Engaging multi-sectoral collaboration to combat schistosomiasis in Napu highlands, Poso District, Central Sulawesi

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Abstract. Background. In Indonesia, schistosomiasis is endemic in Napu and Bada Highlands in Poso District and Lindu Highland in Sigi District, Central Sulawesi. Schistosomiasis in Indonesia is caused by blood fluke (trematode worm) Schistosoma japonicum with Oncomelania hupensis lindoensis snail as an intermediate host. The presence of Oncomelania hupensis lindoensis is an indicator of an area to be called a focus area for Schistosoma japonicum. Integrated control of schistosomiasis is vital in schistosomiasis control. However, lack of coordination and collaboration between multiple sectors has occurred many times. The objective of this study was to identify the role of multi-sectoral in schistosomiasis control. The identification process was needed to engage multisectoral in schistosomiasis control program. Methods. A comprehensive snail survey was conducted in Napu, Lindu and Bada Highland in 2017 which found 242 O.h. lindoensis foci area in 21 villages where 208 snail foci located in 14 villages in Napu highland. This research was part of 2017 study of ‘Mapping of Oncomelania hupensis lindoensis snail’, the intermediate host of schistosomiasis in the endemic area in Indonesia. After the mapping was carried out, an action plan to control schistosomiasis was designed by invited related sectors from the province and Poso district to develop the action plan together. Results. In order to eliminate schistosomiasis, several sectors both from province and Poso district were committed to engaging in schistosomiasis control. Those sectors were Agency for Regional Development, Agriculture Office, Maritime and Fisheries Office, Plantation and Livestock Office, Public Works Office, Environmental Office, Health Service and Lore Lindu National Park Agency. To eliminate schistosomiasis, integrated control of schistosomiasis has played a significant role. The responsibility and task of each sector involved were made clear according to each sector duty and function with the goal of the elimination of schistosomiasis by 2020.

1. Introduction
In Indonesia, schistosomiasis is endemic in Napu and Bada highlands in Poso District and Lindu highland in Sigi District, Central Sulawesi. Blood fluke (trematode worm) Schistosoma japonicum causes schistosomiasis in Indonesia with Oncomelania hupensis lindoensis snail as an intermediate host. The presence of Oncomelania hupensis lindoensis is an indicator of an area to be called a focus area for Schistosoma japonicum. Other than human, S. japonicum can also infect mammals [1].

The schistosomiasis prevalence fluctuated for the past years in Napu highland. From 2011 to 2015, the reported prevalence of schistosomiasis in Napu highland was 0.31%, 1.43%, 2.25%, 0.8% and 1.9% respectively [2]. Schistosomiasis is not only prevalent in human but also in mammals which the
reservoir hosts of schistosomiasis. The prevalence of schistosomiasis in rodents was 18.2% in 2009. In 2015, the reported prevalence of schistosomiasis in rodent was 7.3% in Napu [2]. Moreover, the survey on mammals showed that the prevalence of 12.1% in dogs and 5% in buffaloes (3). The latest study on mammals in Lindu highland reported the prevalence of schistosomiasis in dogs to range from 8.3-20%, pigs 8.3-20%, cows 16.7-33.3% and buffaloes 36.4-47.5% [4].

Buffaloes, cows and dogs dung was found in O.h. lindoensis habitat, potentially contaminating O.h. lindoensis habitat with S. japonicum. It is suggesting this is an important transmission source [3]. The infection rate in snails was reported 4.8% in Napu [2]. A study in 2016 found the infection rate in snails ranged between 1.1-40% and about 50% of snail foci were positive [5]. A comprehensive snail survey conducted in Napu, Lindu and Bada highlands in 2017 found 242 foci area of O. hupensis lindoensis in 21 villages where 208 snail foci located in 14 villages in Napu highland and 18 snail foci in four villages in Bada highland [6]. The infection rate in snails in 2017 was found between the range of 0.4-21.4% in Napu highland [7].

The first schistosomiasis control program was first initiated in 1973 in Lindu which consisted of treatment with Niridazole, mollusciciding and agro-engineering. The control programs were able to reduce the prevalence of schistosomiasis in human from 75% to 25%. As the continuation of the initial program, the first phase of schistosomiasis control was done from 1982 to 1986, which based on disease control by diagnosis and treatment although the prevalence remained high. Community participation was also part of the control program through human stool examination and rat survey. From 1986 to 1990, during the second phase, community participation was a priority with both education and environment modification of snail habitats. Mass treatment strategy was switched to selective treatment. The health sector was the leading sector during the second phase. The prevalence of schistosomiasis decreased during this time. The third phase was started from 1991 to 1993 where a schistosomiasis working group was formed with representatives from district, province and central level. The Provincial Agency for Regional Development was the leading sector. However, the programs were not effective due to each sector had their interest and applied for the program separately. The fourth phase was between 1993 to 1998. Many sectors were interested in schistosomiasis control program. However, the activities were not well designed. From 1998 to 2004, during the fifth phase, Central Sulawesi Integrated Area Development and Conservation Project (CSIADCP) was started. CSIADCP activities included snail surveys, environmental modification, human stool survey and selected drug treatment. The prevalence of schistosomiasis in human was down to 0.52% when the project ended in 2004 [3, 8].

