Thailand is the only Asian country in the reviewed papers that has attained universal health coverage though people residing in rural areas have low immunisation coverage (Yiengprugsawan et al, 2010). There are barriers that people in rural areas usually face which are acceptability, affordability and availability (Nabyonga-Orem et al, 2014). Health insurance may be a barrier for women who do not have it because they are afraid they will be made to pay even though services are free but lack of knowledge affects coverage of immunisation (Asuman et al, 2018).

In all the reviewed papers, immunisations are free in the public sector , which should automatically narrow SES inequalities but there are indirect costs that can be a barrier such a transport cost for patients who live far from health facilities (Tajima-Pozo et al, 2015). The opportunity cost for poor mothers makes them rather work than spend the whole day at the clinic and forego some income which was shown in the results of most of the studies (Phiri & Ataguba, 2014b). Mothers who are employed could sometimes negate taking their children to the clinic though they are at a better position than those who are not employed or are self-employed (Hu et al, 2017)

There may not have been many developed country studies on this topic because most of them have achieved universal immunisation coverage according to UN statistics and they are trying to eliminate diseases as opposed to most developing countries that are trying to increases coverage (Wiysonge et al, 2012). Most developed countries have passed the 90% immunisation coverage mark such as Ireland at 95%, Canada at 91%, Italy at 94%, France at 96% and Switzerland at 97% coverage (UNICEF, 2018). Minorities in developed countries are the ones usually affected, who in most cases are usually migrants and people of marginalised ethnic groups (Joseph & Marrow, 2017; Tiley et al, 2018). The household structure, income and SES and health behaviours such as smoking were the main contributors to disparities in immunisation coverage with little effect on the age, literacy, birth order (Doherty et al, 2014)

Andrew Wakefield, a British doctor, published an article in 1998 that concluded that immunisations cause autism among children (Rao & Andrade, 2011). Although this article was revoked after many studies revealed that the conclusions were false, there had been ripple effects among parents being hesitant to get their children immunised (Rao & Andrade, 2011). Social attitudes and perceptions contribute to barriers against some of the immunisation coverage that has been observed in countries such as the United States of America and Scotland (Arede et al, 2019; Haider et al, 2019). Religion is another social variable that was tested in Ghana and results showed that Christians and Muslims were more likely to get their children fully immunised compared to Buddhists (Asuman et al, 2018). Access to Television and radio was considered an important factor that allowed mothers access to better information regarding immunisation schedules (Handy et al, 2017).

Region of residence usually plays a role because in countries such as Zimbabwe there are regions such as Bulawayo that have better development than Mashonaland which has a lot of rural areas and coverage is different between the two regions (Mukungwa, 2015). Kenya, Ghana and India have low immunisation coverage in the slums that are found in the urban areas which are also a comparison within the same region but urbanisation has forced the slums to grow bigger and generally, there are bad sewage systems, unsafe water and unhealthy living conditions which make people prone to sickness and outbreaks are easily magnified in these areas (Asuman et al, 2018; Egondi et al, 2015; Lauridsen & Pradhan, 2011)

Antenatal care (ANC) visits for pregnant mothers improved their access to nurses which improved their chances to get information on immunisation dates (Asuman et al, 2018; Dixit et al, 2013). ANC visits were linked to the place of delivery which was important because a child born at home would not immediately get the BCG vaccine that they are supposed to receive and depending on the knowledge of the mother, they may automatically fall back on the number of vaccines their child needs (Gupta et al, 2016; Meleko et al, 2017).

Birth order was revealed to affect immunisation coverage in all the reviewed papers except in Nigeria, Kenya, Ireland and the multi-country analysis (Doherty et al, 2014; Egondi et al, 2015; Hajizadeh, 2018). Children of higher birth order were less likely to be fully immunised, due to reasons such as 'parents vaccine fatigue' which means parents get tired of the same cycle of going with their children for vaccines but there are other explanations such as the fact that there will be sibling competition to get the parents attention (Hu et al, 2017).

Studies in Kenya and Belgium highlighted that the age of the mother played a crucial role which was supported by a Zimbabwe study. The older the mother, the more likely the child was to be immunised (Egondi et al, 2015; Lernout et al, 2014). The Ghanaian study by Asuman (2018) also supported the idea that younger mothers may not have as much bargaining power as they may have to seek permission from someone else in the household which will likely affect the timing of vaccines or even missing some of the dates. China, on the other hand, disagreed with this theory and believed that younger mothers would have better utilisation of health services allowing them to have a higher immunisation coverage (Hu et al, 2017). Maternal age had no significance in Brazil and England (Branco et al, 2014; Tiley et al, 2018).

The fact that sub-Saharan has the highest rates of child mortality in the world is important that more countries in this region seek to explain factors that hinder immunisation coverage being achieved. Zimbabwe does not have a study of this nature that seeks to explain socioeconomic inequalities in immunisation coverage which makes this study important. Variables that were used in other studies shall be tested to see if they fit in the Zimbabwean context as it is important to have context-specific results that can help policymakers.

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PART C: JOURNAL ARTICLE

Explaining socioeconomic inequalities in immunisation coverage in Zimbabwe

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Abstract

Background: Socioeconomic inequalities in health have received significant attention globally because of the well-known association between wealth and health. A lot of studies show that poor people are more prone to sickness than their counterparts. Immunisation has been a key antidote to avert deaths for children under the age of 5. This study represents an initial attempt to assess specific variables that contribute to socioeconomic inequalities in immunisation coverage in Zimbabwe.

Methods: Data were obtained from the 2015 Zimbabwe Demographic Health Survey, a nationally representative survey. Immunisation coverage was measured using four categories: full immunisation (a child who will have received 10 doses of vaccines), partial immunisation (a child who will have received at least one but not all vaccines), no immunisation (a child who will not have received any immunisation dose from birth) and immunisation intensity (a proportion of doses received to total doses that they should have received). Inequalities in immunisation coverage in Zimbabwe were assessed using concentration curves and indices. A positive (negative) concentration index indicates immunisation coverage concentrated among the rich (poor). The concentration index was decomposed to identify how different variables contribute to the socioeconomic inequality in immunisation coverage in Zimbabwe.

