 doi:10.20944/preprints201809.0034.v1

Outputs, Outcomes, and Behavioural Impacts of an Antibiotic-Related Educational Activity in Lao PDR

Marco J HAENSSGEN [a, b, c, d, i *]

Thipphaphone XAYAVONG [e, f, g]

Nutcha CHAROENBOON [d]

Penporn WARAPIKUPTANUN [d]

Yuzana KHINE ZAW [h]

[a.] Centre for Tropical Medicine and Global Health, Nuffield Department of Clinical Medicine, University of Oxford, Old Road Campus, Roosevelt Drive, Oxford OX3 7FZ, UK
[b.] CABDyN Complexity Centre, Saïd Business School, University of Oxford, Park End Street, Oxford OX1 1HP, Oxford, UK
[c.] Green Templeton College, 43 Woodstock Road, Oxford OX2 6HG, UK
[d.] Mahidol Oxford Tropical Medicine Research Unit, Faculty of Tropical Medicine, Mahidol University, 3/F, 60th Anniversary Chalermprakiat Building, 420/6 Rajvithi Road, Bangkok, Thailand
[e.] Department of Peace and Conflict Studies, University for Peace, Costa Rica
[f.] Department of Political Science, School of Social Science, Ateneo de Manila University, Manila, Philippines
[g.] Lao Oxford Mahosot Wellcome Trust Research Unit (LOMWRU), Mahidol Oxford Tropical Medicine Research Unit (MORU), Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand
[h.] Department of Global Health and Development, London School of Hygiene & Tropical Medicine, London, UK
[i.] email: marco.haenssgen@ndm.ox.ac.uk, phone: +66 (0) 951906543
[*.] Corresponding author

 doi:10.20944/preprints201809.0034.v1

Abstract

Education and awareness raising are the primary tools of global health policy to change public behaviour. Considering the limitations of awareness agenda and the lack of social research to inform alternative approaches, our objective was to generate new empirical evidence on the consequences of antibiotic-related awareness raising in a low-income country context. We implemented an educational activity in two Lao villages to share general antibiotic-related messages, but also to learn about people's conceptions and health behaviours. Two rounds of census survey data enabled us to assess the activity's outputs, its knowledge outcomes, and its immediate behavioural impacts in a difference-in-difference design. Our panel data covered 1,130 adults over two rounds, including 58 activity participants and 208 villagers exposed indirectly via conversations in the village. We found that activity-related communication circulated among more privileged groups, which limited its indirect effects. Among participants, the activity influenced the awareness and understanding of "drug resistance," while effects on attitudes were minor. Evidence on behavioural impacts was sparse and mixed, but the range of possible consequences included a disproportionate uptake of antibiotics from formal healthcare providers. Our study casts doubt on the continued dominance of awareness raising as a behavioural tool to address antibiotic resistance.

Keywords

Antimicrobial resistance; antibiotics; health behaviour; health education; survey; development studies; rural; LMICs; Lao PDR

 doi:10.20944/preprints201809.0034.v1

Main Text

1 Introduction

Antibiotic resistance (ABR) as a subset of antimicrobial resistance (AMR) has reached the highest policy levels. National and global policies have been developed to address a problem that is feared to become the leading cause of death globally by 2050 with a disproportionate impact on low- and middle-income countries [1,2]. The leading global policy document to address AMR is the *Global Action Plan on Antimicrobial Resistance* by the FAO/OIE/WHO Tripartite Collaboration on AMR,[1] the first objective of which is to "improve awareness and understanding of antimicrobial resistance through effective communication, education and training" [3] (p. 8). According to the latest monitoring report for the *Global Action Plan*, "125 countries have some awareness raising activities about the risks of AMR in human health" [4] (p. 12). However, the scale of the global education and awareness-raising agenda for the general public raises questions.

Firstly, global AMR policies are multi-faceted and cover several domains of antibiotic supply and demand, the latter of which pertains to the general public as well as other medical and agricultural users of antibiotics [2,3,5]. Despite the variety of strategies, few mechanisms apply to population behaviour, and awareness raising has acquired a questionable dominance therein. Contributions by economic institutions like the World Bank [1] and health systems researchers like Bloom, *et al.* [6] suggest for instance that antibiotic-related population behaviour partly reflects health system dysfunctions and inequity especially in low- and middle-income settings, in which case awareness raising may fail to achieve its objectives.

[1] FAO: Food and Agriculture Organization; OIE: World Organisation for Animal Health; WHO: World Health Organization.

 doi:10.20944/preprints201809.0034.v1

Secondly, awareness campaigns like other development interventions can have side-effects that undermine their original purpose. For example, Fynbo and Jensen [7] (p. 4) reported how the public framing of AMR entailed the stigmatisation of pig farmers in Denmark, to the extent that leaflets began advising that, "If you work on a pig farm, you should refrain from having sex with others or seeing anybody […]." Similarly, Davis, *et al.* [8] (p. 1163) suggested that the rhetoric of antimicrobial resistance may "spawn negative health impacts in a range of other conditions if people are taught to reduce help-seeking following initial symptoms." The broader literature on health communication problematises such potential of adverse and unforeseen consequences [9,10], thereby raising doubts about the centrality of awareness-raising in global antibiotic and antimicrobial resistance policies.

On the surface, global health policy and the public health literature continue to champion a "knowledge deficit" model and individual responsibility among the public in tackling antimicrobial resistance [11,12]. Beneath the surface, national action to address antibiotic resistance [13] and internal global health policy development processes have started considering interdisciplinary perspectives of human behaviour [14]. However, the tendency of public health evaluations of communication campaigns to focus on positive outcomes among intended audiences [10], and the continued underrepresentation of social science research—comprising only 0.6% of all AMR-related publications—are barriers to a more holistic and nuanced approach to human behaviour in antibiotic and antimicrobial resistance.[2]

[2] 345,410 AMR-related publications between 1890 and 2019. Medicine, biology, immunology, pharmacology, and related disciplines: 83.9%; other disciplines outside the social sciences: 14.7%; social sciences: 0.6%; unspecified "multidisciplinary" publications: 0.9%. Results as of 30 August 2018, based on *Scopus* database search query: TITLE-ABS-KEY("antibiotic resistance" OR "drug resistance" OR "antimicrobial resistance" OR "AMR") [15].

The objective of this study was therefore to generate empirical social science evidence on antibiotic-related awareness raising in a low-income country context. We conducted a two-directional educational activity in Salavan (southern Lao PDR) with the intention to learn about local conceptions and behaviours from the villagers and to share information about antibiotic use and drug resistance. Our study used detailed quantitative health behaviour data collected in two census surveys rounds in two villages. We analysed the activity's outputs, its knowledge outcomes, and its immediate behavioural impacts in a difference-in-difference design.

Although this work did not constitute a formal evaluation because the research team both developed and assessed the consequences of the educational activity [16], our study design enabled us to detect direct and indirect consequences of the activity—positive as well as negative. Our detailed quantitative health behaviour data from nearly 2,500 survey interviews permitted us to document the inequitable diffusion of new information, mild changes in villagers' awareness of drug resistance, weak links to antibiotic-related attitudes, and mixed but potentially detrimental impacts on antibiotic consumption. This study therefore contributes to the limited yet growing social understanding of the consequences and limitations of ABR interventions in low-income contexts.

