An insight into the Implementation of the Global Action Plan on Antimicrobial Resistance in the WHO African Region: A Roadmap for Action

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Highlights

- The overall implementation of the Global Action Plan (GAP) on antimicrobial resistance in the World Health Organization (WHO) African region is inadequate
- WHO African countries performed poorly in terms of surveillance
- GAP implementation was not significantly different between African sub-regions
- There was no significant difference in GAP implementation between income levels

Abstract

The Global Action Plan (GAP) on antimicrobial resistance (AMR) delivers a 'One Health' strategy for the development of the national action plan. It encourages the optimal use of antimicrobials and strengthens the evidence base through surveillance and research. This study evaluated the current status of implementation of the GAP on AMR in WHO African countries via a retrospective, cross-sectional analysis of routinely collected data on AMR. A SWOT analysis was used to identify the strengths, weaknesses, opportunities and threats involved in the GAP implementation and propose a roadmap for action. The overall mean GAP performance score across all the countries assessed was 32%±SD:12 (95% CI: 27%-36%). The mean thematic scores were 59%±12 (53%-65%) for multi-sector and One Health collaboration; 50%±22 (42%-58%) for developing national AMR action plans; 38%±12 (33%-42%) for awareness and training; 18%±13 (13%-23%) for surveillance; 33%±13 (29%-38%) for infection prevention and control; and 28%±23 (20%-37%) for optimal use of antimicrobial medicines in human, animal and plant health. The difference in GAP performance scores between African sub-regions and between income categories was not statistically significant ($p>0.05$). While seven countries exhibited strengths in two themes, 25 countries exhibited weaknesses across all themes. Six threats and six opportunities were identified to inform a practical roadmap for AMR action. Findings from this study indicate that the overall GAP implementation on AMR in the WHO African region is inadequate. Some thematic GAP scores appear to be relatively good, but at closer inspection, individual indicators reveal a lack of progress and implementation, requiring action.

Keywords: Antimicrobial resistance, Global action plan, One Health, Infectious diseases, Public health.

1. Introduction

Antimicrobials are considered one of the greatest achievements in contemporary medicine [1]. However, the emergence and spread of antimicrobial resistance (AMR) impair the successful treatment of common infections like pneumonia, surgical site infections, some cancers and even top killer infectious diseases like tuberculosis (TB), malaria and HIV/AIDS. Consequently, this results in high morbidity, mortality, extended hospitalization, loss of income and grave economic and social implications [2,3].

Although AMR evolves through natural processes, its development and spread are influenced by some external factors such as incorrect use of antimicrobials, wrong prescriptions of antimicrobials, use of antimicrobials as growth promoters in livestock production and extensive use of antimicrobials for agricultural purposes [4,5]. The migration of people also permits the dissemination of drug-resistant organisms across the globe [4]. Unlike other medical conditions, AMR is an issue that affects all countries irrespective of their developmental status and income level [6]. However, the impact is felt more in low- and middle-income countries as many patients have limited or no access to effective healthcare [7]. This calls for a range of multidisciplinary approach and interventions to tackle the issues of drug resistance, especially in Africa.

In 2015, the global action plan (GAP) was initiated by the WHO, through the decisions made from the Food and Agriculture Organization of the United Nations (FAO) Governing Conference, the World Assembly of World Organization for Animal Health (OIE) Delegates and the World Health Assembly. The goal of this plan is to ensure the infinite continuity in the prevention and treatment of infectious diseases through the accessibility of effective antimicrobials as well as the responsible use of safe antimicrobials that are quality assured [8]. Five strategic objectives were set to achieve this goal: (1) to improve awareness and understanding of antimicrobial resistance; (2) to strengthen knowledge through surveillance and research; (3) to reduce the incidence of infection; (4) to optimize the use of antimicrobial agents; and (5) to ensure sustainable investment in countering antimicrobial resistance [8].

Countries developed their national action plan on AMR that is consistent with the GAP, to implement appropriate policies to prevent, control and monitor AMR. There is a need to measure the progress towards the delivery of the GAP on AMR to help identify key achievements and

persisting gaps across the human, animal, plant, food, and environment sectors in efforts to tackle AMR. This study evaluated the current status of the implementation of the GAP in WHO African countries. The GAP performance scores were compared to the income levels of the countries and the sub-regions of the respective countries. The strengths, weaknesses, opportunities and threats involved in the implementation of the GAP were identified to suggest a road map for action.

2. Methods

2.1 Study design and data source

An explorative study design involving a retrospective cross-sectional analysis of routinely collected data on AMR in the WHO African region was used to evaluate the GAP performance scores of the WHO African countries shown in Supplementary Table 1. The global open-access WHO, FAO and OIE global tripartite database [http://amrcountryprogress.org/] was accessed for the country's current status (2018/2019) in the implementation of the GAP on AMR. Countries that lacked a GAP were not included in the study.

