

A Comparative Analysis of National and State Level Action Plans on Antimicrobial Resistance in India

Soumya Ranjan Barik¹,  Himanshu Sekhar Pradhan^{2*},  Jyoti Prakash³,  and Sudhir Kumar Satpathy⁴, 

^{1,2,4}*School of Public Health, KIIT Deemed to be University, Bhubaneswar, Odisha, India*

³*Public Health consultant, Flat No-201, Kalpataru Residency, Nayapali, Bhubaneswar, Odisha, India*

*himanshu.pradhanfph@kiit.ac.in (Corresponding Author)

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ABSTRACT

Background: In 2015, the World Health Assembly endorsed a Global Action Plan on Antimicrobial Resistance (AMR) and recommended its member countries to create their own action plans on the subject. Following the launch of India's National Action Plan (NAP) on AMR in 2017, Indian states- Kerala, New Delhi and Madhya Pradesh consequently developed their action plans while other states are in the process of developing their own action plans on AMR. The present study is an attempt to compare NAP-AMR India and three state's AMR action plans.

Objectives: To study the similarities and variations among National and State Action Plans (SAPs) on AMR in India.

Methods: A review of India's NAP-AMR and the SAPs-AMR of three states (Kerala, Delhi and Madhya Pradesh) has been conducted to document the similarities and variations among these plans. Apart from AMR action plans other relevant documents obtained from Google, and National Centre for Disease Control, India were used.

Results: All strategic priorities of SAP-AMR of Kerala, New-Delhi and Madhya Pradesh are similar to NAP-AMR of India. Focus areas under strategic priorities of three state action plans are well aligned to the National Action Plan. Though suggested activities under various focus areas are more or less similar among state and national action plans, however each State Action Plan has introduced some of the unique activities under some focus areas. All the three State Action Plans are having well-defined monitoring and evaluation frameworks akin to National Action Plan, India.

Conclusion: So far only three Indian states have launched their state action plans on AMR following the launch of National Action Plan of India on AMR in the year 2017. The findings of this study may be useful for the experts while developing the state level action plans on AMR formulating antimicrobial policy and research etc.



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1. Introduction

Antimicrobial Resistance (AMR) currently accounts for 700,000 annual deaths, but is expected to rise to 10 million by 2050, and this may result a 3.5 percentage point reduction in global gross domestic product (GDP). AMR makes up one of the top 10 worldwide health concerns, in accordance to the World Health Organization (WHO). India is the largest consumer of antibiotics (Koya *et al.*, 2022) also highest bacterial disease burden in the world. (National & Pillars, n.d.; Gandra *et al.*, 2017) Realising the situation In 2015, the World Health Assembly adopted a "Global Action Plan" for AMR and urged all member states to align their Action Plans with it. Subsequently "Government of India

launched a National Programme on AMR Containment during the 12th five-year plan (2012-2017)" (*National Programme on AMR Containment:: National Centre for Disease Control (NCDC), n.d.*) By 2018, over 100 countries had completed the process of developing their National Action Plans (NAPs) on AMR on the basis of Global Action Plan (GAP) on AMR, while 67 had initiated the process. As we all know, India is a democracy country with a lot of cultural variety, socioeconomic diversity, political diversity, and cultural difference across states. In recent years, it has been seen that there is significant increase in socioeconomic development as well as population growth, which resulted in the rapid expansion of food production systems and a growing demand for antimicrobials. India has emerged as a key AMR reservoir despite being a hot

spot for the emergence of new infectious diseases (Siddiqi *et al.*, 2009).

Each state has a different socio-cultural status, socio-economic status, demographic variations, political variations, climatic changes, administrative variations, and performance, so they prepare their own State Action Plans (SAPs) on AMR contextualising local situations. Some states of India are in the process of developing action plans on AMR and three states already have SAPs in the public domain: “Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP), State Action Plan to Combat Antimicrobial Resistance in Delhi (SAP-CARD), and Madhya Pradesh State Action Plan for Containment of Antimicrobial Resistance (MP-SAPCAR)”. Currently there is no study conducted regarding the comparative analysis of the content of national and state action plans on AMR in India. The purpose of the study is to narrate the similarities and variations among National and State level action plans on AMR in India. This findings of the study may be help to develop the other state action plans on AMR. The study was conducted in the year 2022.

2. Methodology

The website of the National Centre for Disease Control (NCDC) was searched to find the National and State Action Plans on Antimicrobial Resistance of India. In addition, the websites of the Ministry of Health and Family Welfare, Govt. of India, health departments of the various states, National Health Mission of the central and states of India were searched to confirm availability of AMR plans. A search strategy with combination of different key words such as ‘National Action Plan’, ‘State Action Plans’, ‘Antimicrobial resistance’, and India were used to obtain AMR Action Plans and other relevant documents. The National Action Plan on AMR of India and three State Action Plans on AMR of Kerala, Delhi and Madhya Pradesh, which were available in public domains (websites) have been used for comparisons among these plans.

2.1. Parameters of the Study

Mainly this study has been focused on four aspects.

A. Policy and Governance aspects: Policy and Governance aspects will validity period, strategic priorities, focus areas, objectives, governance mechanism, administration mechanisms and stakeholder involvement.

B. Implementation aspects: Implementation aspects include, Information Education and Communication (IEC) resources, Education and training, Surveillance, infection prevention and control of Human and Animal health, Optimizing antimicrobial usages, Financing of AMR, Research and Innovation, Local, National and International collaboration.