It was known that chemotherapy-based approach could reduce the schistosomiasis prevalence rapidly. However, the snail habitats, which foci area of S. Japonicum, would not change and could be a source of infection for many at-risk populations. Hence, a new approach in schistosomiasis control program aimed to reduce transmission on human, mammals, and snails needs to be developed [9-11].

Learning from more than 35 years of schistosomiasis control in Indonesia, a well-designed multi-sectoral control program with community participation is vital to eliminate schistosomiasis in Indonesia. The control program could be chemotherapy, snail control and environmental management, health education, water supply, sanitation or molluscicides. Each sector needs to recognize what they can do for schistosomiasis control program. Moreover, the activities between sector should not overlap. The schistosomiasis control program is not only focused on reducing prevalence in human but also decreasing prevalence in mammals and more importantly environmental modification to lessen the foci area [3, 12-16]. Integrated control of schistosomiasis is vital in schistosomiasis control. However, lack of coordination and collaboration between multiple sectors has occurred many times. Therefore, this study aimed to identify the role of multi-sectoral in schistosomiasis control program that inline with each sector respective responsibility. The identification is needed to engage multi-sectors to participate together in schistosomiasis control program and also to support each other activities in schistosomiasis control program.
2. Methods

This research was part of 2017 study of 'Mapping of Oncomelania hupensis lindoensis snail, the intermediate host of schistosomiasis in the endemic area in Indonesia’. Mapping of all snail habitats in Napu highland was done from February to March 2017. After the mapping was carried out, an action plan to control schistosomiasis was designed by invited related sectors from the province and Poso district to develop the action plan together. Coordination and advocacy were carried out throughout the year to develop the action plan, particularly for environmental management control program. The action plan was develop based on the result of the mapping of the snail habitats which provide information on the number, type and m2 of foci area. The multi sectors, including Agency for Regional Development, Agriculture Office, Maritime and Fisheries Office, Plantation and Livestock Service, Public Works Office, Environmental Office, Health Services and Lore Lindu National Park Agency, were all involved in developing the action plan. The action plan was developed to identify the right environmental management for each focus area and which sector responsible for the control program.

After the action plan was developed, a roadmap of schistosomiasis control was designed with the National Development Planning Agency, Ministry of Health, World Health Organization (WHO) and related sectors. The roadmap designed based on the action plan for schistosomiasis control program, particularly for environmental modification.

The ethical approval of this study was obtained from the Ethics Committee of the National Institute of Health Research and Development, Ministry of Health of Indonesia, No. LB.02.01/5.2/KE.012/2017.

3. Results

Mapping of the foci area in Napu highland was done in two years in 2016-2017. The mapping in 2017 found a total of 208 foci area in 14 villages while the previous mapping in 2016 found 35 foci area in different two villages. The action plan for environmental management for schistosomiasis control program was designed based on the mapping results (table 1).

Table 1. The action plan for environmental management by multi-sectoral in foci area for schistosomiasis control in Napu highland

| No. | Village | Total foci | Type of focus area | Area of snail habitats (m²) | Control activities | Sector responsible |
|-----|---------|------------|--------------------|-----------------------------|--------------------|--------------------|
| 1   | Wuasa   | 4          | Irrigation channel in cocoa plantation and paddy fields, abandon cornfield and paddy fields | 155,640           | Draining water bodies, chemical molluscicides, cleaning and improve irrigation channel (ex. lining channels with cement), continuously used of paddy fields, cleaning foci area, make new paddy fields and fish ponds | Agriculture office, public works office, maritime and fisheries office, health office and village administration |
| 2   | Banyusari | 1         | Irrigation channel in cocoa plantation | 291                    |                    |                    |
| 3   | Watumaeta | 19        | Irrigation channel in cocoa plantation | 113,832              |                    |                    |
| 4   | Alitupu | 23         | Irrigation channel in plantation area, swamp, canal in inhabitants area | 182,969              |                    |                    |
| 5   | Kaduwaa | 11         | Irrigation channel in plantation area, abandon land | 90,793               |                    |                    |
Several sectors are responsible for environmental management for the schistosomiasis control program, such as the Public Works Office, Agriculture Office, Health Office and Village Administration. One focus area can be treated with more than one activity. Draining, cleaning foci area and chemical insecticides are the responsibility of Public Works Office, Health Service Office and Village administration/community. Continuously used of paddy fields or making a new paddy fields/plantation in foci area are the responsibility of Agriculture Office and villagers. Agriculture office and Public Works office are working together in improving or making irrigation channel. Village administration can also participate in constructing or improving irrigation channel by using ‘village fund” which is granted by the central government to all villages in Indonesia each year. The fish ponds are the responsibility of the Maritime and Fisheries office which provide workshop, fish ponds fund and fish for the fisher community in village.