2.2 Evaluation of the GAP performance scores

A checklist with 53 indicators (Supplementary Table 2) was used to create and evaluate the performance score per country concerning the implementation of the GAP. The indicators represent the standard questions issued to all the WHO countries for self-assessment by WHO, FAO and OIE. These indicators were grouped into six thematic areas namely: 1) multi-sectoral approach to addressing AMR (7 items); 2) developing national AMR action plans at the country level (9 items); 3) awareness and training (11 items); 4) surveillance (21 items); 5) infection prevention and control (3 items); and 6) optimization of the use of antimicrobial medicines in human, animal and plant health (2 items).

The GAP performance score per country was calculated by allotting 0, 1, 2, 3 or 4 points to each indicator depending on the response. A score of "0" was assigned to an indicator with a negative response such as "no" or "not provided" or "not involved" etc. A score of "1" to "4" was allotted to the indicators with a positive response, in an ascending order depending on the extent to which the indicator is implemented in the country. The supposed standard or maximum performance score for the implementation of the GAP in each country is 123, while 10, 12, 32, 50, 11 and 8 are the supposed standard or maximum performance scores for the thematic areas 1, 2, 3, 4, 5 and 6

respectively. Countries that scored 0% to 24%, 25% to 49%, 50% to 74% and 75% to 100% in the GAP and the themes were considered poor, moderate, good and excellent respectively.

2.3 SWOT analysis and roadmap for action

A SWOT (strengths, weaknesses, opportunities, threats) analysis was carried out to identify which opportunities should be pursued, which current strengths can aid struggling countries to re-evaluate their plans, which weaknesses can be improved to maximize AMR plans and which strategies can be put into place to be prepared for threats. The GAP themes with performance scores ≥75% were considered as strengths while the GAP themes with performance scores <25% were considered as weaknesses. Information on the external opportunities and threats were obtained from the literature. Google Scholar and PubMed were searched for relevant articles. The search terms used include: antimicrobial resistance, AMR, drug resistance, Africa, surveillance, global action plan, GAP, WHO African region.

An AMR road map for action framework involving the amalgamation of the common roadmap framework [9] and the framework for continuous agile road-mapping [10] is proposed to present a clear action plan for an improved GAP implementation in the WHO African region.

2.4 Data analysis

The overall GAP and thematic performance scores for each country in the WHO African region were evaluated using the descriptive statistical analysis in STATA (version 16). Percentages, measures of central tendency and dispersion were calculated. A one-way analysis of variance (ANOVA) was used to compare the GAP performance scores to the income status of the countries as stipulated by the World Bank Country and Lending Groups 2019 [11] as well as their respective sub-region. The Bonferroni correction test was applied to determine which pairs are different and a significant level of 0.05 was applied.

2.5 Ethical consideration

This study involved the analysis of secondary data set from the WHO database. Ethical clearance with ethics reference number 573/2020 was received from the Research Ethics Committee, Faculty of Health Sciences, University of Pretoria before the commencement of the study.

3. Results

3.1 The GAP performance in WHO African countries

The overall GAP performance scores ranged from 15% in Togo and Lesotho to 59% in Ethiopia with a mean score of 32% [standard deviation (SD): 12, 95% confidence interval (CI): 27% to 36%] as shown in Figure 1.