C. Monitoring and Evaluation

D. One Health Approach

3. Results

NAP-AMR of India has six strategic priorities. These are “(i) Improving awareness and understanding of AMR through effective communication, education and training; (ii) Strengthening knowledge and evidence through surveillance; (iii) Reducing the incidence of infection through effective infection prevention and control; (iv) Optimizing the use of antimicrobial agents in health, animals and food; (v) Promoting investments for AMR activities, research and innovations; and (vi) Strengthening India’s leadership on AMR.” Each strategic priority has two or three focus areas and each focus area has two to three objectives. All three available state action plans of Kerala, Delhi, and Madhya Pradesh followed the same pattern as NAP-AMR for India.

As mentioned above India’s strategy against AMR focuses on key priorities: enhancing awareness through education and targeted communication, training healthcare professionals, expanding surveillance efforts across clinical, community, and environmental settings, and fortifying laboratories for better AMR detection. Additionally, they aim to reduce infections through robust infection control measures, emphasizing sanitation through campaigns like Swachh Bharat Abhiyan. Optimizing antimicrobial use involves revising essential medicine lists and establishing consumption patterns while strengthening stewardship programs. Setting priorities funding in AMR research and innovation, including financing methods and the development of innovative therapies, is critical. India seeks to bolster its global leadership in AMR by fostering international collaborations and local action through state-level partnerships (Kakkar, 2014). Followings are the key findings of the studies:

3.1. Policy and Governance Aspects

3.1.1. Purpose of the AMR action plans and Stakeholders Involvement

Broadly, the purpose of all action plans are more or less similar. NAP-AMR of India has clearly mentioned the validity period however the end date of validity period of SAPs hasn’t clearly mentioned. The NAP-AMR primarily focuses on bacterial resistance. Key stakeholders of national action plans are NCDC, MoHFW, MoAFW, NIPER, and Centre for Science and Environment - CSE but key stakeholders of Kerala SAP are Department of Health and Family Welfare, animal husbandry, agriculture, food, environment, research and civil society.

Table-1: Purpose of the AMR action plans and Stakeholders Involvement

| NAP and SAPs | Name of Documents | Year | Purpose of the Action plans | Stakeholder Involved |
|----------------------------|--|--------------|---|--|
| National Action Plan INDIA | National Action Plan on Antimicrobial Resistance (NAP-AMR) | 2017-2021 | To effectively combat antimicrobial resistance in India, and contribute towards the global efforts to tackle this public health threat. To establish and strengthen governance mechanisms as well as the capacity of all stakeholders to reduce the impact of AMR in India. The scope of the NAP-AMR focusses primarily on resistance in bacteria | National Authority for Containment of Antibiotic resistance(NACA), Ministry of Health and Family Welfare (MoHFW), Ministry of Agriculture and Farmers Welfare (MoAFW), NCDC, Indian Council for Agricultural Research(ICAR), Indian Council for Medical Research (ICMR), Ministry of Consumer Affairs, Food and Public Distribution(MoCAFPD), Ministry of Information & Broadcasting(MoIB), Ministry of Human Resource Development(MoHRD), Medical Council of India (MCI), Indian Nursing Council(INC), Veterinary Council India (VCI), Pharmacy Council of India(PCI), Dental Council of India(DCI), National Institute of Pharmaceutical Education and Research (NIPER), Central Health Education Bureau(CHEB), Ministry of Chemicals and Fertilizers(MoCF), Ministry of Environment, Forest and Climate Change(MoEFCC), Ministry of Food Processing Industries(MoFPI), Central Pollution Control Board(CPCB), Centre for Science and Environment(CSE), University Grants Commission(UGC), WHO, Food and Agriculture Organization of the United Nations(FAO), World Organisation for Animal Health (Office International des Epizooties(OIE) |
| State Action Plan Kerala | Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP) | October 2018 | To address antimicrobial resistance in the State by involving all stakeholders to develop and implement a State Action Plan on AMR with focus of creating awareness on AMR among cross sectoral stakeholders, Strengthening laboratory capacity for AMR surveillance and collating the data on AMR and Application of good infection prevention and control (IPC) measures across human health, animal health and agriculture | Animal husbandry, fisheries, agriculture, pollution control board, drug regulator, food safety, science and technology, AYUSH, research institutes, and the private sector, among others |
| State Action Plan Delhi | State Action Plan to Combat Antimicrobial Resistance in Delhi | January 2020 | To take suitable action to address AMR by Inter-sectoral collaboration with all stakeholders to develop and implement a State Action Plan on AMR, in alignment with the NAP-AMR and the GAP-AMR | Directorate of Health and Family Welfare(DHFW); Drug Control Department(DCD); Delhi State Health Mission (DSHM); Department of Animal Husbandry (DAH); Department of Food Safety (DFS); Delhi Pollution Control Committee(DPCC); Delhi Jal Board(DJB); Directorate of Agricultural Marketing (DAM); Department of Social Welfare (DSW); Women and Child Development Department (WCDD); Department of Education (DE); Directorate of AYUSH; Directorate of Information and Publicity (DIP); Integrated Disease Surveillance Programme(IDSP); Municipal Corporation of Delhi(MCD); New Delhi Municipal Corporation(NDMC); State Disease Control Programmes (SDCP); Delhi State Medical, Nursing, Dental and Pharmacy Councils; Delhi Society for Promotion of Rational Use of Drugs (DSPRUD); Food and Agriculture Organization of the United Nations(FAO); Food Safety and Standards Authority of India (FSSAI); Hospital Infection Society of India(HISI); Indian Association of Medical Microbiologists(IAMM); NCDC; WHO. |

| | | | | |
|----------------------------------|---|--------------|--|---|
| State Action Plan Madhya Pradesh | State Action Plan for Containment of Antimicrobial Resistance (MP-SAPCAR) | 26 July 2019 | To take suitable actions to address antimicrobial resistance in the state by involving relevant stakeholders to develop the Action Plan for Containment of Antimicrobial Resistance, aligned with the National and Global Action Plans through Inter- sectoral collaboration and a One Health Approach | Department of Animal Husbandry (DAH); Farmer Welfare & Agriculture Development (FWAD); Fisheries, Health & Family Welfare, Labour, Medical Education, Public Work & Environment |
|----------------------------------|---|--------------|--|---|

(Govt. of NCT of Delhi, 2020; Madhya Pradesh State Action Plan for Containment of Antimicrobial Resistance (MP-SAPCAR) :: Ministry of Health and Family Welfare, n.d.; National & Pillars, n.d.; Theodoridis & Kraemer, n.d.)