After the action plan, a roadmap of schistosomiasis control was designed with WHO, Ministry of Health and multi-sectors. The environmental management activities in the action plan were included in the roadmap with the addition of several activities from sectors which not responsible for environmental management (table 2)
Table 2. Multi-sectoral roles in schistosomiasis control based on Roadmap of schistosomiasis control 2018-2025

| Sectors                                                                 | Roles                                                                                                                                 |
|------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| 1. National Development Planning Agency                                | To plan national agenda and budgeting for schistosomiasis eradication.                                                                 |
| 2. Agency for Regional Development                                      | • Leading sector: to coordinate all sectors in province/district
|                                                                         | • To plan agenda and budget for schistosomiasis control                                                                                     |
| 3. Ministry of Home Affairs                                            | To make sure that the roadmap is integrated into regional planning and budgeting.                                                           |
| 4. Ministry of Village, Development of Disadvantaged Regions and Transmigration/Regional Office | • Responsible in the formulation of the policy of village fund for schistosomiasis control and its monitoring.                                    |
|                                                                        | • Community involvement in schistosomiasis control                                                                                                |
| 5. Ministry of Health/Regional Health Office                           | • Mass treatment for schistosomiasis in human                                                                                             |
|                                                                        | • Chemical molluscide                                                                                                                        |
|                                                                        | • Schistosomiasis surveillance in human and snails                                                                                           |
|                                                                        | • Research on schistosomiasis                                                                                                                |
| 6. Ministry of Public Works/Regional Public Works Office               | • Primer irrigation rehabilitation                                                                                                           |
|                                                                        | • Water supply in the community                                                                                                               |
|                                                                        | • Basic sanitation facilities                                                                                                                 |
|                                                                        | • Land Revitalization                                                                                                                        |
| 7. Ministry of Agriculture/ Regional Agriculture Office                 | • Paddy fields intensification                                                                                                                |
|                                                                        | • Treatment for schistosomiasis on mammals                                                                                                   |
|                                                                        | Agroforestry intervention in the buffer area                                                                                                |
| 8. Ministry of Health/National Park of Lore Lindu                       | • Revitalization of community fish ponds                                                                                                    |
|                                                                        | • Make new fish ponds                                                                                                                        |
| 9. Ministry of Maritime and Fisheries/Regional Maritime and Fisheries Office |                                                                                                                                               |

Based on the action plan and roadmap, each related sector in Poso District has planned some activities for schistosomiasis control. However, due to the restriction in the budget, the control activities cannot be delivered in all foci area or village endemic to schistosomiasis in 2018. Other foci area and endemic villages will be addressed on the following year. The schistosomiasis control on each sector can be seen in table 3.
Table 3. Schistosomiasis control program for 2018 in Poso District

| Sector                              | Program                                                                 | Total village covered |
|-------------------------------------|-------------------------------------------------------------------------|-----------------------|
| Public Works Office                 | - Improving irrigation                                                 | 2                     |
|                                     | - Communal septic tank                                                 | 5                     |
|                                     | - Community water supply                                                | 2                     |
|                                     | - Water catchment area                                                 | 2                     |
|                                     | - Rehabilitation                                                       | 5                     |
| Health Office                       | - Laboratorium rehabilitation                                           | -                     |
|                                     | - Chemical insecticides                                                | 23                    |
|                                     | - Selective treatment in human                                          | 23                    |
|                                     | - Mass treatment in human                                               | 23                    |
|                                     | - Stool survey in human                                                 | 23                    |
|                                     | - Snail and rodent survey                                               | 23                    |
|                                     | - Health promotion in schools                                           | 23                    |
|                                     | - Workshop for health workers and cadres                                | 23                    |
|                                     | - Community involvement in cleaning foci area                           | 2 sub-district         |
| Agriculture Office                  | - Building trench dams                                                 | 4                     |
|                                     | - Building animal health post                                           | 1                     |
|                                     | - Surveillance of schistosomiasis in mammals                            | 23                    |
| Development of Disadvantaged Regions and Transmigration Office | Community empowerment                                              | 23                    |
| Maritime and Fisheries Office       | - Fish for community                                                   | 2                     |
|                                     | - Workshop                                                             | 2                     |
| Environment Office                  | Monitoring water quality                                               | 23                    |
| Education Office                    | Curriculum of schistosomiasian                                          | -                     |
| Agency for Regional Development     | Coordination meeting                                                   | -                     |