Results: The immunisation intensity and full immunisation concentration indices were (0.0154) and (0.0250) respectively, indicating that children from lower socio-economic status are less likely to receive all doses of vaccines. No immunisation and partial immunisation concentration indices were (-0.0778) and (-0.0878) indicating that children from higher socio-economic status are more likely to have their children immunised opposed to their poor counterparts. The main contributors to socioeconomic inequality in immunisation coverage are the mother's education, socioeconomic status and place of residence (rural/urban and province).

Conclusion: While immunisation services are free of charge in the public health sector in Zimbabwe, coverage rates are higher among the wealthy, which shows that there may be barriers to utilising these services that may not be the direct cost of vaccination. There have to be measures by the government to reach people in areas that are not easily accessible. Also, more needs to be done to reduce socioeconomic inequalities in Zimbabwe.

Keywords: Immunisation, socioeconomic, inequality, decomposition, Zimbabwe, immunisation coverage

Introduction

Child mortality is a key health topic of concern globally, falling under the third goal of the seventeen Sustainable Development Goals (SDGs) (Lauridsen & Pradhan, 2011). Under 5 (U5) mortality rate has decreased by 58% globally. In 2018, one in 26 children died before they reach the age of 5 compared to one in 11 children in 1990 (UNICEF, 2018). The World Health Organization (WHO) introduced the Expanded Program on Immunisation (EPI) in 1974 to avert childhood immunisation-related deaths. The EPI has proven to be a cost-effective solution used to reduce child deaths from preventable diseases especially in developing countries (Keja et al, 1988).

In 2017, an estimated 6.3 million children under the age of 15 died; about 5.4 million of these deaths were children under the age of 5. Even though immunisation has improved, reducing the number of U5 deaths from 12.6 million to 5.4 million between 1990 and 2017, an estimated 19.9 million children did not receive the 3 doses of DPT (diphtheria, pertussis, and tetanus) (WHO, 2017).

Under 5 deaths are mainly caused by pneumonia, diarrhoea, malnutrition, and malaria (WHO, 2017). Despite the decrease in mortality rates, there are still disparities between countries and regions (Raza et al, 2018). Sub-Saharan Africa is the region with the highest proportion of child deaths as children are 15 times more likely to die in the region compared to other regions. In 2018 the mortality rate in sub-Saharan Africa was 78 deaths per 1000 live births (UNICEF, 2019). The major reason for the disparities between regions is incomplete or no vaccinations (Donfouet et al, 2019; Mackenbach et al, 2003). As the world progresses and nations become richer, gaps in socioeconomic inequalities in health in some countries have also widened (Mackenbach et al, 2003). This phenomenon goes against the 1978 Alma Ata declaration that advocated the need to bridge the gap between the rich and the poor in accessing health services (Gillam, 2008). These gaps limit poor people's full capacity to function and contribute fully to the economy due to poor health (Bloom et al, 2004). A vibrant economy needs to ensure that people are healthy so that they can contribute to economic growth (Adams, 2009).

Perpetuating inequalities among different socioeconomic groups within society create a poverty trap for the poorest (Carter & Barrett, 2006). Many countries in sub-Saharan Africa face great inequalities due to unstable political and economic atmospheres and one of those countries is Zimbabwe (Mbaku, 1988). The poverty rates in Zimbabwe have increased as the country's economic growth has been declining (Stoeffler et al, 2016)

Zimbabwe had an estimated population of 16.7 million people and an HDI of 0.535 in 2018 which is very low (UNDP.). It introduced the EPI in 1981 to fight against 6 vaccine-preventable diseases: measles, tuberculosis, pertussis (whooping cough), diphtheria, tetanus and poliomyelitis (Mukungwa, 2015). In 1990, the country had attained universal child immunisation with a high reduction in mortality and morbidity. Poor economic performance has largely affected full immunisation coverage causing it to decline from 91% in 2016 to 89% in 2018 (Sibanda & Doctor, 2013).

The infant mortality rate in the country in 2015 was estimated at 36 deaths per 1000 live births, and the under-5 mortality rate was 69 deaths per 1000 live births (UNICEF, 2018). HIV and AIDS had been a significant contributor to the high child mortality rates in the country, accounting for about 21% of child deaths (WHO, 2018). As a way to reduce the mortality rates, in 2017, the government of Zimbabwe removed user fees for the vulnerable population (children under the age of 5, pregnant mothers, and citizens over the age of 65 years) (Meessen et al, 2011). Removing user fees is a pro-poor policy in health aimed to increase the use of health services for those of lower social status in society with the intent to improve health outcomes and offer financial protection (James et al, 2006).

Vaccine services are free of charge in the public sector, yet the poor still do not utilise these services as much as they should, which is reflected by lower immunisation coverage among the poor (Mukungwa, 2015). Access barriers can explain this inconsistency: Indirect costs (affordability) such as transport and food costs can play a role in them being unable to access health services (Goudge et al, 2009). There are other access barriers affecting immunisation services such as long walking distances to clinics especially in rural areas, poor service delivery brought by poor governance that enable problems like drug stock-outs and obsolete equipment (availability) (Gupta et al, 2016; LUCAS et al, 2009). Drug stock-outs can affect caregivers trust in travelling long distances and possibly not having their child (ren) vaccinated. Drug stock-outs have been a serious issue despite the high demand for drugs from patients, which can be frustrating for nurses because they are unable to do their job efficiently without patients feeling discontent (Gilson & McIntyre, 2005). Acceptability from expectations that patients have and the attitudes that health workers have also played a very crucial role, essentially if caregivers are not treated fairly with health workers they can decide not to seek immunisation services (Goudge et al, 2009)