3.2. Strategic Priority

Strategic Priority-1 and Strategic Priority-3 of three SAPs are more or less same with NAP-AMR. Even though strategic priorities-2 of all the state action plans are well aligned with NAP-INDIA. However, Delhi State Action Plan specifically more emphasis on laboratory strengthening to increase the surveillance system. In the fourth strategic priority of Delhi State Action Plan there is a special mention to restricted availability of superior antimicrobials. All national and state

action plans have financing in AMR activities, research, and innovations as their fifth strategic priority, but in Madhya Pradesh State Action Plan there is a special statement mention regarding governance mechanism. Strategic Priority-6 of the National Action Plan, India is working to improve its leadership in the fight against AMR through international partnerships, national collaborations, with national stakeholders, and state-level collaborations but Kerala's strategic priority focuses on cooperation between civil society organisations and the corporate sector.

Table 2: All the six strategic priorities of NAP-INDIA and 3 SAPs

| Strategic Priorities: | National Action Plan-India | State Action Plan-Kerala | State Action Plan-Delhi | State Action Plan-Madhyapradesh |
|-------------------------|--|--|---|--|
| Strategic Priorities: 1 | Improve awareness and understanding of AMR through effective communication, education and training | Improve awareness and understanding of AMR through effective communication, education and training | Improve awareness and understanding of AMR among all stakeholders through effective communication, education and training | Improve awareness and understanding of AMR through effective communication, education and training |
| Strategic Priorities:2 | Strengthen knowledge and evidence through surveillance | Strengthen knowledge and evidence for containment of AMR through surveillance | Strengthen knowledge and evidence through surveillance and laboratory Strengthening | Strengthen knowledge and evidence through surveillance |
| Strategic Priorities:3 | Reduce the incidence of infection through effective infection prevention and control | Reduce the incidence of infection through effective infection prevention and control | Reduce the incidence of infection through effective infection prevention and control | Reduce the incidence of infection through effective infection prevention and control |
| Strategic Priorities:4 | Optimize the use of antimicrobial agents in health, animals and food | Optimize the use of antimicrobial agents in health, animals and food | Optimize the use of antimicrobial agents in health, animals and food and regulated access to high-quality antimicrobials | Optimize the use of antimicrobial agents in health, animals and food |
| Strategic Priorities:5 | Promote investments for AMR activities, research and innovations | Promote research and innovations for AMR containment | Promote investments for AMR activities, research and innovations | Promote investments for AMR activities, research and innovations for AMR containment |
| Strategic Priorities:6 | Strengthen India's commitment and collaborations on AMR at international, national and sub-national levels | Partnership with private sector and civil society organizations for AMR containment | Strengthen Delhi's commitment and collaboration on AMR | Strengthen MPs commitment and collaborations on AMR |

(Govt. of NCT of Delhi, 2020; Madhya Pradesh State Action Plan for Containment of Antimicrobial Resistance (MP-SAPCAR):: Ministry of Health and Family Welfare, n.d; National & Pillars, n.d.; Theodoridis & Kraemer, n.d.)

3.3. Focus Areas under Strategic Priorities Heading

The state action plans (SAPs) showing substantial alignment with “India’s National Action Plan on Antimicrobial Resistance (NAP-AMR)” across various strategic priorities. Strategic Priorities-1 and 2 share common focus areas in all three state plans, echoing the national strategy. In Strategic Priority-4, there’s significant coherence among the plans, with some additional domain such as Madhya Pradesh’s focus on surveillance of antimicrobial use. Kerala and MP state plans place additional emphasis on optimizing antimicrobial usage in veterinary sectors. Furthermore, Kerala’s plan emphasizes the establishment of surveillance

systems across multiple sectors. Strategic Priority-5 aligns well across all plans, with Kerala particularly highlighting alternative research techniques. In comparison to strategy priority-6 of the NAP-AMR focuses on international role, sub-national role and national role, Kerala State Action Plan is having two focus area i.e. Public private partnership and state disease control programme, Delhi Action Plan focuses on strengthen state-level collaborations to contain AMR and Madhya Pradesh State Action Plan put emphasis on three focuses i.e. Governance mechanisms, state collaboration and Inter-sectoral mechanisms and private sector engagement.