2 Material and Methods

Our study was part of a research project to study rural medicine use in the context of marginalisation in Thailand (Chiang Rai) and Lao PDR (Salavan) [17].[3] In the present study, we assessed a half-day educational activity that interspersed two rounds of complete census surveys

[3] The research was reviewed and approved by the University of Oxford Tropical Research Ethics Committee (Ref. OxTREC 528-17), and it received local ethical approval in Thailand from the Mae Fah Luang University Research Ethics Committee on Human Research (Ref. REH 60099), and in Lao PDR from the National Ethics Committee for Health Research (Ref. NEHCR 074).

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in two peri-urban villages near a district capital city in Salavan, Lao PDR's poorest province (see Figure 1 for a map and timeline of research activities) [18]. The village location reflected an environment of higher affluence and smaller families compared to the provincial average (Table 1), but we nonetheless observed widespread hardship consistent with the low-income country setting of Lao PDR. The selection of the villages was aided by a local public health official who indicated interest in these village case studies for future education and communication activities.

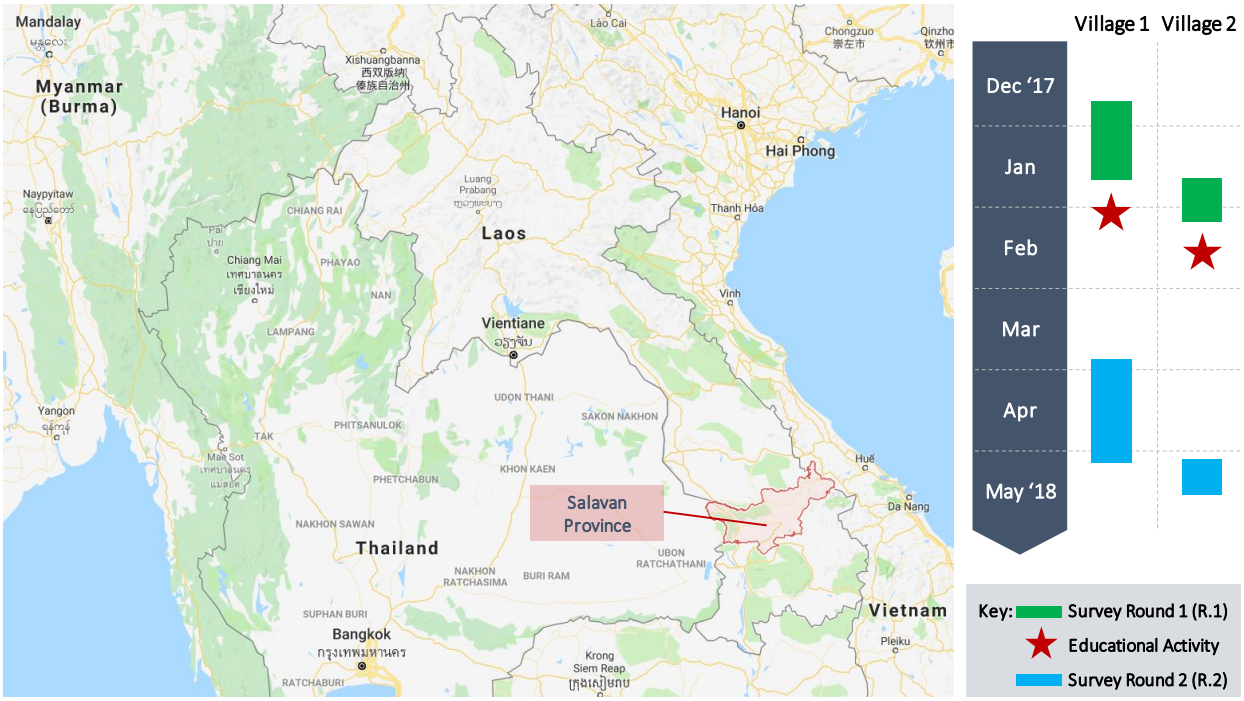

Figure 1. Site Map and Research Timeline in Lao PDR.

Source: Authors, adapted from Google Inc. [19].

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Table 1. Characteristics of Network Villages Compared to Provincial Average

	Village 1	Village 2	Salavan Average
Village Size	1,462	744	369[a]
Household Size	5.0	4.5	5.9
Female Population Share	48.8%	53.1%	50.1%
Dependency Ratio[c]	0.68	0.63	0.64[b]
Households Owning Mobile Phones	96.0%	89.9%	81.6%

Source: Primary survey data and Lao Statistics Bureau [20].
[a.] Village numbers based on data from National Geospatial-Intelligence Agency [21].
[b.] National average for rural areas.
[c.] Non-working-age population divided by working-age population (15-64 years).

We developed the educational activity following more than a year of qualitative research on antibiotic use and treatment-seeking behaviour in Thailand, Myanmar, and Lao PDR. Owing to the public engagement nature of the activity, the development studies background of our research, the caveats in the social sciences literature on health communication, and our own research of antibiotic use and treatment-seeking behaviour in rural Southeast Asia, we decided that the objective of the activities was not to *change* behaviour, nor to *convince* villagers that their current behaviour was wrong. The activity rather aimed at *sharing* information and ideas about antibiotics and drug resistance in line with messages from the World Health Organisation [e.g. 22], but it also aimed at the team *learning* from the participating villagers about their antibiotic-related behaviour and conceptions as well as how they received the messages from the activity. Nevertheless, our two-round data collection enabled a quasi-experimental design in which we could ascertain knowledge, attitude, and behaviour changes among people who participated in the activity (i.e. direct exposure), who talked about the activity (i.e. indirect exposure), and who were not involved in the activity in any way (i.e. non-exposure).

 doi:10.20944/preprints201809.0034.v1

The one-off activity in Salavan was designed to cover half a day of interactive sessions for 25 to 40 people.[4] We selected well-known individuals from the across each village, expecting that they would inform other villagers about the content of the activity (corresponding to approaches of targeting opinion leaders [24,25]).

The six sessions of the activity (presented in detail in Table 2) covered a mapping exercise to understand treatment choices in the village, a medicine matching game to learn about local conceptions and medicine uses, a resistance game to introduce the idea of evolving microbes, a role play to explain drug resistance in a social context, a healthy-wealthy game to reflect on treatment-seeking choices, and a final feedback and reflection session to understand how the participants received the messages from the activity. Specifically, the messages embedded in the activity were,

- "Always follow health workers' advice when using antibiotics,"
- "Never demand antibiotics if health workers say you don't need them,"
- "Only use antibiotics when prescribed by a certified health professional,"
- "Germs can become 'stronger' if treated inappropriately until the point that there is no medicine to treat them anymore," and
- "Drug resistance can spread."

[4] We developed the activity simultaneously for rural Thailand and rural Lao PDR as part of the larger project. Because of the cultural context and varying logistical constraints, the specific sessions in the two countries varied slightly [17,23]. For example, the Thai activity included traditional song and a poster-making exercise.

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Table 2. Elements of the Educational Activity.