Financial protection is essential for a pariah state like Zimbabwe with a high rate of unemployment (Rusvingo, 2014). Majority of people work in the informal sector and this has a ripple effect on most of the country's sectors, especially the health sector. The government is unable to collect revenue from taxes that is sufficient to fund public programmes. Most funding of EPI comes from out of pocket payments and NGOs. UNICEF, WHO, GAVI and MCHIP are the main financers of supplies, medicines, equipment etc (Ministry of Health and Child Care, 2016). The government mainly only supports the program in terms of salaries and allowances for staff. Due to this, the government only allocated 7% of the national budget to the health sector in 2017, which is insufficient to pay salaries; hence, there is a serious staff shortage in the sector (Kidia, 2018). The shortage of staff is met with an increase in health services utilisation associated with the removal of user fees (Meessen et al, 2011). This free user policy has put a strain on the short-staffed workforce with a doctor-patient ratio of 1:250,000 (Kidia, 2018), compared to the World Health Organization recommended doctor-patient of 1:1000 (WHO, 2019).

Like many developing countries, Zimbabwe is heavily reliant on donor funding, but donors usually come with their agendas and the government is unable to divert funds to issues that may deem more necessary than others (Salama et al, 2014). There is need for the government to be able to come up with ways to increase its internal financing so that it is able to allocate resources to pressing issues such as increasing immunisation coverage across all SES groups. There is consistent evidence globally and in Zimbabwe on the social gradient, where people of lower socioeconomic status suffer a greater burden of illness, having higher mortality rates compared to their better-off counterparts (Gwatkin, 2000b). This inverse care relationship explains that people who need health services (usually the poor) do not use them and vice versa (Warren, 2009).

Knowing the social gradient, the specific factors that contribute to socioeconomic inequalities must be identified so that governments are able to tackle each factor individually. This study is the first to decompose health inequalities in Zimbabwe and seeks to make policymakers aware of disparities that are observed between different SES groups in the country so that they can address issues to allow equal opportunity for all to access good health. Better governance would allow for better allocation of resources, but the ultimate goal is for immunisation coverage to increase for all groups of people, especially among the poorer populations.

Methods

Data

This study uses data from the sixth wave of the Demographic Health Survey (DHS), conducted in 2015. This is the most recent DHS conducted in conjunction with the government of Zimbabwe. The primary objective of the survey is to provide demographic and health information(ZIMSTAT & ICF International, 2016). The DHS uses a two-stage sampling method, involving a selection of 400 enumeration areas (EAs), 166 in urban areas and 234 in rural areas, in the first stage. A total of 11,196 households were sampled in the second stage, using a stratified method. The main advantage of the DHS dataset is that it has a high response rate of 99%

Box 1: Zimbabwe immunisation schedule for children under 12 months

First contact at birth – BCG

Second contact at 6 weeks – OPV 1, DTP-HepB-Hib1 (Pentavalent), PCV 1, Rotavirus 1

Third contact at 10 weeks – OPV 2, DTP-Hep B-Hib 2 (Pentavalent), PCV 2, Rotavirus 2

Fourth contact e at 14 weeks – OPV 3, DTP-Hep B-Hib 3 (Pentavalent), PCV 3, IPV

Fifth contact at 9 months – Measles and Rubella vaccine

Source: Ministry of Health and Child Care (2017)

The data set had information on 6132 children. About 81% (4904) of the children are aged between 12 to 59 months, are then used to create a sub-sample used for the study analysis. Children aged 12 months were the cut off age because that is the age at which full immunisation can be observed (i.e. where a child has received all 10 doses required). It is important to note that this paper uses 10 vaccines in the analysis as opposed to the 14 shown in Box 1 above. 10 vaccines are used because the rotavirus was introduced in 2014, a year before the survey, which would not have given a good reflection of the number of children who received the dose. Specifically, rotavirus 1 and 2 were dropped. The Inactivated Polio Vaccine (IPV) was also introduced in 2019 which is an obvious exclusion. Measles and Rubella was a supplementary dose introduced in Zimbabwe in 2015 and may not be included in the mainstream vaccine doses or collected in the 2015 DHS data. After removing these 4 doses due to the reasons mentioned above, the remaining 10 doses were used to categorise children into different immunisation coverage indicators.

In a majority of DHS surveys, people eligible for individual interviews include women of reproductive age (15-49 years) and men (15-59 years). Individual questionnaires include information on fertility, mortality, family planning, marriage, reproductive health, child health, nutrition, and HIV/AIDS (ZIMSTAT & ICF International, 2016).

In the analysis, four indicators of immunisation coverage are created, namely: fully immunised (children from the age of 12 months that received all 10 doses of vaccines), partially immunised (children who received between 1 and 9 doses of vaccines) and not immunised (children who never received a dose of vaccine from birth). The partially immunised group made way for a fourth group that measures immunisation intensity (the proportion of the 10 doses of vaccines received at 12 months).

Wealth Index

The wealth index used as the SES measure was constructed within the DHS dataset using a method developed by Rustein and Johnson (Rustein, 2004). The index uses several household assets, including the source of drinking water, type of flooring and ceiling in the house and sanitation facilities. This is done in 3 steps: (1) a subset of indicators that are common to rural and urban is used to create wealth scores for each household in both areas and transformed into binary indicators. A principal components analysis method is then used to create wealth scores for every household. (2) Households in rural and urban areas have separate factor scores using area-specific indicators, and (3) the last step combines the specific area indicators to produce a national wealth index. The wealth index is essential for plotting the concentration curves and computing the concentration index (Rustein, 2004).