Table 3: Different focus areas under each of the strategic priorities

| Strategic Priorities: | Focus Areas: | National Action Plan-India | State Action Plan-Kerala | State Action Plan-Delhi | State Action Plan-Madhya Pradesh |
|------------------------|--------------|--|--|--|--|
| Strategic Priorities:1 | Focus:1 | Communication, IEC resources | Communications and IEC | Increase AMR awareness and understanding | Information and communication |
| | Focus:2 | Education and training | Education and training | Education and training | Education and training |
| Strategic Priorities:2 | Focus:1 | Strengthen laboratories | Strengthen laboratories | Laboratory capacity | Laboratory |
| | Focus:2 | Surveillance of AMR -human, animal, environment | Surveillance of AMR – human, animal, environment | Surveillance of AMR | Surveillance |
| Strategic Priorities:3 | Focus:1 | IPC in healthcare | IPC in human health. | IPC in healthcare. | IPC in human health |
| | Focus:2 | IPC in animal health | Animal feed & foodstuff | IPC in animal health and food | IPC in animal sector/ farms, community and environment |
| | Focus:3 | IPC, hygiene, and sanitation in the community | Environment | IPC, hygiene, and sanitation in the community | NA |
| | Focus:4 | Reduce environmental spread of AMR | NA | NA | NA |
| Strategic Priorities:4 | Focus:1 | Access to high-quality antimicrobials is regulated | Regulations | Access to high-quality antimicrobials is regulated | Regulations |
| | Focus:2 | Antimicrobial usage is being monitored | Hospitals in addition healthcare institutions | Antimicrobial usage is being monitored | Hospitals |
| | Focus:3 | In terms of human health, antimicrobial stewardship is important | Veterinary also aquaculture | In terms of human health, antimicrobial stewardship is important | Animals as well as Food |
| | Focus:4 | Animal husbandry and food antimicrobial stewardship and policy | Surveillance of antimicrobial use | Animal husbandry and food antimicrobial stewardship and policy | NA |
| Strategic Priorities:5 | Focus:1 | Financing for AMR | Research on AMR | Financing for AMR | Research on AMR |
| | Focus:2 | Research and innovations | Innovation | Research and innovations | Innovation |

| | | | | | |
|------------------------|---------|--------------------|----------------------------------|--|---|
| Strategic Priorities:6 | Focus:1 | International role | Public private partnership | Strengthen state-level collaborations to contain AMR | Governance mechanisms |
| | Focus:2 | National role | State disease control programmes | NA | State collaborations |
| | Focus:3 | Sub-national role | NA | NA | Inter-sectoral mechanisms and private sector engagement |

(Govt. of NCT of Delhi, 2020; Madhya Pradesh State Action Plan for Containment of Antimicrobial Resistance (MP-SAPCAR) :: Ministry of Health and Family Welfare, n.d.; National & Pillars, n.d; Theodoridis & Kraemer, n.d)

3.4. Summary of the Objectives of Focus Areas under Strategic Priorities

3.4.1. Strategic priority-1

The objectives in both the state action plans (SAPs) and the “National Action Plan on AMR (NAP-AMR)” are similar. However, Kerala’s SAP introduces a mass sensitization initiative targeting schools and colleges, utilizing platforms like the “National Service Scheme” and “National Cadet Corps” for broader outreach.

3.4.2. Strategic priority-2

All the objectives under strategic priority-2 focuses on strengthening microbiology laboratory capacity and strengthening surveillance. All the objectives of three state action plans are well aligned with National Action Plan, India. However, MP SAP has mentioned the extra statement of conducting regular training and monitoring activities throughout Madhya Pradesh.

3.4.3. Strategic priority-3

All the objectives under the strategic priority-3 focuses on developing and establishing “IPC activities as well as IPC programmes in veterinary settings and animal husbandry”. All the objectives of AMR action plans are more or less similar. However, Madhya Pradesh SAPs has mentioned an extra statement regarding IPC practices in Environment. NAP India has mentioned one extra objective which explain about decrease the amount of pathogen and antibiotic residue-resistant genes that contaminate the environment. There is no statement regarding environmental contamination in any of the three SAPs.

3.4.4. Strategic priority-4

All the objectives under the strategic priority-4 focuses on assuring constant availability of superior antimicrobials, create a nationwide surveillance system for the use of antibiotics, fortify legal protections, enhance the qualifications of medical scholars, prescribers, and dispensers, and guarantee the proper use of antibiotics in animals.

Though all the objectives are almost similar few variations like Kerala SAP added an objective on stepwise introduction towards reducing OTC-Over the counter sale of drugs, MP SAP has added a statement regarding development of Antibiotic Stewardship Programme in healthcare. Also the objectives of Kerala SAPs and Madhya Pradesh SAPs focuses only on optimizing the use of “antimicrobials in veterinary and aquaculture”. Kerala is the only state to strategise one extra objective which focuses on “antimicrobial use at health facilities, manufacturer, distributor, seller, user and import level in humans, animals, agriculture and food sectors”.

3.4.5. Strategic priority-5

All the objectives under Strategic Priority-5 basically focuses on sustainable investments for AMR interventions, and research activities. However, Kerala SAPs specifically mentioned about study with a focus on zoonotic bacteria and also discussed other innovations, such as screening phytochemicals and herbal extracts, to counteract antimicrobial resistance.

3.4.6. Strategic priority-6

All the objectives under the strategic priority-6 focuses on strengthening India’s dedication to combating AMR through international, national, and state cooperation. However, Kerala State Action Plan focuses on public private partnership and state disease control programme, Delhi Action Plan focuses on strengthen state-level collaborations to contain AMR and Madhya pradesh state action plan focuses on governance mechanisms, state collaboration and Inter-sectoral mechanisms and private sector engagement.

3.5. Governance Mechanisms

AMR prevention efforts must be effectively coordinated across sectors, and this requires the use governing systems. In order to guarantee their ownership throughout the implementation phase, it is also crucial to involve major stakeholders in the creation of NAP-AMR. To take action, governing structures require political backing and power. They also have a higher chance of success when their purview is well-defined. Research has revealed that weak governance and transparency actually have a stronger correlation with antimicrobial resistance (AMR) for example irrational use of antibiotics. National action plans (NAPs) on antimicrobial resistance (AMR) are currently being implemented in many African countries, but it is doubtful if public access to information on their implementation, funding, and monitoring is available (Harant, 2022). In order to solve this issue, the Indian Ministry of Health and Family Welfare notified three governance mechanisms in September 2016 like “(Intersectoral Coordination Committee on AMR (ICC-AMR); Technical Advisory Group on AMR; Core Working Group on AMR). Two committees were notified by the Delhi Government (AMR Advisory Committee; AMR Technical Committee). Four committees were notified by the Madhya Pradesh Government (Advisory Committee; Technical Committee, Core AMR Team and state committee for Antimicrobial Stewardship (AMS)) and one committee was notified by the Kerala Government i.e. State AMR Committee.” (Govt. of NCT of Delhi, 2020; Madhya Pradesh State Action Plan for Containment of Antimicrobial Resistance (MPSAPCAR) :: Ministry of Health and Family Welfare, n.d.; Munkholm & Rubin, 2020a; Ranjalkar & Chandu, 2019).