Session & Duration	Description	Expected Outcomes	Main Message[a]	Direction of Communication
Ice breaking (15 mins)	Ice Breaking			
(1) Community Mapping (30 mins)	In groups, participants sketch a village map and mark down their own houses, important locations in the village, and draw lines to connect themselves with places as well as people they go to when sick.	Team learns about places, existing health networks, and health facilities within and nearby the village.		Participants ↓ Team
(2) Medicine Matching (30 mins)	Part I) Participants sort medicines into 2 groups: those that they know and do not know.	Team gains overview of medicines and their purposes from participants' perspective.		Participants ↓ Team
	Part II) Participants free-sort pictures of common medicines into their own categories.	Team understands participants' general conceptions around medicines and treatments.		Participants ↓ Team
	Part III) Participants sort medicines into two groups: over-the-counter medicines and prescription medicines.	Participants reflect on the ways to access medicines.	Only use antibiotics when prescribed by a certified health professional	Team ↓ Participants
(3) Resistance (30 mins)	Participants pass a germ around in a circle. When music stops, person with the germ answers a right-or-wrong question about taking medicines. If incorrect, she/he are out of the game, the germ evolves, and the game continues. The last remaining person wins a prize.	Participants become familiar with the idea of bacteria evolving and resisting medicines.	1) Germs can become "stronger" if treated inappropriately until the point that there is no medicine to treat them anymore 2) Drug resistance can spread	Team ↓ Participants
Break (15 mins)	Break			
(4) Roleplay (20 mins)	A short skit performed by team with a simple storyline around antibiotics and antibiotic resistance.	Participants gain a deeper understanding about drug resistance and their own part in the issue.	1) Always follow health workers' advice when using antibiotics 2) Never demand antibiotics if health workers say you don't need them 3) Drug resistance can spread	Team ↓ Participants
(5) Healthy-Wealthy Game (30 mins)	Participants simulate running a family business that produces goods and sells to the market. Each group (family) has different tools to make as much money as they can. Throughout the activity, family members will be diagnosed randomly with a disease, provided with different treatment scenarios, and the rest of the family will have to pay hospital fees to bring that sick member back.	Participants reflect on common illnesses and the various ways of treating them; team gains an understanding of health decisions in local context.	Only use antibiotics when prescribed by a certified health professional	Team ↓ ↑ Participants
(6) Feedback & Reflection (15 mins)	Hearing reflections of the activities and lessons learned from the participants.	Participants get the key messages from the activities and express them to the group.		Participants ↓ Participants/Team

[a] Messages based on World Health Organization recommendations, see e.g. WHO [22].

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We collected two rounds of complete census data from all adult villagers. Satellite images helped to enumerate 578 potentially residential buildings, which comprised 459 households [26]. We defined a household as a group of people sharing a kitchen, and its members as those who had lived in the village for the past six months. The ensuing sample comprised 2,480 interviews (1,264 in Round I and 1,216 in Round II), whereby we interviewed virtually every adult at least once and 89.4% of the Round-I respondents could be re-interviewed (only two households refused participation).[5] The description of the survey sample is presented in Table 3.

Our survey instrument was a 45-minute questionnaire on antibiotic-related attitudes and knowledge, treatment-seeking behaviour, and social networks alongside standard demographic indicators [17]. The questionnaire was administered face-to-face using tablet computers with the *SurveyCTO* software [27]. Among others, we elicited attitudes and knowledge of antibiotics that corresponded broadly to WHO messages [e.g. 22], asking four questions on whether respondents (a) would buy antibiotics over the counter, (b) would prefer antibiotics over alternatives, (c) would keep antibiotics for future use, and (d) considered that antibiotic resistance can spread. Considering the range of possible responses to these questions, we trained our survey teams to field-code the responses as "desirable" and "undesirable" from the point of view of the original WHO messages. (An assessment of behaviour as "undesirable" according to these criteria did not necessarily mean that people's behaviours were implausible, irrational, or otherwise inferior; it was merely intended to guide the analysis in light of the objectives of mainstream approaches to awareness raising.) We also collected detailed information on acute illnesses and accidents among the respondents and/or children under their supervision within the two months preceding the survey, and the healthcare

[5] Individuals who could only be interviewed once tended to migrate for labour, which is reflected in a larger share of male (54% vs. 46% in the panel) and younger respondents (33.9 years vs. 40.5 years) compared to the panel average.

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choices (healthcare providers, medicine) that the respondents made therein. We recorded 512 completed illness episodes in the first survey round, and 284 in the second.

Table 3. Sample Characteristics of Two Rounds of Census Survey in Two Lao Villages.

	Variable	Survey Round I					Survey Round II				
		Mean	Std. Dev.	Min	Max	*n*	Mean	Std. Dev.	Min	Max	*n*
Activity	% participated in educational activity: throughout	0.00	0.00	0	0	1264	0.05	0.21	0	1	1216
	% participated in educational activity: partly	0.00	0.00	0	0	1264	0.00	0.06	0	1	1216
	% heard about educational activity	0.00	0.00	0	0	1264	0.22	0.41	0	1	1216
Demographic attributes	Sex (% female)	0.55	0.50	0	1	1264	0.56	0.50	0	1	1216
	Age	39.91	17.14	18	100	1264	40.04	17.02	18	100	1216
	Completed years of formal education	6.28	4.59	0	21	1264	6.22	4.56	0	21	1216
	Wealth index (range: 0 to 1)[a,b]	0.49	0.13	0.11	0.78	454	0.50	0.13	0.11	0.78	446
	% speaking Lao	1.00	0.00	1	1	1264	1.00	0.00	1	1	1216
	Ethnic group: Lao Loum	0.97	0.18	0	1	1264	0.96	0.19	0	1	1216
	Ethnic group: Other	0.01	0.10	0	1	1264	0.01	0.10	0	1	1216
	Ethnic group: Don't know / prefer not to say	0.02	0.15	0	1	1264	0.03	0.16	0	1	1216
Antibiotic knowledge / attitudes	% have seen antibiotic capsules	0.97	0.18	0	1	1264	0.96	0.19	0	1	1216
	% have heard of drug resistance ("*due yah*")[c]	0.39	0.49	0	1	1264	0.63	0.48	0	1	1216
	% have heard of drug resistance ("*lueng yah*")[c]	0.79	0.40	0	1	1264	0.82	0.39	0	1	1216
	% buy antibiotics over the counter (attitude)	0.30	0.46	0	1	1264	0.27	0.44	0	1	1216
	% prefer antibiotics over alternatives (attitude)	0.29	0.45	0	1	1264	0.24	0.43	0	1	1216
	% do not keep antibiotics for future use (knowledge)	0.22	0.41	0	1	1264	0.27	0.44	0	1	1216
	% antibiotic resistance can spread (knowledge)	0.12	0.32	0	1	1264	0.02	0.15	0	1	1216
	No. of desirable knowledge/attitude answers (0-4)	0.93	0.93	0	4	1264	0.81	0.87	0	4	1216
Treatment-seeking behaviour[d,e]	% of illness episodes involving children	0.39	0.49	0	1	512	0.35	0.48	0	1	284
	Self-rated severity (1=mild, 2=medium, 3=severe)	1.79	0.70	1	3	512	1.88	0.67	1	3	284
	Average duration of illness episode (days)	7.29	9.25	1	130	512	7.36	14.42	1	219	284
	Average no. of medicines and treatments received[f]	2.74	1.71	0	13	512	2.46	1.39	0	8	284
	Average no. of antibiotics	0.50	0.70	0	4	512	0.42	0.59	0	3	284
	Average no. of antibiotics (incl. "uncertain" medicine)	1.31	1.45	0	10	512	1.15	1.25	0	6	284
	% public providers (health centres, hospitals)	0.27	0.44	0	1	512	0.27	0.44	0	1	284
	% private providers (clinics, hospitals, pharmacies)	0.53	0.50	0	1	512	0.59	0.49	0	1	284
	% informal providers (grocery stores, healers)	0.02	0.14	0	1	512	0.05	0.22	0	1	284
	% family and self-care	0.97	0.18	0	1	512	1.00	0.06	0	1	284
	% others	0.06	0.25	0	1	512	0.07	0.26	0	1	284

Source: Authors.