Analytical methods

This study used the concentration curves and concentration indices (CI) over other measures such as the slope index of inequality, index of dissimilarity and pseudo-Lorenz curve, to assess health inequalities in immunisation coverage (Regidor, 2004a). The concentration index fulfils certain properties: it is widely used because it consistently reflects the socioeconomic dimension of health, it is sensitive to changes in the distribution of the population across different socioeconomic categories and reflects the experiences of all people rather than just the top and bottom SES groups (Regidor, 2004a; Zhang & Wang, 2007). It can assess relative rather than absolute inequality (Asada, 2010; Ataguba et al, 2016). Relative inequality refers to the idea that measurement of inequality should not depend on the mean health/ill-health such that if everyone's health doubled, inequality measures would not change (Asada, 2010; Wagstaff, 2009).

As a way to reduce any confounding effects of some variables correlated with SES and immunisation coverage, the health variables are indirectly standardised by age and sex (Naing, 2000). Standardising attempts to correct the distribution of immunisation coverage by comparing it with that expected of actual age/sex distribution of children. It, therefore, produces the distribution of immunisation coverage by SES conditional on the confounding variables (age and sex) (Ataguba et al, 2016). The indirect method was used in this study because it has greater accuracy when dealing with individual-level data unlike the direct method which could alter the standardised concentration index according to the number of age/sex groups formed (Ataguba et al, 2016; O'Donnell, 2008). O'Donnell (O'Donnell, 2008) estimate a health regression as:

$$y_i = \alpha + \sum_j \beta_j x_{ji} + \sum_k \gamma_k z_{ki} + \varepsilon_i \qquad (1)$$

where y_i is the immunisation coverage indicator (e.g. full immunisation); i denotes the case 1individual; and α, β, and γ are parameter vectors. The x_j are confounding variables for which we want to standardise (e.g., age and sex), and the z_k are non-confounding variables for which we do not want to standardise but to control for to estimate partial correlations with the confounding variables (O'Donnell, 2008).

Estimates of indirectly standardised health $\hat{y}_i^{IS}$ are given by the differences between actual and x-expected health (using equation 1) plus the overall sample mean.

$$\hat{y}_i^{IS} = y_i - \hat{y}_i^X + \bar{y} \qquad (2)$$

The concentration index is derived from the concentration curve. The x-axis ranks individuals in ascending order of their socioeconomic status, starting with those with the lowest socioeconomic status. The y-axis plots the cumulative share of a health variable (i.e. vaccination coverage) (Phiri & Ataguba, 2014b). The concentration index is twice the area between the 45-degree (line of perfect equality) and the concentration curve. The concentration index ranges from -1 to +1 (Jann, 2016). A key characteristic feature of the concentration index is that it takes account of every individual's level of health and rank when measuring socioeconomic inequality (Erreygers & Van Ourti, 2011).

A negative concentration index means that the immunisation coverage variable is mainly concentrated among the disadvantaged SES group and a positive concentration index means the opposite. A value of zero means there is an equal distribution between the rich and the poor. The larger the value of the CI, the wider the inequalities in the coverage of immunisation.

Wagstaff takes note that the concentration index of a binary variable (such as immunisation coverage) does not have the usual bounds. It lies between ($\mu_H - 1$) and ($1 - \mu_H$) requiring normalisation by dividing by ($1 - \mu_H$) (Wagstaff, 2005), where μ_H is the mean of the immunisation coverage variable. On the other hand, Erreygers views this normalisation as ad-hoc and proposes another way of normalising the concentration index for an ordinal variable as well as a dichotomous variable (Erreygers, 2009). Wagstaff has shown that Erreygers' (Erreygers, 2009) adjusted concentration index, E_c, can be written as:

$$Ec = 4\left(\frac{\mu_H}{b-a}\right) \cdot CH \qquad (3)$$

where a and b are the lower and upper bounds of the variable of interest, respectively and CH is the concentration index.

Decomposing the concentration index

Decomposing the concentration index allows for an explanation of the factors that contribute to socioeconomic inequalities (Hosseinpoor et al, 2006).

Let the relationship between each immunisation coverage variable and the relevant determinant factors be given as:

$$y_i = \alpha + \sum_k \beta_k x_{ki} + \varepsilon_i \qquad (4)$$

where α is the constant, β is the coefficient that measures the relationship between each explanatory factor (x) and the immunisation variable y_i and ε_i is the error term (Wagstaff et al, 2003). The concentration index (C) can also be written as

$$C = \sum_k (\beta_k \bar{x}_k / \mu) C_k + GC_\varepsilon / \mu \qquad (5)$$

where μ is the mean of the immunisation variable, C_k is the concentration index of the k^{th} contributing factor, GC_ε is generalised concentration index from the error term. The first term in equation (5) $(\beta_k \bar{x}_k / \mu)$ represents the elasticity of immunisation variable to marginal changes in the k^{th} factor. When multiplied by C_k it provides the contributions of the k^{th} factor to the overall concentration index (C). The last part $\left(\frac{GC_\varepsilon}{\mu}\right)$ captures the residual, which represents the socioeconomic inequality that cannot be explained across SES groups by variations in the contributing factors.