3.6. Implementation Aspects

3.6.1. IEC Resources

In the context of State Action Plans (SAPs) and “India’s National Action Plan on Antimicrobial Resistance (NAP-AMR)”, there’s a strong focus on Information, Education, and Communication (IEC) strategies. These include various activities like knowledge, attitude, and practice studies targeting diverse stakeholders, implementation of communication campaigns spanning multiple sectors with a collaborative approach involving NGOs and private entities, and leveraging social and mass media for public awareness. The Kerala SAP emphasizes specific actions like promoting World Antibiotic Awareness Week in educational and healthcare settings, developing effective risk communication strategies in animal agriculture and food safety, and launching an online platform with a One Health approach. Meanwhile, the Delhi SAP concentrates on creating safe water and sanitation practices, educating veterinarians, farmers, and food producers about responsible antibiotic use, and ensuring

awareness among stakeholders, especially in fast-food establishments selling meat-based products.

3.6.2. Education and training

Madhya Pradesh’s State Action Plans (SAPs) focus on updating and creating educational content for professionals in various sectors like human and animal health, agriculture, food industry, and the environment. Some shared initiatives across all SAPs and India’s NAP-AMR involve conducting training programs—both online and offline—for healthcare providers and developing tools to enhance understanding of antibiotic resistance. In India’s NAP-AMR, there are two unique elements: conducting a Training Needs Analysis (TNA) across industries and establishing mechanisms for efficient exchange of information and data on antibiotic regimes between doctors and microbiologists. Kerala’s SAPs introduce an additional feature focusing on specialized training programs tailored for farmers, veterinarians (including students), and individuals in the fisheries sector.

3.6.3. Surveillance

According to international, national, and state action plans on AMR, surveillance is a strategic priority. Kerala and Madhya Pradesh State Action Plans (SAPs) prioritize environmental aspects, particularly terrestrial and aquatic environments. Kerala’s SAPs emphasize the implementation of automated systems for identifying and testing antimicrobial sensitivity, while Madhya Pradesh’s SAPs focus on enhancing national laboratories and state-level capabilities for robust surveillance of resistant organisms. Delhi’s SAPs stand out by emphasizing a dedicated budget expenditure for microbiology labs that covers infrastructure, consumables, automation, training, and human resources from several industries. Additionally, Madhya Pradesh’s SAPs aim to promote accreditation such as National Accreditation Board for Hospitals & Healthcare (NABH) and National Accreditation Board for Testing and Calibration Laboratories (NABL) among healthcare providers, specifically targeting microbiology labs in medical colleges and district hospitals for accreditation as a pilot initiative.

State AMR surveillance networks have been set up in Delhi, Kerala, and Maharashtra with help from WHO India and oversight of NCDC. In the year 2018, the Maharashtra Surveillance of Antimicrobial Resistance (MAHASAR) was established. The formalization of the Kerala Antimicrobial Resistance Surveillance Network (KARS-NET) took place in 2019. The Delhi Network for Surveillance of Antimicrobial Resistance (DeNSAR) was formalized in the year 2019 as the WHO-Indian Association of Medical Microbiologist (IAMM) Network for Surveillance of Antimicrobial Resistance in Delhi (WINSAR-D). Every site under these

three networks abides by National Antimicrobial Resistance Surveillance Network (NARS-NET) standard operating procedures, has both public and private microbiology laboratories, and uses WHONET for monthly data sharing. Three networks share data with NCDC, who submits it to WHO Global AMR Surveillance System (GLASS) together with data from NARS-NET, Antimicrobial Resistance Research & Surveillance Network (AMRSN) and Gonococcal Antimicrobial Surveillance Program (GASP) network in India.

3.6.4. IPC in human, animal and environmental health

The NAP-AMR India outlines points not covered in the three SAPs, including a nationwide infection prevention and control (IPC) strategy for various stakeholders and incorporating IPC in healthcare training. IPC policies like biosafety and cleanliness were discussed across all documents, except in Delhi's SAP, which emphasizes certifying antibiotic-free imported goods and ensuring milk products are free from residual antibiotics. Kerala's SAP stands out for its comprehensive biosecurity guidelines across multiple facilities, while Delhi focuses on using soap and water instead of disinfectants to reduce environmental impact. MP SAP uniquely addresses IPC for fruits and vegetables, advocating reduced antibiotic and pesticide usage in cultivation. All SAPs and NAP-AMR India briefly discussed regarding the environmental IPC. Developing biosecurity guidelines, siting suggestions, and waste management standard operating procedures (SOPs) for farms, feed manufacturers, slaughterhouses, food processing units, health and veterinary care facilities, sewage treatment plants, and fish, meat, and dairy processing units represents a few of the specialties of Kerala state action plans.

3.6.5. Optimising antimicrobial usage

All SAPs and NAP-AMR India recognize antimicrobial stewardship programs (ASPs) as essential to optimise the antimicrobial use. Kerala SAPs and NAP India uniquely cover ASPs in human, animal, and food sectors, while Madhya Pradesh and Delhi focus mainly on human and animal health. Rapid diagnostic techniques, a part of ASP efforts, are addressed primarily by NAP-AMR India. Discussions on medication restrictions, including legal measures and penalties, are widespread, but Kerala SAP introduces herbal remedies, animal vaccines, and probiotics as antibiotic alternatives. Enforcing laws against over-the-counter medication sales was broadly emphasized. Only NAP-AMR India references adopting Codex Alimentarius antimicrobial guidelines. Madhya Pradesh SAPs introduce the FDA's H1 medication app expansion for antibiotic

prescription tracking, a unique initiative not found in other documents.