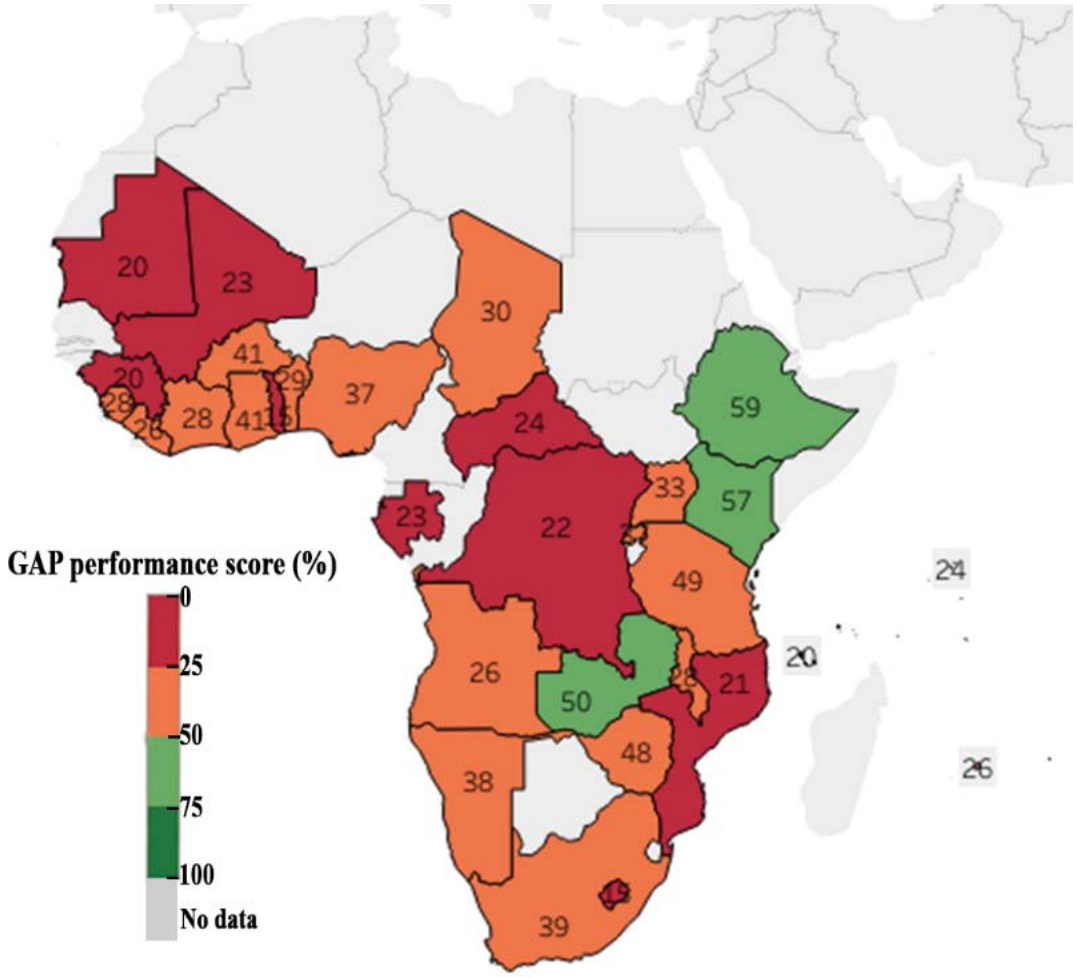

Figure 1: The GAP implementation performance scores of the WHO African countries. Countries that scored 0% to 24%, 25% to 49%, 50% to 74% and 75% to 100% in the GAP and the themes were considered poor, moderate, good and excellent respectively.