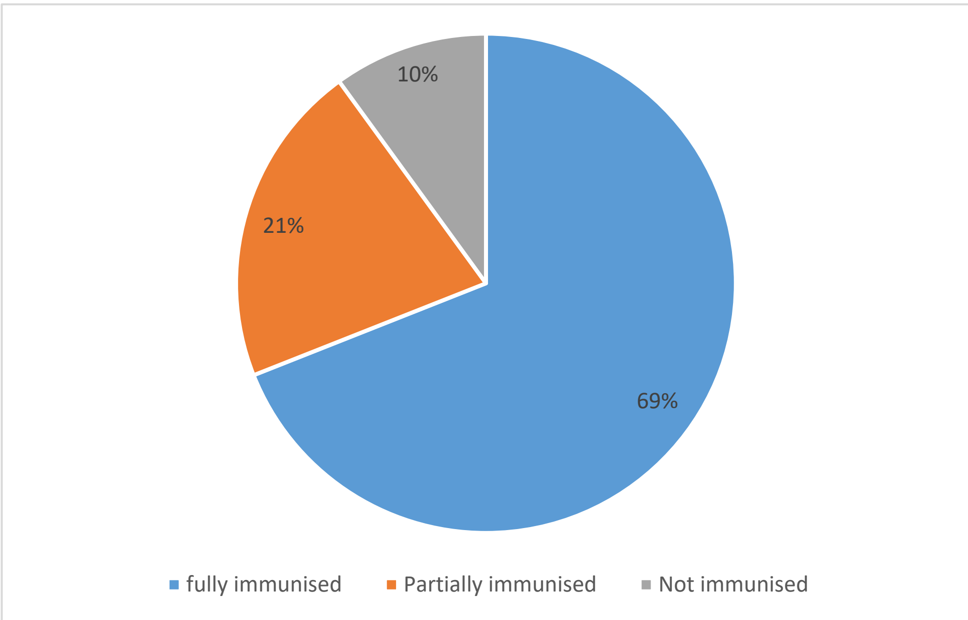
The variables (i.e. the k^{th} contributing factor) used in the study were common variables of interest that have been identified in other research papers that include dummy variable of the provinces to pick up regional fixed effects, mothers education, location of residence, quintiles and age of the child

Stata version 14 was used to perform all statistical analyses. The Human Research Ethics Committee (HREC) of the Faculty of Health Sciences, University of Cape Town, has approved this research.

Empirical results

About 69% of children in Zimbabwe aged 12-59 month were fully immunised, 21% were partially immunised, and 10% did not receive any vaccination dose

(Figure 1). Trend in immunisation coverage in Zimbabwe



The concentration indices shown in Table 1 indicate that children who are not immunised are concentrated more among the lower SES groups because the concentration index is negative (-0.0806). This result means the children from poorer families are most likely not to receive any immunisation, and this relationship is not significant at conventional levels.

Partially immunised children show a pro-poor relationship. Partially immunised children are concentrated among the poorer families with a negative concentration index (-0.0896), which is significant at the 1% significance level. Erreygers' normalisation index (E_c) was estimated at -0.0413 which showed less inequality compared to the indirectly standardised concentration index. Full immunisation and immunisation intensity are pro-rich, with positive concentration indices estimated at 0.0250 and 0.0154, respectively and concentrated among the higher SES groups.

The concentration curves from Figure 2 also show that no immunisation and partial immunisation are concentrated among the poor because the concentration curves lie above the line if equity, and full immunisation and immunisation intensity are concentrated among the richer families because the curves lie below the line of equity.

Table 1: Concentration indices for immunisation coverage in Zimbabwe, 2015

	Unstandardised concentration index	Indirectly standardised concentration index	W_c	E_c
Not immunised	-0.0778 (0.0559)	- 0.0806 (0.0468) **	-0.0878 (0.0559)	-0.0355 (0.0059)
*Partially immunised	-0.0878 (0.0165) **	- 0.0896 (0.0140) **	-0.0995 (0.0165) **	-0.0413 (0.0165) **
*Fully immunised	0.0250 (0.0010) *	0.0257 (0.0007) *	0.1079 (0.0010) *	0.0768 (0.0010) *
*Immunisation intensity	0.0154 (0.0055) *	0.0158 (0.0044) *		

Notes: W_c, Wagstaff's normalisation of indirectly standardised concentration index, E_c, Erreygers normalisation of indirectly standardised concentration index. * (significant at 1% level), ** (significant at 5% level), Number in brackets = P value