3.6.6. Financing of AMR

The statement about AMR finance has only been mentioned by NAP-AMR India and Delhi SAPs. They emphasised a few crucial points, which are as follows: Assess the impact of AMR in India, including morbidity, death, and cost. Develop an operational strategy (including expenses) for implementing National action plans India and Delhi State action plans. Only the Delhi SAP has made an additional declaration about financing AMR, namely, the use of artificial intelligence to surveillance data monitoring in the fields of environment, food, agriculture, animal health, and human health.

3.6.7. Research and innovation

All of the AMR action plans highlighted encouraging research cooperation by developing a multi-stakeholder national research agenda across disciplines. Kerala SAPs has specifically focuses on few area for research and innovation these are: Herbal drug research and development, Promote research on biofilm inhibition, Probiotics of human origin are being developed in research and Encourage the development of fast bacterial diagnosis tests. Delhi SAP has also added some extra points these are: Identifying new antibacterial mechanisms, basic research on combination of antibacterial mechanisms, Social science and economic research on AMR. Artificial intelligence (AI)-based solutions for rapid antimicrobial susceptibility testing was mentioned only in Delhi SAPs.

3.6.8. Collaboration

No nation or state can battle AMR alone because of its numerous, interconnected causes. Every Indian state started exploring the possible public-private partnerships and the involvement of donors and development partners, in addition to the India NAP. Along with that all the three SAPs in India focuses on strengthening and streamlining intra-state collaboration and inter-departmental collaboration on AMR. However, State Action Plan of Madhya Pradesh focuses on governance mechanisms on AMR containment in the collaboration domain.

3.7. Monitoring and Evaluation

India's National Action Plan for Antimicrobial Resistance (NAP-AMR) meticulously outlines a monitoring and evaluation framework comprising elements like planning activities, indicators, data collection specifics, and targets.

It employs 10 indicators to track progress, including awareness levels, educational resources developed, and the integration of AMR into professional curricula. Similarly, Kerala's, Delhi's, and Madhya Pradesh's state action plans adopt a systematic approach to monitoring and evaluation, emphasizing five key components: priority indicators, inputs, processes, outputs, and outcomes. They utilize six critical indicators aligned with strategic priorities such as awareness, knowledge, infection prevention, antibiotic optimization, research, and collaboration. This structured framework ensures a comprehensive assessment of efforts, spanning from resource allocation to the broader impact on population-level outcomes across various sectors.

3.8. One-Health Approach

The "One Health approach" is an integrated strategy that aims to improve public health outcomes by fostering communication and collaboration across many sectors (Govt. of NCT of Delhi, 2020). The environment and the food chain are two ways that antibiotic resistance might proliferate. Consequently, the food, agricultural, and environmental sectors are essential sectors that play a pivotal role in reducing AMR infections. One health approach that combines measures from the human, animal, and environmental health sectors can stop the further development and spread of antimicrobial resistance (AMR) (Alas, 2021). One health strategy was used in both the Indian National Action Plan and the three State action plans on AMR that were available. In all state AMR committees, core working groups, technical advisory committees, and inter-sectoral coordination committees, representation from the human, animal, and environmental sectors has been guaranteed. Inter-ministerial coordination also emphasized to facilitate one health approach in combating AMR. Bridging the gap between One Health sciences and economic and social sciences is pivotal. Effective global strategies to counter AMR must not only embrace One Health principles but also consider economic evidence, social fairness, and equitable access to healthcare for both humans and animals (Robinson *et al.*, 2016).

4. Discussion

To combat AMR, all levels of government and society must work together aggressively and collaboratively. According to the World Health Organisation (WHO), antibiotic resistance is among the top ten worldwide public health concerns. Realizing the situations the World Health Assembly formulated Global Action Plan on antimicrobial resistance (GAP-AMR) in 2015, and urged member states to prepare their Action Plans to align with GAP-AMR(WHO

Evaluation Office, 2021) The report analyzes the second tripartite self-assessment survey, reflecting progress across various sectors in addressing antimicrobial resistance (AMR). Out of 194 WHO Member States, 154 responded, showing sustained progress since 2017 in developing national action plans for AMR. While 93 countries reported having a plan and 51 are in the developmental phase, additional countries have made progress, totaling to 100 countries with national plans (World Health Organisation, 2018). Following the GAP-AMR and NAP-AMR India implemented there are different series of actions and interventions undertaken since long in the states of India. These NAP-India facilitates towards implementing other SAPs. There are lots of similarities and few variations are present in all the SAPs. There are some area which focuses elaborately and few areas which have emphasized more (Ranjalkar & Chandu, 2019). This study mainly focuses on policy and governance aspects, implementation aspects, monitoring and evaluation aspects and one health approach aspects.

The establishment of governance mechanisms is pivotal for effective plan execution. The NAP-AMR sets forth clearly defined committees, but the state plans demonstrate a decentralized approach, each with its own designated committees catering to regional needs. The engagement of diverse stakeholders in Kerala's SAP-spanning various sectors underscores a more integrated and locally informed approach to governance, potentially enhancing ownership and effectiveness in implementation. In order to effectively address the worldwide problem of antimicrobial resistance, it is imperative to strike a balance between the benefits and drawbacks of binding and non-binding methods, while uniting around common ideals. The Global Action Plan conceptualized by the World Health Organization (WHO) and similar action plans by the Food and Agricultural Organization (FAO) and the World Organization for Animal Health (OIE), identify five areas of essential global collective action to address AMR:

- Effective antimicrobial surveillance;
- Better infection prevention and control (IPC) measures;
- Global awareness campaigns;
- Promoting responsible use through stewardship;
- Innovation for successful containment of AMR emergence and spread, including through development of novel antimicrobial drugs.