Figure 2

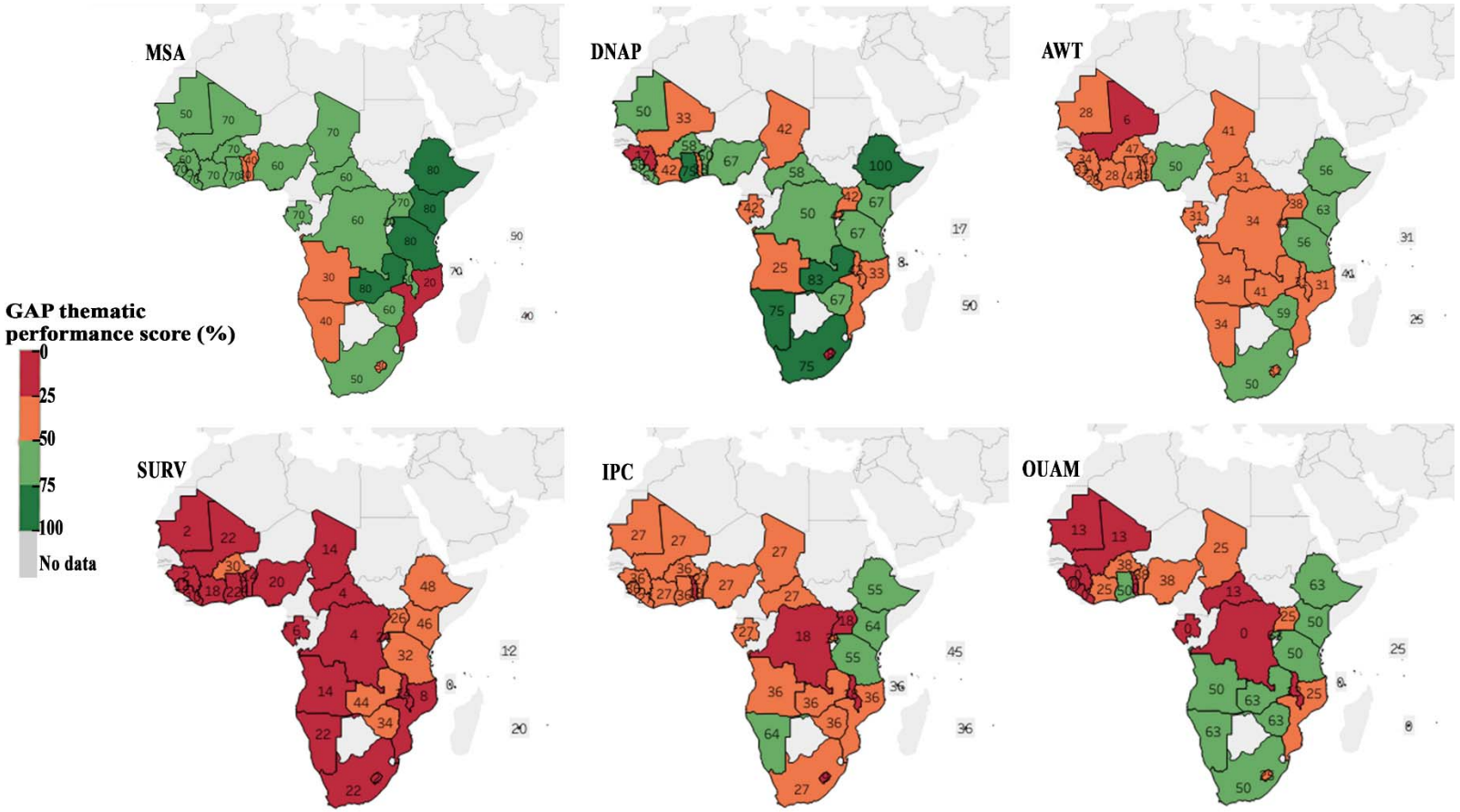

Figure 2: The GAP thematic performance scores of the WHO African countries. **MSA**: Multi-sectoral approach to addressing AMR (*theme 1*). **DNAP**: Developing national AMR action plans at the country level (*theme 2*). **AWT**: Awareness and training (*theme 3*). **SURV**: Surveillance (*theme 4*). **IPC**: Infection prevention and control (*theme 5*). **OUAM**: Optimization of the use of antimicrobial medicines in human, animal and plant health (*theme 6*). Countries that scored 0% to 24%, 25% to 49%, 50% to 74% and 75% to 100% in the GAP and the themes were considered poor, moderate, good and excellent respectively.

The GAP thematic performance scores are shown in Figure 2. For theme 1 (Multi-sector and One Health collaboration/coordination), the performance scores ranged from 20% in Mozambique to 80% in the United Republic of Tanzania, Zambia, Ethiopia and Kenya, with a mean score of 59% [SD: 12, 95% CI: 53% to 65%]. For theme 2 (Developing national AMR action plans at the country level), the performance scores ranged from 8% in Comoros and Lesotho to 100% in Ethiopia, with a mean score of 50% [SD: 22, 95% CI: 42% to 58%]. For theme 3 (Awareness and training), the performance scores ranged from 6% in Mali to 63% in Kenya, with a mean score of 38% [SD: 12, 95% CI: 33% to 42%]. For theme 4 (Surveillance), the performance scores ranged from 0% in Comoros to 48% in Ethiopia, with a mean score of 18% [SD: 13, 95% CI: 13% to 23%]. For theme 5 (Infection prevention and control), the performance scores ranged from 9% in Lesotho to 64% in Namibia and Kenya, with a mean score of 33% [SD: 13, 95% CI: 29% to 38%]. For theme 6 (Optimize the use of antimicrobial medicines in human, animal and plant health.), the performance scores ranged from 0% in Gabon, Guinea, Comoros, Togo, Mauritius, Democratic Republic of Congo, Liberia, Sierra Leone to 63% in Zimbabwe, Rwanda, Zambia, Namibia and Ethiopia, with a mean score of 28% [SD: 23, 95% CI: 20% to 37%].

3.2 GAP performance scores across the sub-regions and income-status of the WHO African countries

In terms of sub-regions (Figure 3A), the GAP performance scores in Central Africa varied from 27 in DRC Congo to 37 in Chad with a median score of 28.5 [interquartile range (IQR), 5.5; 95% CI, 27.00 to 37.00]. In Southern Africa, the GAP performance scores varied from 18 in Lesotho to 62 in Zambia with a median score of 41 [IQR, 24.9; 95% CI, 23.40 to 59.98]. In Eastern Africa, the GAP performance scores varied from 25 in Comoros to 73 in Ethiopia with a median score of 43.5 [IQR, 34.0; 95% CI, 28.38 to 70.98]. In Western Africa, the GAP performance scores varied from 19 in Togo to 51 in Burkina Faso with a median score of 34.0 [IQR, 26.5; 95% CI, 24.71 to 47.15]. The difference in the GAP performance scores between the sub-regions was not statistically significant ($p>0.05$, Bonferroni).

In terms of income status (Figure 3B), the GAP performance scores for LIE countries varied from 19 in Togo to 73 in Ethiopia with a median score of 34.5 [IQR, 19.0; 95% CI, 27.29 to 44.54]. For LMIE countries, the GAP performance scores varied from 18 in Lesotho to 70 in Kenya with a median score of 40.5 [IQR, 27.5; 95% CI, 22.73 to 64.60]. For UMIE countries, the GAP

performance scores varied from 28 in Gabon to 48 in Namibia with a median score of 39.5 [IQR, 17.5; 95% CI, 28.00 to 48.00]. Only one country (Seychelles) is a HIE with a GAP performance score of 30. The difference in the GAP performance scores between the income status of the countries was not statistically significant (p>0.05, Bonferroni).