Figure 2: Concentration curves for immunisation coverage, Zimbabwe

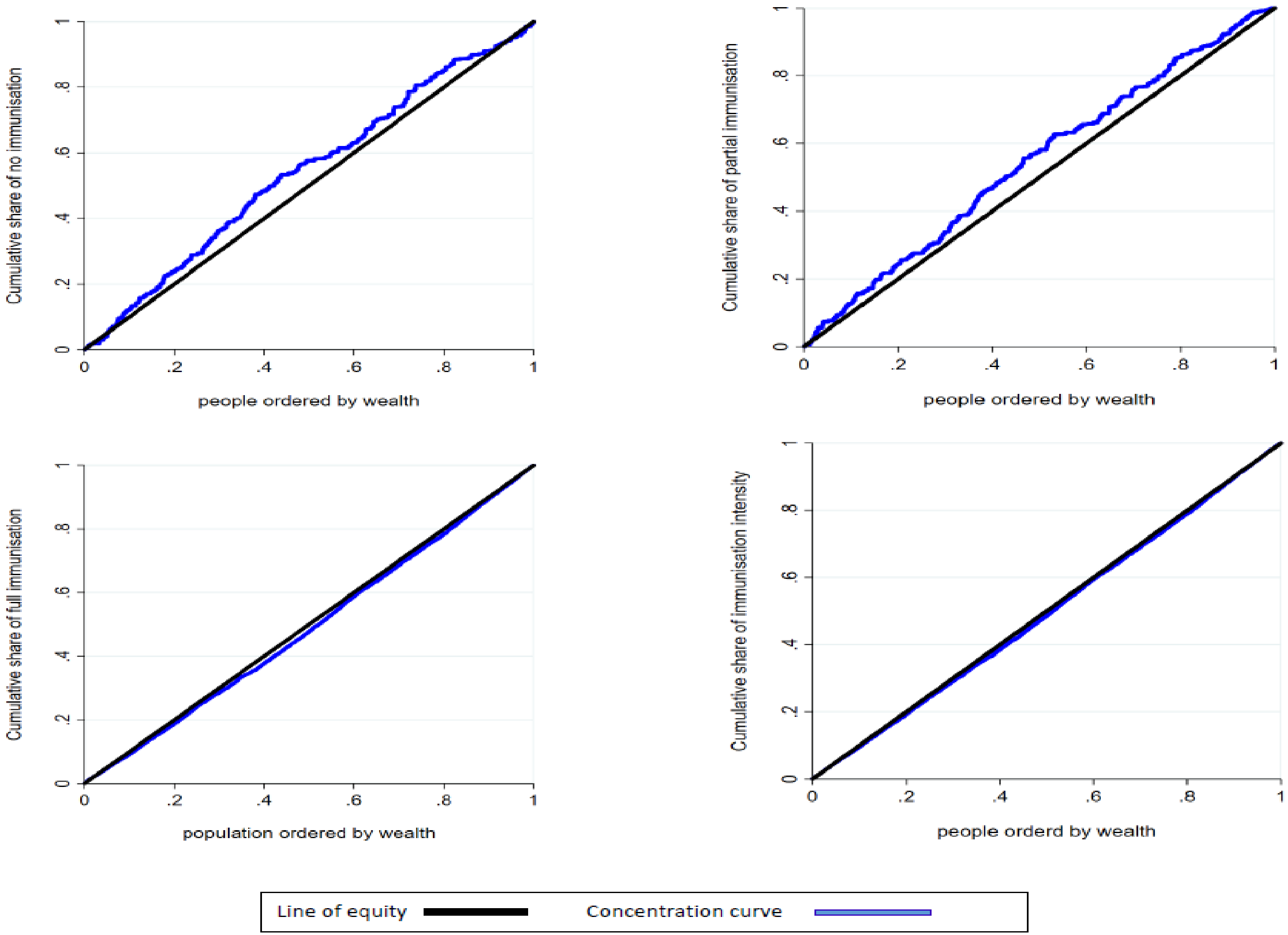


Table 2: Decomposition results for immunisation coverage in Zimbabwe, 2015

	Immunisation Intensity			
	Elasticity	Concentration index	Contribution	Percentage contribution
Age	-0.07089	0.00644	-0.00046	-3%
Female	0.00714	0.02094	0.00015	1%
Urban	-0.01858	0.64941	-0.01207	-78%
Mother's education	0.03227	0.16998	0.00549	36%
Mother's age	0.06797	0.00187	0.00013	1%
Quintiles			0.01861	121%
Fixed effects (provinces)			0.00289	19%
Residual			0.00067	4%

A negative (positive) contribution of an explanatory factor to the C for child vaccination suggests that socioeconomic distribution of the explanatory factor (the Ck) and the relationship between the relevant explanatory factor and child vaccination status contributes to a higher probability of child vaccination uptake among the poor (rich) (Hajizadeh, 2019)

The decomposition analysis was based on immunisation intensity. It had some significant contributors to inequality which included SES, mother's education, provinces fixed effect, and place of residence (rural/urban). The quintiles (SES) showed the most significant contribution to inequality (121%) showing that people from higher socioeconomic statuses are more likely to have their children immunised compared to those from lower socioeconomic status levels. Mother's education has a positive elasticity (0.03227) and a positive percentage contribution (36%) meaning that children with parents with a higher education are more likely to get immunised. Place of residence plays a crucial role according to the decomposition analysis as to the chances of a child getting immunised. The negative contribution of the urban variable means that children in urban areas are less likely to be fully immunised compared to children in rural areas. Proximity to health facilities differs between rural and urban areas, where people in rural areas usually travel longer distances to access a health facility. Overall, the desired full immunisation coverage is concentrated among the high SES groups which need to be addressed.

Discussion

This article revealed that full immunisation and immunisation intensity were concentrated among the rich. Children who were not immunised and those with partial immunisation were concentrated among the poor. This goes hand in hand with the health gradient where higher immunisation would be associated with a higher SES (Deaton, 2002).

Immunisation of children is a very important intervention that has averted diseases like smallpox, polio and measles in some countries like Nigeria (Ataguba et al, 2016). The results of this paper are consistent with most findings elsewhere, supporting the social gradient phenomenon. Social gradient explains that poorer people are more likely to be ill as reflected in the results of this paper (Donkin, 2014). We find that children from poorer families are less likely to be fully immunised. Full immunisation coverage is consistently higher among the rich and those living in urban areas. Unimmunised children are a small portion but they are mainly concentrated among the poor households. All children deserve a fair chance to receive all doses of immunisation that they need to make sure they have a chance to live a full life. As has been discussed, immunisation averts a lot of deaths making the topic of immunisation coverage important. SES is a starting point to an array of problems seen in countries creating a starting point for governments to address a range of issues.

The decomposition analysis showed that variables like mother's education, SES, and place of residence have positive contributions to inequality. Knowledge of these variables should be able to assist the government regarding specific areas that they should be concentrating on such that children have a better chance of living past the age of 5 years.

Mother's education is an important variable, especially in developing countries. It also reflects the patriarchal systems in place (Watson, 1990). Mother's education is a very important variable that contributes highly after SES in a lot of studies that have been conducted in countries like Nigeria, India and Iran (Ataguba et al, 2016; Hosseinpoor et al, 2006; Khan et al, 2017; Lauridsen & Pradhan, 2011). Abuya (Abuya et al, 2011) had results from Kenya that showed that children born to mothers who had a primary education were 2.17 more times likely to be vaccinated than children whose mothers had no formal education. Mothers who have higher education are more likely to have their children vaccinated. Grépin & Bharadwaj (2005) noted in a study in Zimbabwe that an additional year in school for mothers was associated with a 21% decline in mortality. A strong focus to increase educational levels among women who will become mothers is important, as well as to make sure that mothers are educated on the importance of having their children live longer lives, through different methods such as fliers, health talks at health facilities, and media.

Another important factor contributing to socioeconomic inequality is the place of residence. Children residing in urban areas are more likely to be immunised than those in rural areas. Some access barriers are usually associated with rural health facilities, which include proximity, acceptability and indirect costs (Chung et al, 2016). Other studies also report low immunisation coverage for people in rural communities (Ataguba et al, 2016; Hosseinpoor et al, 2006). Namibia was an odd case from similar studies where children who were not immunised were more concentrated in 'urban' locations. This was due to an increase in slums associated with rural-urban migration (Crocker-Buque et al, 2017). Supply-side factors such as incentives to get children immunised can be improved in rural areas and slums (Banerjee et al, 2010).