Thus, we address the question: Which global governance modalities and mechanisms are most likely to produce an effective AMR response (Ruckert *et al.*, 2020). G7 nations have made substantial strides in combatting antimicrobial resistance (AMR) by developing comprehensive policies focusing on rationalizing antimicrobial use, curbing transmission, and fostering new antimicrobial

development. These policies emphasize a “One Health approach, integrating actions across human, animal, and environmental domains”. To address AMR in humans, interventions targeting reduced antimicrobial consumption include stewardship programs, awareness campaigns, and innovative pricing strategies like delayed prescriptions (OECD, 2009). The alignment of national AMR policies can be enhanced through global governance initiatives that emphasize tailored responsibilities, potentially including legally binding commitments (Munkholm & Rubin, 2020b). AMR has gained substantial traction on the global political stage, shifting from a technical issue to a political priority. The 2016 UN General Assembly declaration propelled AMR into international focus, securing attention, funding, and leadership commitment (Gul *et al.*, 2023) while overshadowed by COVID-19, political awareness of AMR persists. The AMR community comprises diverse sectors committed to addressing the issue across human health, animals, agriculture, and the environment (Wellcome Trust, 2020).

It should be mandatory to conduct antimicrobial monitoring in order to continuously monitor the prevalence of microorganisms resistant to drugs and the consequences for future empirical administration (Saleem *et al.*, 2023) From this study it has been identified that all the strategic statements in three SAPs are more or less aligned with NAPs India, but in Delhi State Action Plan specifically more emphasis on laboratory strengthening to increase the surveillance system. The fourth strategic priority of all the AMR action plans focuses more on optimizing the use of antimicrobial agents in health, animals, agriculture and food but in Delhi State Action Plan there is a special mention to regulated access to higher standards of antimicrobials. The fifth strategic priority of all the national and state action plans primarily focuses on promoting monetary resource allocation for AMR activities, research and innovations. Strategic Priority-6 of the National Action Plan, India is attempting to strengthen its position as a leader in the battle against AMR by collaborating nationally and internationally, but Kerala prioritises collaboration with the private industry and civil society organizations. According to Australia's First National Antimicrobial Resistance policy 2015-2019 report, the policy encourages a One Health approach with seven shared goals across the fields of agriculture, food, and human and animal health: 1. Educate people about antimicrobial resistance 2. Put antimicrobial stewardship into practice 3. Create an integrated national surveillance system 4. Enhance methods for infection prevention and control 5. Create a national research agenda for AMR 6. Strengthen global alliances 7. Put in place explicit governance frameworks (Department of Health Department of Agriculture and Water Resources, 2017).

Antimicrobial resistance (AMR) monitoring has to take a One Health (OH) approach, as is now widely recognised, in order to effectively address the serious dangers that this global public health issue poses to people, animals, and the environment (Aenishaenslin *et al.*, 2021). All the focus areas of state action plans are well aligned with National Action Plan of India however, NAP-AMR has mentioned regarding “Reduce the environmental spread of AMR” in a separate focus area. All the AMR action plans focuses on regulated access of high quality Antimicrobials in human, animal, food and agriculture sector but in Madhya Pradesh State Action Plan along with regulations access there is a special mention of surveillance of antimicrobial use. Delhi State Action Plan focuses more on improving appropriate antimicrobial use in healthcare institutions, whereas Kerala SAP and Madhya Pradesh SAPs focuses on optimizing antimicrobial usage in veterinary and aquaculture. NAP-AMR India, Delhi SAP, and Madhya Pradesh SAPs focus on Financing AMR on research-related activities but Kerala SAPs only focuses on research-related activities on AMR. Kerala State Action Plan focuses on alternative AMR research techniques such as phytochemical/herbal extract screening and herbal medicine research and development. To guarantee action against AMR is taken locally, NAP-AMR India concentrates on three areas: state-level partnerships, national collaborations, and international collaborations (Babu Rajendran *et al.*, 2023). All the AMR action plans of states focus on strengthening national collaborations to tackle AMR with disease control programs according to their own national and state-level priority. Madhya Pradesh state action plans focus on strengthening inter-sectoral mechanisms and private sector engagement for AMR containment but there is no statement mentioning inter-sectoral mechanisms in Kerala SAPs and Delhi SAPs. Only Kerala SAPs and NAP India examined ASP in the human, animal, and food sectors, whereas Madhya Pradesh SAPs and Delhi SAPs only considered human and animal health. Kerala SAP has placed a greater emphasis on a one health strategy. The One Health concept is an effective solution to address complex, cross-cutting challenges like AMR (Velazquez-Meza *et al.*, 2022). However, there are several obstacles to implementing One Health methods. Evidence demonstrates that cooperation and fostering equal participation across domains are hindered by conflicts of interest among many contributors, coordination, and insufficient M&E (Aenishaenslin *et al.*, 2021). To build and implement these strategies in a more effective and innovative manner, it is necessary to grasp the complexity of One Health projects (Robinson *et al.*, 2016).