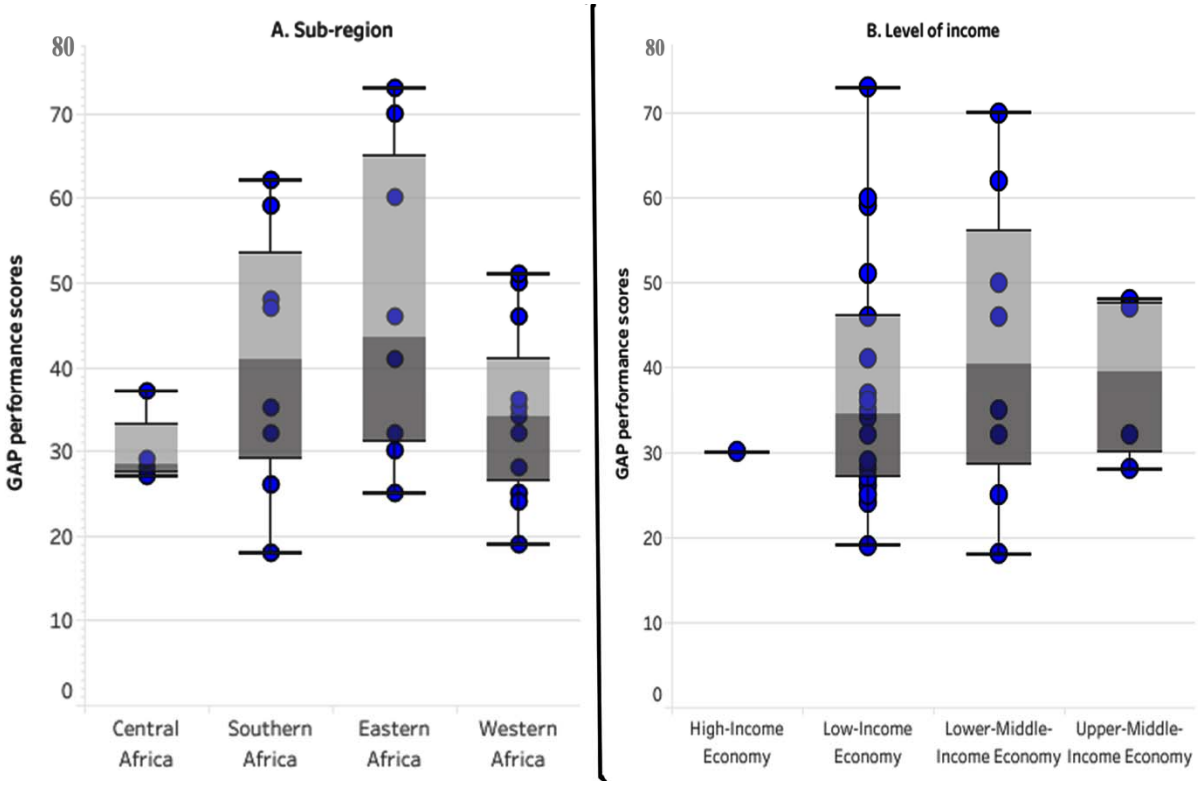

Figure 3: Box and Whisker plots showing the GAP performance scores with respect to the sub-region (A) and income status (B). *Median score.

3.3 The SWOT analysis of the GAP implementation in the WHO African region and the road map for action.

The SWOT analysis (Table 1) showed that only 7 countries (3 from Eastern Africa, 3 from Southern Africa and 1 from Western Africa) exhibited internal strengths to the GAP implementation, particularly in the thematic areas of "*multi-sectoral approach to addressing AMR*" and "*developing national AMR action plans at the country level"*. Conversely, 25 countries (4 from Central Africa, 5 from Eastern Africa, 6 from Southern Africa and 10 from Western Africa) exhibited internal weaknesses across all the GAP thematic areas. The SWOT analysis also detailed the external opportunities and threats involved in the GAP implementation in Africa.

Table 1. A SWOT analysis of the Global Action Plan (GAP) implementation in the World Health Organization African region.

INTERNAL STRENGTHS*	Central Africa	Eastern Africa	Southern Africa	Western Africa
Multi-sectoral approach to addressing AMR	No country	Tanzania, Ethiopia, Kenya	Zambia	No country
Developing national AMR action plans at the country level	No country	Ethiopia	South Africa, Zambia, Namibia	Ghana
Awareness and training	No country	No country	No country	No country
Surveillance	No country	No country	No country	No country
Infection prevention and control	No country	No country	No country	No country
Optimization of the use of antimicrobial medicines in human, animal and plant health	No country	No country	No country	No country
INTERNAL WEAKNESSES*	**Central Africa**	**Eastern Africa**	**Southern Africa**	**Western Africa**
Multi-sectoral approach to addressing AMR	No country	No country	Mozambique	No country
Developing national AMR action plans at the country level	No country	Comoros, Seychelles	Lesotho	Guinea
Awareness and training	No country	No country	No country	Mali
Surveillance	Gabon, Chad, Central African Republic, Congo	Seychelles, Comoros, Mauritius, Rwanda	Zimbabwe, Namibia, Malawi, Lesotho, Angola, Mozambique	Benin, Mauritania, Guinea, Togo, Mali, Côte d'Ivoire, Nigeria, Liberia, Sierra Leone, Ghana
Infection prevention and control	Congo	Uganda	Malawi, Lesotho	Togo
Optimization of the use of antimicrobial medicines in human, animal and plant health	Gabon, Central African Republic, Congo	Comoros, Mauritius	Malawi	Mauritania, Guinea, Togo, Mali, Liberia, Sierra Leone