4. Discussion
For many years the schistosomiasis control in Indonesia has not conducted comprehensively. Too many positive snail foci are found that increase the risk for transmission. However, these foci areas have not received adequate treatment. Mammals still a source of infection of schistosomiasis and limited work has been done to reduce infection in mammals. Health office had been the leading sector of the schistosomiasis control program for many years despite the most effective way to stop the transmission of schistosomiasis was through environmental management which can only be done by other sectors.

China had revised the schistosomiasis control program and adopted the integrated control measurement aiming to reduce the transmission of schistosomiasis from human and cattle to snail since the beginning of the 21st century. The interventions taken include agricultural mechanization, water supply, sanitation and lavatories, molluscicides, chemotherapy, and health education. Chemotherapy is not only for human but also for cattle. Health education is targeting all residents and aiming at modifying the community behavior. Media such as cartoons, videotape, and comic-style booklets were used to disseminate knowledge about risks, symptoms, and prevention of
schistosomiasis. The integrated control strategy has shown positive achievements in China after several years. Some provinces have reached the level of infection control, and some have achieved the goal of transmission control. China has shown that these interventions have been made possible because of strong political, policy and financial support. [9, 17, 18]

Previously, the integrated schistosomiasis control program in Indonesia was lack of coordination and collaboration among multiple sectors. Having learned from China schistosomiasis control program, Indonesia has started the integrated control program by involving multi-sectoral to combat schistosomiasis. The integrated approach was started with the dissemination of mapping of foci area in 2016 and 2017. Several formal and informal coordination meeting with the multiple sectors were initiated to increase the awareness of schistosomiasis and the importance of the integrated control by multiple sectors to combat schistosomiasis.

The results of the mapping of the snail foci area including the latest condition of schistosomiasis prevalence in human, mammals, and snails were presented in front of all sectors. Together, they discussed and identified what control program suitable for each sector. This way, the lack of coordination between sectors can be overcome, and collaboration between sectors can be done. It prevents overlapping program between sectors. For example, the public works office and agriculture office can have coordination in improving irrigation channel. Every six months the leading sector will conduct a coordination meeting with all sectors to have the insight of the progress of the control program.

All sectors contribute to schistosomiasis control in Indonesia have already identified their roles for the next few years with Agency for Regional Development as the leading sector for the control program. The goal of elimination of schistosomiasis by 2020 and the eradication of schistosomiasis by 2025 is far from success. However, the willingmess of all sectors to fulfill their roles and awareness of the importance of coordination and collaboration on schistosomiasis elimination program give a hope that the transmission of schistosomiasis can be interrupted. Hence, the elimination of schistosomiasis is not out of reach.

5. Conclusion
Each sector involved in schistosomiasis control program in Poso District, Central Sulawesi has identified their roles in the integrated control program. The roles have described in the action plan and the roadmap of schistosomiasis control program. It is the beginning of the integrated and comprehensive schistosomiasis control program. In order to ensure the sustainability of the multi-sectoral collaboration program, it is important to make a policy for schistosomiasis control as one of the priority in each institution. Moreover, community participation in schistosomiasis control program needs to be enhanced by empowering people and the community to involve in reducing the foci area near their residence or paddy fieds and plantation area.

6. Abbreviations
CSIADCP: Central Sulawesi Integrated Area Development and Conservation Project
WHO: World Health Organization

7. Acknowledgment
We would like to express our gratitude to all researcher in National Institute of Health Research and Development Unit Donggala for all the field work and all multiple sectors involved in schistosomiasis control program.

8. Conflict of Interest
The authors have no competing interests.
9. Ethical Clearance
The ethical approval of this study was obtained from the Ethics Committee of the National Institute of Health Research and Development, Ministry of Health of Indonesia, No. LB.02.01/5.2/KE.012/2017.

10. Source of Funding
This study was supported by the National Institute of Health Research and Development Unit Donggala, Ministry of Health, Indonesia

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