[a.] Average of 17 household assets and amenities on scale from 0 to 1.

[b.] Household level data.

[c.] The term "drug resistance" has two local expressions: "ດື້ຢາ" ("*due yah*") as the formal term and "ລື້ງຢາ" ("*lueng yah*") as a more colloquial expression.

[d.] Illness-level data.

[e.] Completed illnesses experienced by respondent or a child under their supervision.

[f.] "Number of courses" as in, "How many types of medicine did you receive during step x of your illness?"

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We analysed the quantitative survey data descriptively in a difference-in-difference approach, which enabled us to isolate general trends from changes associated with the educational activities. We considered the changes across survey rounds for three groups: people who participated in the educational activity (direct exposure), who talked about the activity (indirect exposure), and who neither talked about nor participated in the activity (unexposed). The analysis was guided by a simple evaluation framework that considered outputs, outcomes, and impacts of the activity as follows:[6]

- **Outputs** (individual level)
    - Direct and indirect exposure to the educational activity, including the themes related to the activity that were communicated between villagers.
    - Lessons and feedback from the educational activity.
- **Outcomes** (individual level)
    - People's awareness and understanding of drug resistance (using "ດື້ຢາ" or "*due yah*" as the formal term, and "ລື້ງຢາ" or "*lueng yah*" as a colloquial but also broader expression in the context of drug resistance).[7]
    - The "desirability" of people's antibiotic-related attitudes and knowledge (see Table 3 for associated indicators).
- **Impacts** (illness level)

[6] Note that, because the study team developed and assessed the activity, this did not constitute a formal evaluation. In addition, because we did not specify behaviour change targets, we were more interested in an exploratory analysis of the range of outcomes, be they positive or negative.

[7] While *lueng yah* did not exclusively refer to drug resistance, it had arisen consistently as a theme during the questionnaire testing phase and, as can be seen in Result Section 3.2, it was commonly mentioned as an explanation for the formal term *due yah*.

- Patterns of healthcare utilisation during acute illnesses, focusing especially on formal healthcare providers (public hospitals and primary care units, private clinics, hospitals, and pharmacies) and informal providers (e.g. traditional healers, grocery stores, retired doctors, itinerant medicine traders).
- Sources of antibiotics during acute illnesses, focusing on formal sources (as above) and informal sources (as above, plus antibiotics stored at home and provided by family and friends).

On the individual level, we used the matched panel data set based on the census data, which enabled like-for-like comparisons of the village before and after the activity, and which made inferential statistics obsolete and confidence intervals inapplicable.[8] Data on the illness level could not be matched accordingly, considering that only a subset of respondents would report an acute illness or accident, which were also not immediately comparable for the same individual across the two survey rounds. As a result, we treated the data on the illness level as repeated cross-sectional data.[9] The analysis was carried out using *Stata* 15 [28].

3 Results

3.1 Outputs

The educational activities took place in two comparatively large peri-urban villages located on main roads with easy access to urban and formal health facilities. Within the villages, a range of informal healthcare providers including traditional healers and grocery shops provided treatment

[8] In other words, our sample comprised the complete population of the two villages, while otherwise the data from two villages would be insufficient to make inferences for the Salavan population. Another part of the broader research project involved representative survey data collection to enable inferences for the provincial population.
[9] Multilevel models in future research will account for individual-level clustering of behaviour.

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and medicine alongside public and private primary healthcare providers (mapped in Figure 2; households indicated by circles, village infrastructure by triangles, and healthcare and medicine providers by diamonds with antibiotic sources having red borders).

The activity was attended by approximately 30 people per village and implemented in the presence of local officials (i.e. village head and public health officer). Most participants in both villages were highly engaged throughout the day, and the presence of village administration and medical officers throughout the entire activity did not appear to inhibit the participation of the villagers. They eased into discussing and exchanging ideas with their team mates especially during small group sessions, but they were more hesitant to share their discussion in the larger group. Nevertheless, by sharing their ideas, the study team learned that the participants were familiar with common medicines. In the “medicine matching” session, the villagers categorised antibiotics like capsules of penicillin or ampicillin commonly in a single group, whereas other medicines were grouped by mode of administration (eating, diluting in water, injection, etc.), their shape (tablets, liquids, etc.) and their functions (for coughing, headaches, etc.). Our final feedback and evaluation session revealed further that the respondents were able to identify the key messages that we intended to share. For example, one participant responded that she would tell her husband to stop buying and keeping antibiotics at home. However, the feedback involved only small sample of three to four participants per village. We therefore based the remaining analysis of the activity outcomes on our quantitative data.

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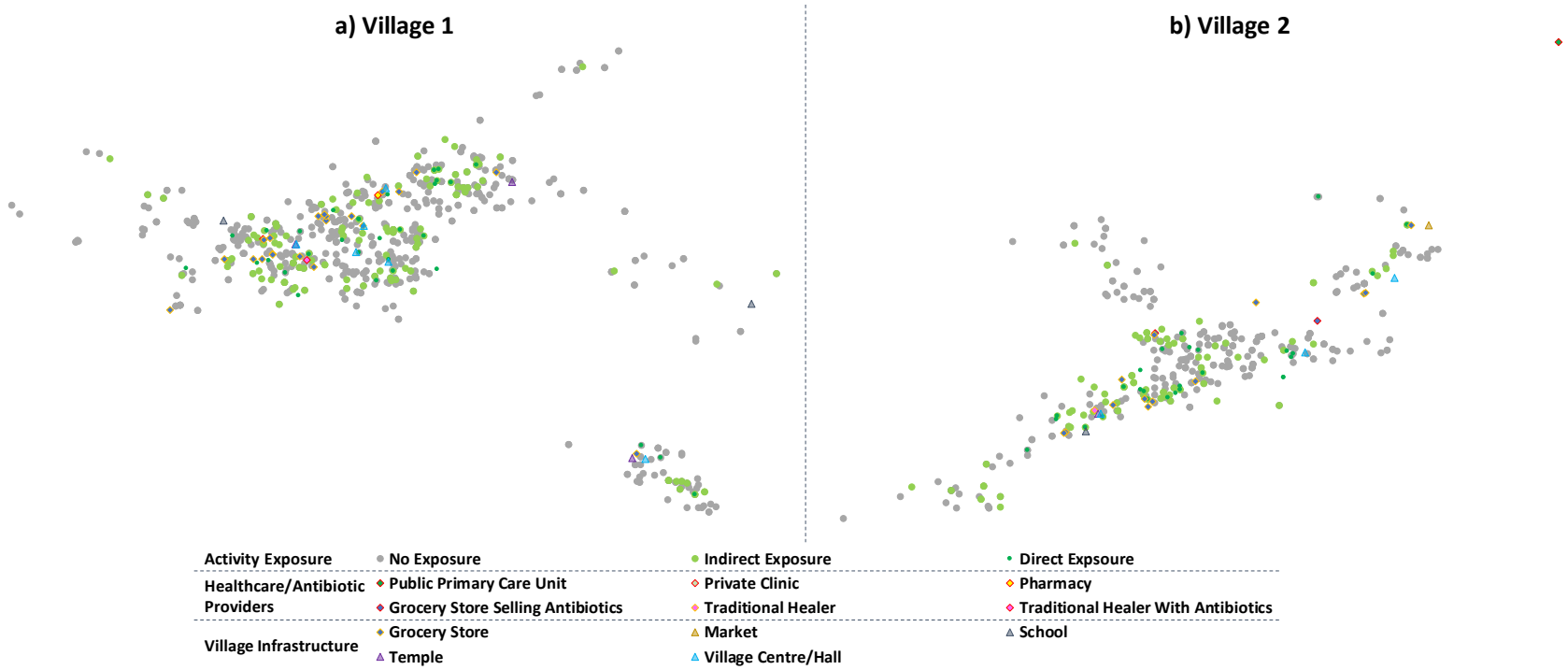