EXTERNAL OPPORTUNITIES					
Inter country and inter-sectoral collaborations	Antimicrobial stewardship programs	Education and training	Improving AMR awareness	Research and Development	Improving surveillance

EXTERNAL THREATS					
Migration, urbanization and climate change	Inadequate laboratory facilities	Inadequate infection control procedures and wound management in hospitals	Circulation of sub-standard and counterfeit antimicrobials	High level of illiteracy and patient's non-compliance	Inadequate epidemic/ pandemic preparedness

*The GAP themes with performance scores ≥ 75% were considered as strengths, while the GAP themes with performance scores < 25% were considered as weaknesses.

AMR, antimicrobial resistance

The proposed AMR roadmap for action (Figure 4) describes how the integration of the GAP indicators, planning, updating/reviewing and strategic analysis can improve all the countries progress in the GAP implementation. The roadmap posits a clear future objective and answers the pivotal "why-what-how" questions that define and explain a clear action plan for GAP implementation.

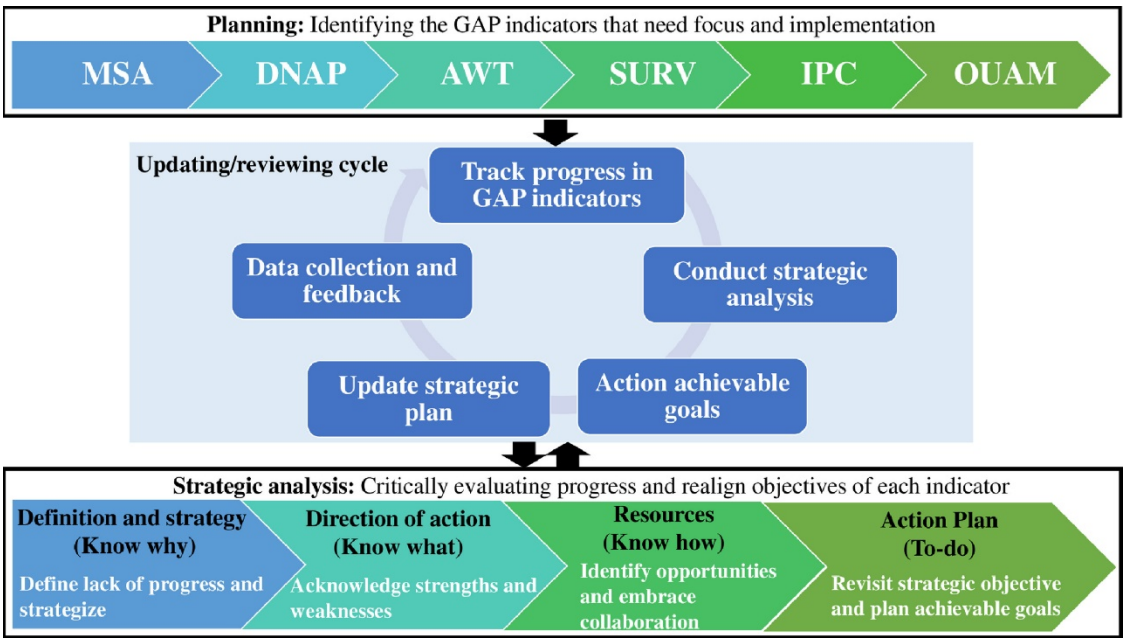

Figure 4. AMR roadmap for action indicating planning, reviewing and strategic analysis phases. **MSA:** Multi-sectoral approach to addressing AMR (*theme 1*). **DNAP:** Developing national AMR action plans at the country level (*theme 2*). **AWT:** Awareness and training (*theme 3*). **SURV:** Surveillance (*theme 4*). **IPC:** Infection prevention and control (*theme 5*). **OUAM:** Optimization of the use of antimicrobial medicines in human, animal and plant health (*theme 6*).

4. Discussion

This study shows that the overall implementation of the GAP in the WHO African region is inadequate. Although Ethiopia, Kenya and Zambia performed relatively good, majority of the WHO African countries had moderate to poor performance scores. This may be attributed to the economical, sociological, technological, industrial and ecological factors gravely impacting the ability of African countries to successfully implement the GAP and combat AMR [12].

The GAP addresses AMR from a multi-dimensional viewpoint. In terms of multi-sectoral and one health collaboration, the findings of this study indicated that WHO African countries performed relatively well. Although countries like the United Republic of Tanzania, Zambia, Ethiopia and Kenya performed excellently, Mozambique performed very poorly and should improve their collaborations with the human, plant, environmental, animal and food production sectors. This is in contrast to the situation in high-income countries like the USA, where integrated approaches have been used to implement the AMR action plan [13].