One of the review article written by Willemsen *et al* highlights crucial gaps and challenges in developing “National Action Plans (NAPs) to combat antimicrobial resistance (AMR)”. These designs are noticeably devoid of

environmental factors, which makes a holistic One Health approach difficult to implement. Effective collaboration requires the participation of stakeholders from the human health, animal health, and agricultural sectors; yet, several nations struggle with capacity difficulties due to a lack of requisite knowledge in particular areas. The structure and content of NAPs vary significantly among countries, with some providing comprehensive SWOT analyses that offer insights into their capabilities, while others offer more generalized information, making interpretation and assistance difficult (Charani *et al.*, 2023). Policies restricting antimicrobial use in livestock vary based on a country's reliance on these animals for income and food security. For instance, countries like Singapore and Sweden, with higher food security, can afford stricter regulations compared to countries heavily reliant on livestock (Chua *et al.*, 2023). Developing NAPs also needs to be considered on the impact of restricting antimicrobial use and providing alternative, supportive options like improving access to affordable veterinary care. Also, low and middle-income countries face challenges in establishing surveillance for AMR due to availability of limited infrastructure and qualified resources, especially in animal health and agriculture sectors. Strengthening surveillance systems globally is crucial to gain a comprehensive understanding of AMR from a One Health perspective (Willemsen *et al.*, 2022).

One another article report analyzes antibiotic consumption in 76 countries over 16 years, revealing a troubling trend: “low and middle-income countries (LMICs)” are catching up to, and in some cases surpassing, the antibiotic usage rates typically seen in high-income nations. However, disparities persist in drug access, with many LMICs facing high infectious disease-related mortality rates despite lower antibiotic consumption. The report emphasizes the necessity of global surveillance to monitor antibiotic use and advocates for policies to curtail consumption and combat resistance while maintaining access to these vital medications (Klein *et al.*, 2018). Apart from all this implementation aspects one of the major contributing factor for combating AMR is research related activities. All the SAPs and NAP-India has mentioned regarding various operational research related activities. All the documents mainly focuses on to maximize the usage of antimicrobials to improve infection prevention and control in the health of humans and animals, as well as to specify the goals of scientific and applied research. However, Kerala SAP has indicated a specific topic of study, namely, research focused on zoonotic bacteria and screening of phytochemicals/herbal extracts.

“India's National Action Plan for AMR” meticulously outlines a comprehensive monitoring and evaluation framework encompassing various elements such as planning, indicators, types, and purposes. Ten indicators are utilized,

including aspects like awareness levels, resource development, and institutional terms of reference approvals. In contrast, State Action Plans in Kerala, Delhi, and Madhya Pradesh adopt a systemic approach, employing five components for monitoring and assessment: priority indicators, inputs, processes, outputs, and outcomes. The establishment of multisectoral groups for coordination has improved, but challenges persist, with 15% still lacking any coordination mechanism. While progress in the human sector is notable, there's a pressing need for action and resource prioritization in the animal and food sectors. Data gaps in environmental and plant sectors pose emerging concerns, impacting policy efforts to combat AMR. Monitoring and surveillance systems across human and non-human sectors need improvement to inform effective interventions and policies against AMR (World Health Organisation, 2018).

By the year 2022, only three Indian states (Kerala, Madhya Pradesh and Delhi) have successfully launched their state action plans on AMR following the launch of National Action Plan of India on AMR in the year 2017. Few other states are in the process of developing their state specific AMR action plans. The existing state action plans will certainly be useful for the other states while developing their AMR action plans, priority setting, identification of focus areas, activity planning, implementation planning, formulating antimicrobial policy and research etc. According to my knowledge, probably this is one of the first studies documenting the similarities and variations among NAP-AMR India and SAPs focussing on four aspects of the plans: policy and governance, implementation, monitoring and evaluation and one health approach for better understanding. Since apart from NAP-AMR, only three state action plans were available in the public domains, all my analysis and reporting is based on only these action plans. The findings of the present study may be useful as a reference literature for the various stakeholders while developing the AMR action plans at state level.

5. Conclusion

So far only three Indian states have launched their state action plans on AMR following the launch of National Action Plan of India on AMR in the year 2017. The findings of this study may be useful for the experts while developing the state level action plans on AMR, formulating antimicrobial policy and research etc. The Indian National Action plans for AMR integrates all of the GAP main goals and commits to implement the “One Health Approach” to solve important legal and regulatory limitations on the use of antibiotics (Haseeb *et al.*, 2023; Yadav *et al.*, 2023). In India, antibiotic resistance has not been given enough attention. Recent policy changes, however, demonstrate a

rising political commitment at the highest levels to vigorous action against AMR, as well as support for stewardship to contain resistance and nationwide surveillance (Kakkar, 2014). The comparative review of all the published NAPs and all SAPs in various aspects, it has been concluded that a few specific areas, such as law and regulations authority, administered mechanism, funding and resource allocation, international collaboration, IPC on human and animal health, and environmental sector integration, need to be strengthened, evaluated, monitored and documented in contentment of AMR. The most important elements that are essential for the success of implementing policies in “low and middle-income countries (LMIC)” have not received enough attention, including the ability to enforce policies, opposition from powerful stakeholders, and financial interests (Durrance-bagale *et al.*, 2020). The improvement of these areas, as well as the adoption of best practises, may facilitate to make new policy creation which can smoothen the implementation process at various level. Healthcare professionals (HCPs) contribution in addressing antibiotic resistance plays a vital role. In order to to achieve this, focus must be on several key actions like: reducing inappropriate antibiotic prescription and distribution, reducing the sell of antibiotics at the over the counter (OTC) drugs without prescriptions, capacity building on AMR, monitoring the current usage and resistance patterns, and initiating antimicrobial stewardship (ASP) initiatives (Alam *et al.*, 2023; Karimi *et al.*, 2023; Lagarde & Blaauw, 2023). Along with three states that have already implemented the AMR Action Plan, India should urge other states to implement State Action Plan with newer initiatives that are appropriate to track and regulate the use of antibiotics, adhere to national action plan, and also focus on community and hospital-based research on public health aspects of AMR are all critically needed (Ahmed *et al.*, 2019; Gelband & Delahoy, 2014; Sahni *et al.*, 2020); (Ruckert *et al.*, 2020).

6. Competing Interests

The authors declares that there is no conflict of interest

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