Different provinces adopt health policies differently, and it is reflected in how they offer health services in different health facilities. Under-5 mortality rates among provinces range from 50 deaths out of 1000 births in Bulawayo, to 112 deaths out 1000 births in Manicaland. Different provinces have different religions and cultures which could attribute to how people accept health services, including getting their children immunised. Mukungwa (Mukungwa, 2015) notes that a province such as Manicaland has the highest concentration of the Johanne Marange religion that opposes healthcare but rely on prophetic healing, which could be the reason for the high mortality rates in that province. In Northern Nigeria, polio immunisation is low due to lack of trust in the government and the immunisations themselves (Ataguba et al, 2016).

Previous studies looking at a socioeconomic inequality concentrating on immunisation coverage have concluded that children from lower SES groups are less likely to get fully immunised (Donfouet et al, 2019; Hajizadeh, 2018; Lauridsen & Pradhan, 2011).

In Zimbabwe and Africa in general, there is an increasing need to cater to the health needs of the poorest members of society. More broadly, the indictment of the effects of the current political, social and economic conditions of the Zimbabwean government on population health is clear (Kevany et al, 2012). In particular, the inability of the Zimbabwean government to provide even the most basic forms of public health services to its citizens means that those in need are increasingly limited to more expensive private-sector providers, which they can ill-afford (Kevany et al, 2012). Because the private sector is perceived to have better service, people are sometimes forced to seek private health services where out-of-pocket payment plans are most common (Kwesiga et al, 2015)

The study has some strengths that are shown by immunisation categorisation. People will have different reasons for the different categories, and it is important to know why some caregivers do not get their children immunised. An extra category of immunisation intensity was added. Knowing the factors that account for full immunisation are essential so that the government can further invest in them. This article does not merely provide an estimate of socioeconomic inequality but goes further to explain factors that underlie the disparities, which is essential for policy formulation. The most important thing is for the government to know what affects full immunisation coverage and be able to deal with the issues so that immunisation coverage can be increased and eliminate vaccine-preventable diseases and deaths. A challenge faced in the analysis is data availability and not calculating standard errors. Some information from the survey was self-reported which may over or underestimate the number of vaccines received

Recommendations

The government of Zimbabwe has to get to a point where it does not rely heavily on donor funding to try and try raise funds internally, just like how Thailand has managed to take control of its health sector. However, this requires the economy to be functioning normally as well (Yiengprugsawan et al, 2010).

Poor governance is a serious issue in Zimbabwe, and there is a general lack of transparency in a lot of the things that happen (Cain, 2016). Rural areas usually have a significant proportion of partially immunised children because of issues like access barriers. In knowing this, the government would need to build more health facilities within a certain radius to allow people to access health services without having problems (Ray & Masuka, 2017).

Measles and cholera are outbreaks that Zimbabwe has recently faced exposing the poor infrastructure that the country has such as cracked sewers, water shortages etc. The country's weak health system urgently needs to be revived (Mihigo et al, 2017). Inadequate funding of the health sector will likely affect other projects if money is directed towards fighting outbreaks.

Traditional healers are a common destination for a lot of people and a good way to regulate some of the things they have people doing is to incorporate them into the formal health system network. This way, they are accountable when they give bad advice to people.

Conclusions

Reducing child mortality has been recognised to be essential, therefore it is important for Zimbabwe to improve immunisation coverage after understanding the different factors that affect poor people especially from getting their children immunised. Mothers' education, place and province of residence and SES are key factors in immunisation coverage, which means these are areas that need to be improved and reduce the disparities that are in the country.

Local context adoption of health policies between different provinces can improve acceptance of immunisation services within communities depending on how the Ministry of Health educates people in regards to the importance of certain practices such as uptake of immunisation services.

The high disease burden that the country faces should be taken into account when tackling all these public health. There could be children who have other diseases that may adverse reactions when they receive immunisation doses.

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Author contribution

Tariro M. Chigwenah was responsible for the acquisition of the dataset, performed data analysis and wrote up the manuscript.

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PART D: POLICY BRIEF

Policy Brief

Addressing disparities in immunisation coverage between the poor and rich in Zimbabwe

Key Messages

- Full immunisation is in favour of the rich than the poor.
- Children from well of families are more likely to be fully immunised as opposed to children from poor families

INTRODUCTION

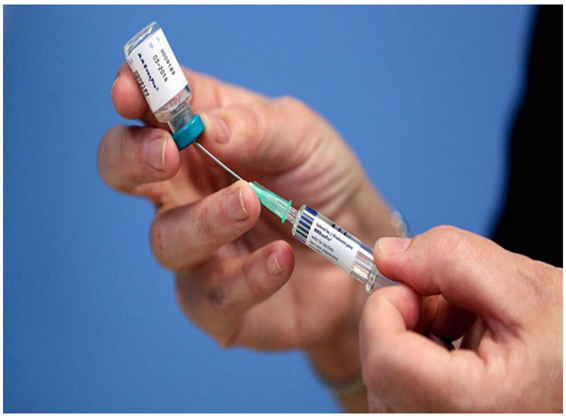
Child mortality is a global issue that has been receiving a lot of attention. Under 5 mortality rates have improved globally with children less likely to die before the age of 5 years currently, as compared to the 1990s. Sub-Saharan Africa region still has the highest mortality rates and lowest rates of immunisation coverage. In Africa, children are 15 times more likely to die before they reach the age of 5 years. Even in Africa, there are disparities in under 5 mortality rates between countries and sub-regions.

Internationally, disparities in immunisation coverage between the poor and the rich continue to raise a concern for policymakers. Poor people are usually unable to get their children fully immunised as opposed to their rich counterparts. Low-income countries experience more disparities.