Figure 2. Map and Overview of Educational Activity Exposure in Case Study Villages.

Source: Authors.

Notes. "Endline" (R.2) data, matched panel data. n = 723 (Panel a), n = 407 (Panel b). Marker size adjusted to distinguish overlapping responses.

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The characteristics of the 58 participants are presented in Table 4, together with 208 respondents who talked about the activity in the village, and 864 villagers who had not been exposed directly or indirectly. The table indicates that the activity participants included a higher share of women and higher levels of education than the village average. People who talked about the activity also tended to be female and better educated, while the small fraction of non-Lao ethnic groups remained largely unexposed.

Table 4. Characteristics of Individuals by Activity Exposure.

Variable	Direct Exposure (i.e. participated in activity) (*n* = 58)	Indirect Exposure (i.e. talked about activity) (*n* = 208)	Unexposed (*n* = 864)
	Mean (Std. Dev)	Mean (Std. Dev)	Mean (Std. Dev)
Sex (% female)	0.71 (0.46)	0.63 (0.49)	0.54 (0.50)
Age	44.76 (11.36)	38.18 (14.91)	40.85 (17.75)
Education	7.10 (4.06)	8.18 (4.99)	5.67 (4.36)
Wealth index (range: 0 to 1)[a]	0.51 (0.12)	0.54 (0.11)	0.50 (0.12)
Ethnic group: Lao Loum	1.00 (0.00)	0.99 (0.12)	0.96 (0.20)
Ethnic group: Other	0.00 (0.00)	0.01 (0.10)	0.01 (0.11)
Ethnic group: Don't know / prefer not to say	0.00 (0.00)	0.00 (0.07)	0.03 (0.16)

Notes. "Endline" (R.2) data, using matched panel data. Mutually exclusive groups, i.e. the group "talked about activity" does not include participants (among whom 53 talked about the activity with other villagers).
[a.] Average of 17 household assets and amenities on scale from 0 to 1.

As the maps in Figure 2 above indicated, indirect exposure was widespread but less likely to permeate peripheral areas of the villages. In addition, indirect exposure encapsulated only a fraction of the themes of the educational activity, as Figure 3 demonstrates. More than 90% of the participants reported conversations with other villagers about the activity, 85% of whom recalled conversation themes that related directly to the activity content (e.g. "going to the doctor when sick"). Another common theme among 81% of the participants was the entertainment component of the activity. In contrast, among villagers who did not participate in the activity, conversation themes were almost exclusively limited to the activity in general (e.g. it being announced by the

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village head) and to its entertainment component. Only 17% of the 208 indirectly exposed villagers recalled a theme that related to the antibiotic content of the activity. The striking mismatch between sent and circulated themes suggested that indirect exposure to the activity content was limited despite the extensive conversations across the village. Because the villagers who recalled activity-related themes were on average slightly wealthier by 0.055 wealth index points (0.581 vs. 0.526) and had two more years of formal education (9.9 vs. 7.8 years), content-related indirect exposure also appeared to have been confined to socio-economically more privileged strata. In the next section, we examine the outcomes of the direct and indirect exposure on awareness and interpretations of "drug resistance" and on villagers' antibiotic-related attitudes and knowledge.

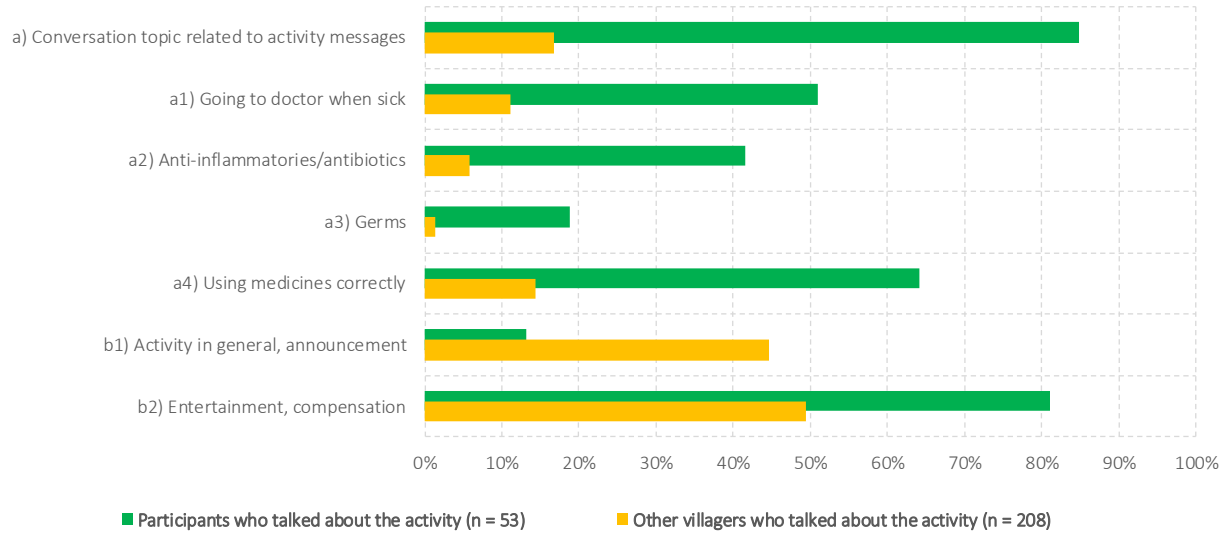

Figure 3. Differences in Communicated Activity Themes Across Participants and Non-Participants.

Notes. "Endline" (R.2) data, using matched panel data.

3.2 Outcomes

The outcomes of the activity were concentrated on knowledge and attitudes among people who were exposed directly. The recognition of the various terms for "drug resistance" is shown in

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Figure 4; Panel a presenting the technical but lesser-known term of "*due yah*," Panel b presenting the colloquial but broader translation "*lueng yah*" as "[e.g. the body getting] used to medicine." Against a generally increasing trend in the recognition of *due yah*—potentially an artefact of the survey asking the same question twice in three months—the recognition of the term increased disproportionately among the participants of the activity (Panel a, green line). The average recognition of the term rose from 28% to 91% among the participants, compared to 36% to 59% among the unexposed group. In contrast, the colloquial expression of *lueng yah* was already widely recognised prior to the educational activity, and direct and indirect exposure exhibited only a marginally higher rate of change in the first village compared to the unexposed group.