In terms of developing the national AMR action plans at the country level, the performance of the WHO African countries was relatively good. While most of the countries assessed in the present study have their national AMR action plans under development, Guinea and Angola have no national AMR action plan. However, these two countries have policies and regulations on antimicrobial use on humans and animals [13]. Surprisingly, Comoros and Lesotho have their national AMR action plans under development, but they scored least because they lack the policies and regulations that prohibit antimicrobial use on humans and animals. Interestingly, South Africa and Ghana have not only developed their national AMR action plans, but they also have their plans approved by the government and reflects the objectives of the GAP with an operational plan and monitoring arrangements. While Namibia has only just developed their national AMR action plans, Ethiopia has identified funding sources, implemented their plans, and have relevant sectors involved with a defined monitoring and evaluation process in place hence scoring 100% just like the USA [13]

It has been shown that raising awareness on AMR and encouraging behavioral change through effective training and communication which targets stakeholders from the human health, animal health and agricultural sectors play a pivotal role in combatting AMR [14,15]. Unfortunately, our study indicates a moderate performance of AMR awareness and training in WHO African countries. This is because, there have not been significant activities that raises the awareness of AMR risks in the human health, animal health, food production, food safety, water, sanitation and hygiene (WASH) and environmental health sectors in the WHO African region. Also, training and professional education on AMR in the human health, veterinary sector and farming sector within the region need to be revised and made more accessible. Interestingly, this is well implemented in high-income countries like the USA where targeted nationwide government supported activities have been implemented to change the behavior of people and stakeholders within key sectors [13].

This study indicated poor AMR surveillance in the WHO African region. This is because, most of the countries not only have a poor national monitoring system for the consumption and rational use of antimicrobials on humans, animals and plants, but they also have a poor national AMR surveillance system. Countries like Zimbabwe, the United Republic of Tanzania, Zambia, Burkina Faso, Kenya and Uganda were shown to have a moderate performance with regards to surveillance as shown in Figure 2. This is because they have made some efforts in having a designed system

that monitors the sales and use of antimicrobials, reports collected data to the OIE and have AMR surveillance activities for common bacterial infections with a national reference laboratory [13]. However, no country in the region has an effective integrated laboratories involved in AMR surveillance as seen in other high-income countries like the USA [13].

Infectious diseases account for more than 50% of the burden of disease in many low and middle-income countries [16]. Since attempting to reduce the risks of infectious diseases usually have an impact on AMR, infection prevention and control (IPC) has been identified as one of the most cost-effective interventions in controlling the AMR risks. However, it receives very little attention [17]. This is evident from the findings of this study where the IPC performance in the WHO African region is moderate. Although some of the countries such as Kenya, Ethiopia, Namibia and the United Republic of Tanzania had a relatively good performance, others like Malawi, Lesotho, Democratic Republic of Congo and Uganda performed poorly as shown in Figure 2. This is because they either lack a national IPC program such as WASH and environmental health standards or have it but have not fully implemented it which is in contrast to some high-income countries like the USA [13]..

This study indicated that WHO African countries had a moderate performance regarding the optimum use of antimicrobial medicines in human, animal and plant health with an average performance score of 28%. This is because most of the countries either lack or have a weak national policy on the appropriate use of antimicrobials. Alternatively, some countries like Zimbabwe, Rwanda, Zambia, Namibia and Ethiopia had a good performance concerning optimal use of antimicrobials. This is because they have implemented the guidelines and practices that enable the appropriate use of antimicrobials [13].

Comparing the overall GAP performance between the sub-regions of the WHO African region, our findings indicated that the Eastern African countries performed best, followed by the countries in Southern Africa, then Western Africa and then Central Africa. This corroborates the findings of Elton et al. (2020) as they indicated that countries from Eastern African and Southern African performed best in terms of AMR preparedness [18]. The authors suggested that Eastern Africa has the highest number of countries with multi-sectoral national action plans, AMR surveillance for both human and animal pathogens and have embraced the One Health perspective of AMR. They also suggested that Southern Africa has the highest percentage of countries with antimicrobial

stewardship guidelines in place with human and animal antimicrobial legislation [18]. These apply to our study, and as a part of a unified roadmap for AMR action, it is envisaged that countries from other sub-regions can adapt some of these strategies to attain better implementation of the GAP.

The present study demonstrated that LMIE countries performed best in terms of GAP implementation, followed by UMIE countries, then LIE countries and finally the HIE country. Since the majority (58.06%) of the countries assessed in this study are LIE countries with low GAP performance, and a recent study demonstrated a strong negative association between income status of a country and AMR prevalence in invasive isolates [19], then there is urgent need to improve GAP implementation on AMR within LIE countries to minimize the devastating effects of AMR. Seychelles is the only HIE African country assessed in this study, yet it has the least GAP performance when compared to the median GAP scores of other income categories. This implies that combating AMR within the country is not prioritized, and this is detrimental to the global fight against AMR.