The Zimbabwean government introduced the Expanded Program on Immunisation in 1981 to avert child deaths from 6 vaccine-preventable diseases: measles, tuberculosis, pertussis (whooping cough), diphtheria, tetanus and poliomyelitis. However, the country's challenging economic conditions have affected immunisation coverage rates, especially in recent times. Data show that full immunisation coverage rate reduced to 89% in 2018 from 91% in 2016.

The health system is challenged by poor infrastructure such a scracked sewers shown by the typhoid and cholera outbreaks experienced. There is a lack of internal funding and a heavy reliance on donor funding, making it difficult to address key health-related issues including ensuring adequate immunisation coverage for children in Zimbabwe.

Zimbabwe's infant mortality rate was estimated at 36 deaths per 1000 live births and under 5 mortality rate was 69 deaths per 1000 live births in 2017. HIV and AIDS have contributed to 21% of child deaths. In efforts to reduce mortality rates and increase health service utilisation for poor and needy, the country abolished user fees in 2017. While this was welcomed, the free vaccine services did not address other major access barriers, especially for those in rural areas.



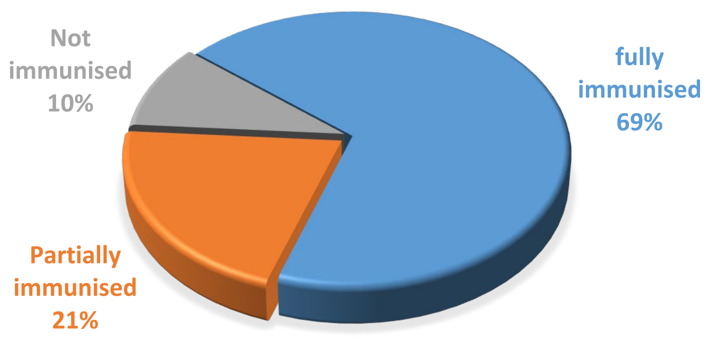
Access barriers such as long distances to reach health facilities, attitudes of staff at health facilities, drug stock outs and indirect costs such as transport costs and food costs remain. All these factors are issues that need to be addressed by governments to help improve immunisation coverage in Zimbabwe. Addressing these barriers in addition to removing user fees will enable all groups especially the marginalised to receive immunisation services for their children.

The aim of the paper was to explain the factors that contribute to disparities in immunisation coverage. Better knowledge of these factors could help improve utilisation of immunisation services.

Approach to analysis

Data were obtained from the 2015 Demographic and Health Survey that covers Zimbabwe.

FIG 1.TREND IN IMMUNISATION COVERAGE IN ZIMBABWE



In 2015 69% of children were fully immunised, 21% were partially immunised and 10% did not receive any immunisation dose as shown in figure 1

Box 1: Zimbabwe immunisation schedule for children under 12 month
First contact at birth – BCG Second contact at 6 weeks – OPV 1, DTP-HepB-Hib1 (Pentavalent), PCV Third contact at 10 weeks – OPV 2, DTP-Hep B-Hib 2 (Pentavalent), PCV 2

In the analysis immunisation was grouped into four categories namely: fully immunised (having received 10 doses), partially immunised (having received between 1 and 9 doses), not immunised (not having received any dose) and immunisation intensity (proportion of doses received over the 10 doses that should be received). The analysis assessed disparities between the rich and poor by showing which group was more likely to be fully, partially or never immunised.

Results

Table 1: Who gets immunised in Zimbabwe? The rich or the poor?

Category of immunisation	**Who gets immunised?**
Full immunisation	Predominantly the rich
Partial immunisation	Predominantly the poor
No immunisation	Predominantly the poor
Immunisation intensity	The rich receive more immunisation than the poor

Children belonging to poorer households are less likely to be fully immunised as opposed to children from richer households.

Certain variables contribute to the disparities in immunisation coverage in Zimbabwe. The less education a mother attains, the less likely they will have their child fully immunised. Location of residence (urban/rural) is also important. Children residing in urban areas are more likely to receive full immunisation compared to children in rural areas. Proximity to health facilities differs depending on the location of residence. People in rural areas travel longer distances to health facilities than those in urban areas. The province of residence also contributes to chances of immunisation occurring because different provinces adopt policies differently. Generally, full immunisation is concentrated among the wealthier groups in society.

Policy recommendations (long term)

- Find methods to improve internal funding within the country, relying less on donor funding.
- Ensuring that vaccines are made available to all Zimbabweans services by outreach services
- Government to build more health facilities in closer proximity to peoples' homes, especially for the rural population so that they do not incur access barriers

Support and Funding

The study was funded by the National Research Fund (NRF).

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PART E: APPENDICES

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Faculty of Health Sciences
Human Research Ethics Committee

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25 July 2019

HREC REF: 499/2019

A/Prof John Ataguba
Health Economics Unit
1.08
Public Health and Family Medicine

Dear A/Prof Ataguba

PROJECT TITLE: EXPLAINING THE SOCIO-ECONOMIC INEQUALITIES IN CHILD IMMUNIZATION COVERAGE IN ZIMBABWE (MASTERS CANDIDATE - MISS T CHIGWENAH)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until 30 July 2020.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

The HREC acknowledge that the student, Tariro Chigwenah will also be involved in this study.

Please quote the HREC REF in all your correspondence.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

HREC 499/2019

Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938
NHREC-registration number: REC-210208-007
This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use: Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2006), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki (2013) guidelines. The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

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Databases and repositories (Figshare, arXiv)	Roberts SB. QPX Genome Browser Feature Tracks; 2013 [cited 2013 Oct 5]. Database: figshare [Internet]. Available from: http://figshare.com/articles/QPX_Genome_Browser_Feature_Tracks/701214
Multimedia (videos, movies, or TV shows)	Hitchcock A, producer and director. Rear Window [Film]; 1954. Los Angeles: MGM.

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