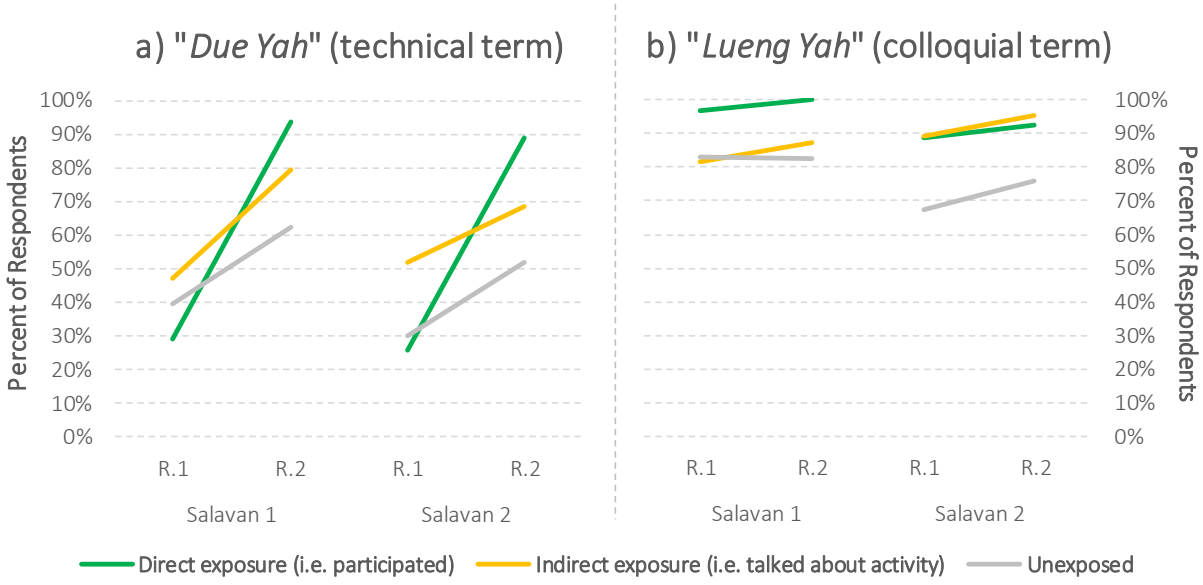

Figure 4. Changes in Villagers' Recognition of the Term "Drug Resistance" by Exposure to Educational Activity.

Notes. Pooled data set using matched panel data (n = 1,129).

Even in the absence of changing rates of recognition, the educational activity might have influenced people's interpretation of the term "drug resistance." Separated again by the notions of

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due yah and *lueng yah*, Figure 5 illustrates the changes in people's response to the question, "What do you think is 'drug resistance'" (see Appendix Table 1 for absolute levels). Panel a shows that the interpretation of *due yah* changed most among the participants of the activity, where a decreasing share of "don't know" responses was replaced with broad and antibiotic-independent interpretations of "*due yah* means *lueng yah*," "medicines [in general] do not work anymore," and "taking medicines in the wrong way." The activity participants also exhibited fewer interpretations that conflict with the biomedical concept of drug resistance, like "patients being stubborn," "being addicted to medicine," or "medicines having side-effects."[10] However, the fraction of interpretations relating directly to antibiotics and germs only increased marginally from 1.7% to 3.5% among the participants, and it decreased among indirectly exposed villagers at a higher than the unexposed group (from 5.3% to 1.0% vs. from 3.7% to 2.4%). Aside from an increase in the interpretation "*due yah* means *lueng yah*," the indirectly exposed group also exhibited small changes in the themes "stubborn patients" (–6.3%) and "medicine side-effects" (+2.9%).

Panel b in Figure 5 indicates that changes in the interpretation of *lueng yah* were less pronounced among all groups. Compared to the trend among unexposed villagers, activity participants nevertheless declared more interpretations relating to antibiotics and drug-resistant germs, and fewer interpretations relating to "drug resistance" as medicine addiction. Among the indirectly exposed group, we also observed a shift away from antibiotic-specific towards more general interpretations of medicine becoming less effectual (typically involving notions that the body develops a "tolerance" against medicine in line with the broader meaning of *lueng yah*).

[10] Side-effects refer here not to drug resistance but to medicine-related complications like dizziness, nausea, rashes, or allergic reactions.

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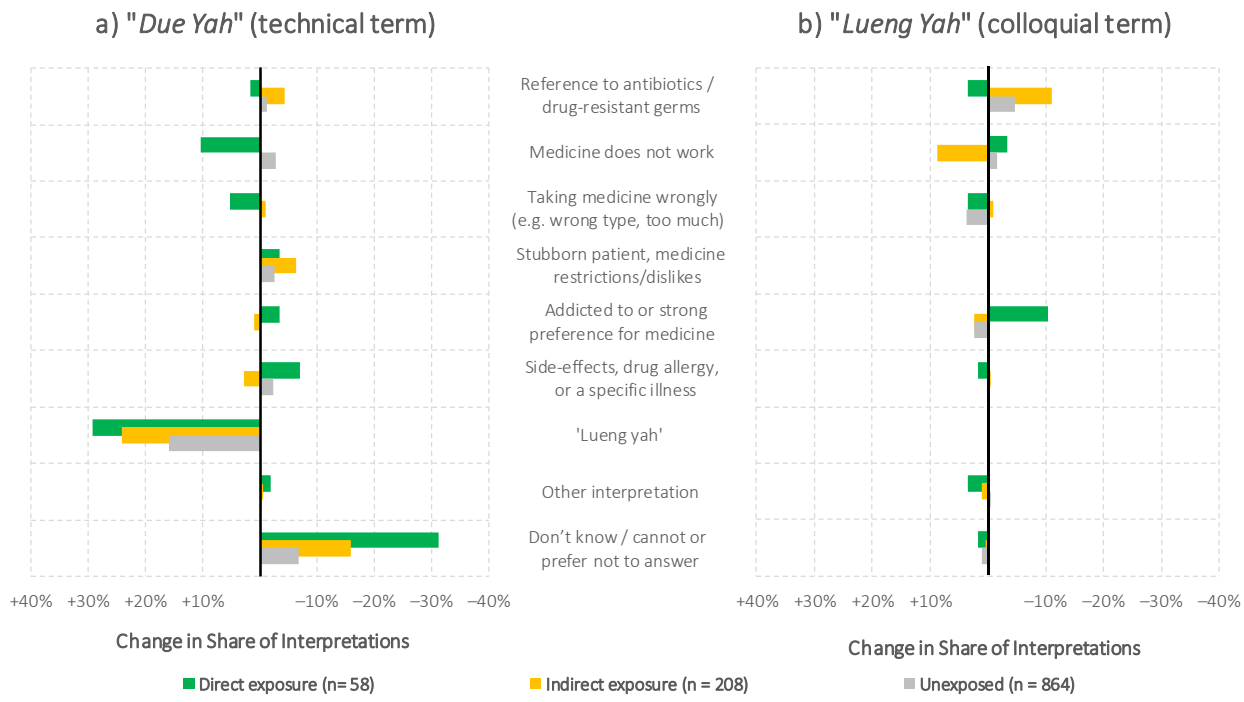

Figure 5. Changes in Interpretations of "Drug Resistance" Across Survey Rounds.