The SWOT analysis indicated that the multi-sectoral approach to addressing AMR and developing national AMR action plans at the country level were the only strengths exhibited in the GAP implementation in the WHO African region. Sadly, the strengths of these themes were exhibited by only 7 countries. This is majorly impacted by the threats indicated in the analysis which overwhelms the efforts to combat AMR. Studies have shown that uncontrollable human movements due to travelling, migration and urbanization creates an opportunity for antimicrobial-resistant organisms to be moved from one geographic location to another [20,21]. Climate change causes temperature fluctuations which influences the thermal adaptability of microorganisms, consequently increasing AMR potentials in microbes [22]. Extreme weather conditions increases the incidence of emerging and reemerging infectious diseases, thus increasing AMR risks [23]. Laboratory facilities and competent staff to carry out ASTs so that infectious diseases are treated empirically are inadequate in Africa, and these have caused the misuse of antimicrobials hence favoring AMR [24–26]. Inadequate IPC and wound management strategies in the health care system in Africa increases the prevalence of antimicrobial-resistant infectious diseases [27,28]. Many antimicrobials dispensed in Africa have low quality in terms of pharmacological properties while many more are counterfeit. This causes the pathogens to be exposed to sub-lethal concentrations of the drugs, consequently encouraging the emergence of AMR [29,30]. The high

level of illiteracy in Africa affects people's knowledge and behaviors when it comes to the use of antimicrobials. The lack of awareness thwarts the success of antimicrobial stewardship in Africa [31]. Also, the patient's non-compliance to complete treatment regimen, either deliberately or by mistake contributes largely to AMR development [32]. During an epidemic/pandemic, for instance, the COVID-19 pandemic, health care services are usually disrupted. There is an increase in hospital admissions, an increase in the risks of healthcare-associated infections and treatment interruptions of other infectious diseases such as TB and HIV. These factors consequently encourages the emergence and spread of antimicrobial resistant strains [33]. This is exacerbated by inadequate preparedness for public health emergencies [34].

The SWOT analysis demonstrated that most of the WHO African countries exhibited weaknesses across all the themes. For the weaknesses to be turned into strengths, the analysis highlights certain opportunities that can be adapted in Africa. Intercountry and inter-sectoral collaborations and partnerships are required to coordinate more harmonized human, animal and environmental health policies [35]. Antimicrobial stewardship programs in Africa are required to preserve the efficacy of antimicrobials by reducing, and possibly avoiding their misuse while upholding their access [36]. Incorporating AMR into the educational and training curriculum of professionals in human and veterinary sciences in Africa is required to ensure better understanding among professionals. Improving AMR awareness via effective communications in Africa is required to promote "expert-driven" changes in behaviors [37]. Advanced research and development in Africa are needed to develop new antimicrobials, improve diagnostics, develop vaccines and antimicrobial alternatives [38,39]. Finally, the surveillance system in Africa needs to be improved to provide substantial data that will monitor changes in the susceptibly patterns and resistance trends of pathogens as well as help control AMR in the region [40].

The roadmap proposed in this study posits a strategic analysis that has a three-part architecture, the "why-what-how" questions that culminate in the required actions, the timely "to-do's." Using the individual and overall GAP scores in the planning phase, a country can enter the updating/reviewing phase, where implementation, data collection, analysis and feedback are vital in reviewing the progress made. Based on the results from the SWOT analysis, the progress in the GAP indicators can be identified and a strategic analysis can take place to identify the indicators that lack progress as well as identify achievable, yet measurable performance targets aligned to the

AMR objectives. Key in the strategic analysis phase is to identify how actions, resources risks, and opportunities will be implemented. The roadmap should be dynamic and be open to external opportunities, whilst keeping a clear focus on the end goal of the AMR agenda.

Study limitations

This study is limited to data from only 31 WHO African countries. Also, data on the 5th strategic objective of the GAP "*to ensure sustainable investment in countering antimicrobial resistance*" is not available in the database and was not included in the study. Efforts were made to eliminate potential sources of bias during analysis since secondary data was used.

Conclusion

This study demonstrated that the overall GAP implementation performance in the WHO African region is inadequate. There was no significant difference in the GAP implementation performance between the African sub-regions and between the income groups. We recommend a roadmap for action to realign country-specific AMR plans to the Global AMR agenda and promote intercountry and multi-sectoral collaborations involving the government, health care providers, veterinarians, researchers, academicians, farmers and other stakeholders to tackle the complex and multi-faceted problems associated with AMR in Africa.

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Declaration of competing interests

The authors declare that they have no competing interests

Authors' contributions

CDI and SMP contributed to the conception and design of the study. CDI collected and analysed the data, and prepared the draft manuscript. CDI and SMP revised the sections of the manuscript. All authors read and approved the final manuscript.

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