Notes. Absolute changes reported. Pooled data set using matched panel data (n = 1,129). Single response per panel.

Despite the association between the activity and villagers' recognition and interpretation of "drug resistance," the changes in the biomedical "desirability" of people's antibiotic-related knowledge and attitudes varied only to a small extent across the study groups. As shown in Figure 6 and in more detail in Appendix Table 2, direct exposure yielded a slightly stronger increase in our assessment of "desirability," whereas indirect exposure was not associated with an increase beyond the general trend. Broken down by its four component questions (Appendix Table 2), the sources of the increase among the directly exposed group were the attitude to not buy antibiotics over the counter (from 43.8% to 55.2%; disproportionately large increase compared to other groups) and the knowledge to not keep antibiotics at home for future use (from 27.6% to 32.8%; increase higher than unexposed group but short of the larger increase in indirectly exposed group). Curiously, responses the question "Can your *due yah* spread to other people?" became noticeably less

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"desirable" over time among the groups with indirect and without exposure to the activity. Overall, the outcomes on attitudes are inconclusive despite the mild relative increase in our measure of "desirability" among the activity participants in Village 2.

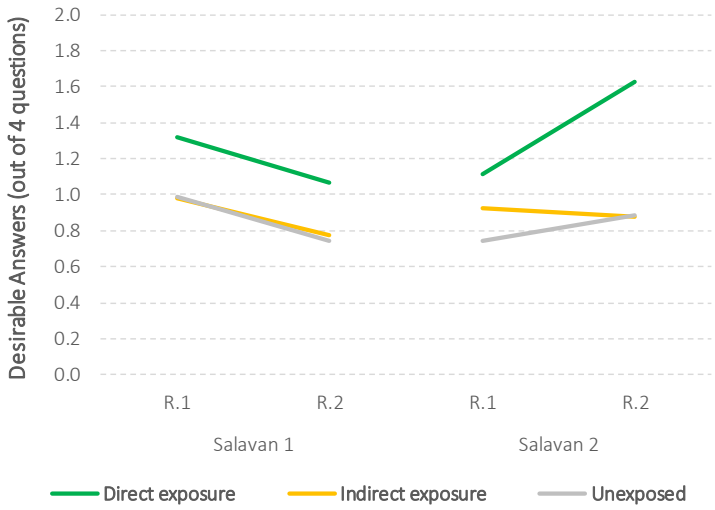

Figure 6. Changes in Antibiotic-Related Attitudes by Exposure to Educational Activity.

Notes. Pooled data set using matched panel data (n = 1,129).

3.3 Impact

As the final step in our analysis, we examined the impact of the activity on villagers' behaviour, focusing specifically on healthcare choices and antibiotic use during recent acute illnesses and accidents. The main results are presented in Figure 7 and detailed results in Appendix Table 3.

Panel a in Figure 7 presents the patterns of healthcare access during people's recent illness episodes with the caveats that (a) people could report multiple healthcare choices during an illness episode, (b) illnesses in Survey Round 2 were reported less frequently, (c) the self-reported severity of illnesses was marginally higher in Survey Round 2 (see Appendix Table 3 for details), and (d) the illness episode samples among the directly exposed group were small with 18 and 12 observations

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in Survey Rounds 1 and 2 and should therefore be considered cautiously. Pending further discussion in the next section, the main observations from this panel were:

- The directly and indirectly exposed groups reported higher public healthcare access in the second survey round.
- Private healthcare access followed a slightly increasing trend that was absent from the indirectly exposed group.
- Informal healthcare access was generally low but followed a slightly increasing trend that was absent from the directly exposed group.
- The involvement of "other" healthcare providers (esp. retired doctors running informal practices in the villages) decreased only in the directly exposed group—to a level similar to the other groups.

While these patterns suggest that there may be an association between the educational activity and public healthcare seeking, Panel b explores in greater depth the use of antibiotics from formal and informal healthcare sources (including both confirmed antibiotics and unclassified medicines that might be antibiotics). Contrary to the patterns of informal healthcare access, reported antibiotic use from informal sources was consistently lower across all three groups in Survey Round 2. In addition, whereas the unexposed group indicated a slight general decline in antibiotic use from formal sources, the directly and indirectly exposed groups exhibited higher rates in Survey Round 2 (which exceeded the lower informal antibiotic use). At the same time, formal antibiotic access among the activity participants rose to a level similar to the first-round levels in the other two groups, which suggests regression to (and random variation around) the mean, rather than an actual effect of the educational activity. Despite the possible trend, the impact of the activity on antibiotic use therefore remained inconclusive.

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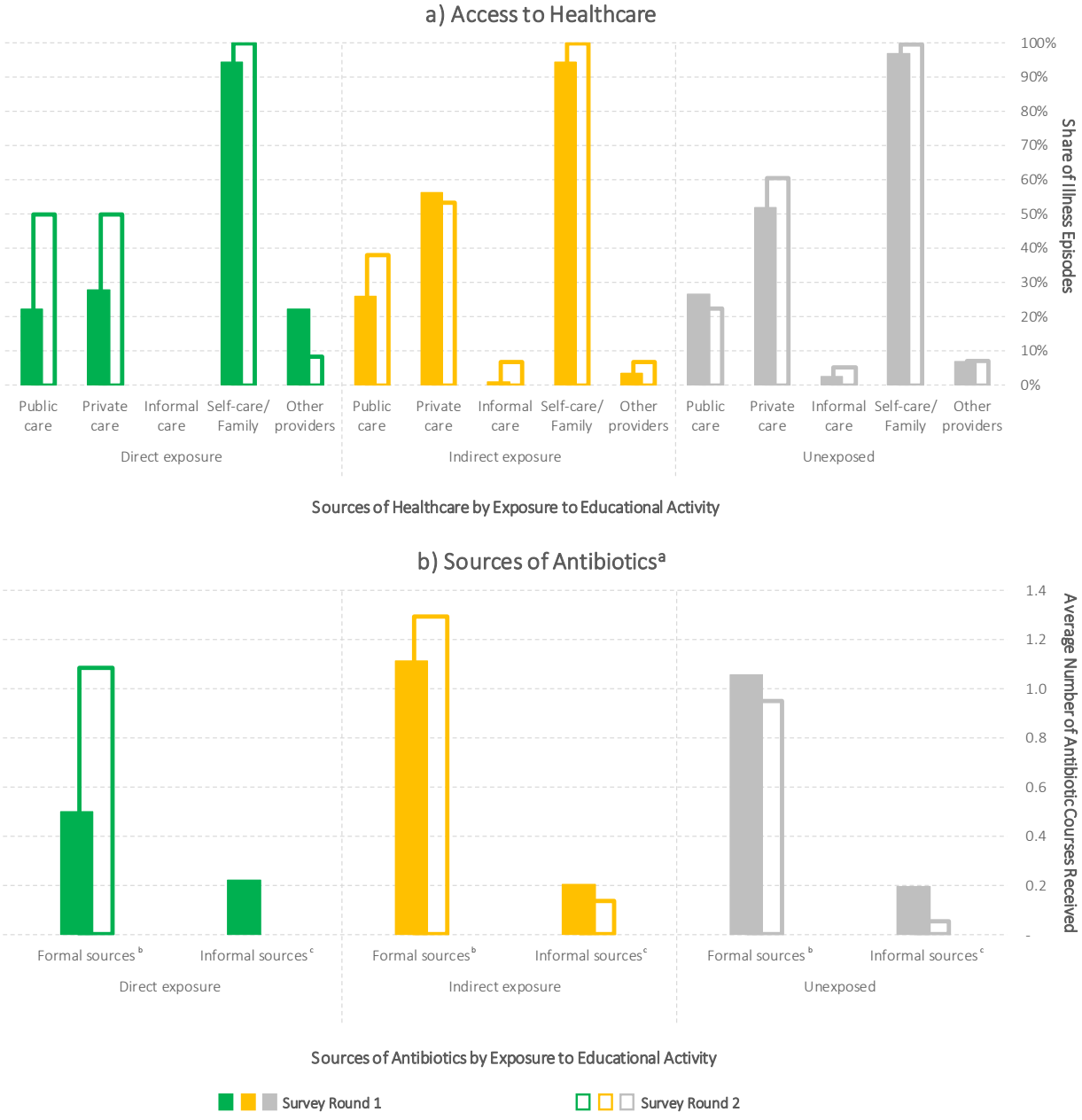

Figure 7. Healthcare Access and Sources of Antibiotics Across Survey Rounds.

Notes. Pooled data set using complete survey data; repeated cross-sections of illness episodes (n = 727). Sub-sample sizes by survey round are: Round 1 / direct exposure (n = 18) / indirect exposure (n = 89) / unexposed (n = 337); Round 2 / direct exposure (n = 12) / indirect exposure (n = 59) / unexposed (n = 213). Multiple sources of antibiotic access per illness episode possible.

[a.] "Antibiotics" including confirmed and possible antibiotics based on reported medicines received during the illness and respondent's reported names and uses of antibiotics shown during the interview.

[b.] Includes public and private healthcare providers.

[c.] Includes traditional healers, grocery stores, retired doctors, itinerant medicine traders), and medicine stored at home and provided by family and friends.

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4 Discussion

Our study documented outputs, outcomes, and impacts of an antibiotic-related educational activity in peri-urban Lao PDR to contribute to our understanding of communication activities in the context of antimicrobial resistance as a current global health priority. The analysis of outputs suggested geographically widespread direct and indirect exposure to the educational activity, but a closer examination of communication patterns revealed that activity-related messages did not circulate within the villages as a whole but within socio-economically more privileged strata. On the outcome level, the educational activity entailed changes in the awareness and interpretation of the term “drug resistance” that were broadly in line with the content of the activity but limited to the directly exposed participants. Weak outcomes among indirectly exposed groups could be explained with the aforementioned communication frictions on the outcome level. In addition, the biomedical “desirability” of antibiotic-related attitudes changed only marginally relative to the general trend. On the impact level, the association between the activity and health behaviour was weak at best, and at worst it could suggest that activity participants overcompensated antibiotics from informal sources with antibiotics from formal healthcare providers.

Three study limitations deserve particular discussion in the context of these findings. Firstly, the repeated rounds of survey collection among all villagers together with the month-long presence in each village contributed to priming effects and the often positive trends among the responses across the survey periods. The messages of the activity itself might have created an additional social desirability bias among participants, which could have affected response patterns across our study groups. We should therefore take the role of response biases into consideration when interpreting these findings, and they also deserve more general attention in public awareness studies. However, our consideration of the three different study groups in a difference-in-

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difference design aimed at mitigating the influence of priming effects on the conclusions of the analysis, and feedback from the villagers and from regular survey team meetings suggested that social desirability biases played some but no overwhelming role in explaining people's responses.

Secondly, the small sample of illness episodes among the activity participants weakened the analysis and rendered the impact assessment only indicative. As a sensitivity test, we carried out Wilcoxon rank-sum hypothesis tests [29,30] to compare antibiotic use from different sources among villagers with "desirable" and "undesirable" attitudes towards buying antibiotics over the counter (Appendix Table 4). The test suggested that informal antibiotic use was consistently lower among people with "desirable" attitudes, but this reduction could be outweighed by formal antibiotic use depending on the definition of antibiotics. [11] The results therefore remained inconclusive but reinforced the possibility that more "desirable" attitudes could entail higher antibiotic use. It might have indeed been the case that respondents who reported higher antibiotic use also needed more antibiotics, but the absolute levels of between 0.45 and 1.05 antibiotic courses per illness episode may have also been an indicator of needlessly high levels of consumption in general. To establish the direction and meaning of impacts more firmly, future impact assessments of awareness-raising activities should collect large population samples with repeated follow-up to generate extensive and longer-term treatment-seeking data.

Thirdly, we selected well-known villagers purposively and situated our case study in peri-urban Salavan. These choices were based on our intention to stimulate indirect exposure to the activity with the help of opinion leaders, and on the public health interests of our local stakeholders. Yet,

[11] The comparison suggested that people with more "desirable" attitudes had significantly higher use of confirmed antibiotics from formal sources ($p<0.10$), which outweighed the lower use of antibiotics from informal sources ($p<0.05$). If also unclassified medicines were included in the definition of medicines that could possibly be antibiotics, then the informal antibiotic use among people with more "desirable" attitudes was still significantly lower ($p<0.01$), but outweighed the small and statistically insignificant difference between antibiotics from formal sources.

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these choices also meant that the documented effects among the participants may not hold for a representative sample of the village, and that the village themselves only partially reflected living conditions in rural Salavan as the poorest province of Lao PDR. As part of a larger research project on rural health behaviour in Salavan and Chiang Rai, we are nevertheless able to put the findings of this case into perspective. For example, our representative survey in rural Salavan documented high formal antibiotic uses and a similarly weak link to antibiotic-related attitudes [31]. Furthermore, comparable educational activities in rural Chiang Rai produced more varied outcomes and behavioural side-effects, for instance rumours and increasing informal healthcare access [23]. As we followed the same methodology in both field sites, these differences may have resulted from programmatic or contextual variation like the (passive) presence of health officials and the peri-urban environment in Salavan.

In sum, this study suggests that the outputs of our educational diffused inequitably, its outcomes on awareness were discernible while the effects on attitudes were weak, and its immediate behavioural impact was inconclusive with potentially detrimental facets. Together with the residual influence of social desirability biases, this case study adds to the social understanding of awareness-raising health interventions and provides support for the caution with which the social sciences approach health communication in general and AMR-related awareness raising in particular.

It appears that one for medical sociologists perhaps obvious obstacle to changing behaviours was that people had existing notions around drug resistance as a vernacular concept. Rather than being “empty vessels” [32], new information competed with the existing knowledge and other sources of information [33]. Beyond the activity participants, the limited circulation of content-related themes suggested that the main messages resonated with more privileged lifestyles irrespective of

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our efforts to translate and convey them in a way that is meaningful for the broader rural population. These problems also highlight tensions between core and peripheral knowledge similar to those raised by Broom, *et al.* [34] in a clinical context in rural Australia. A further complication for the diffusion of the messages was that people might not deem information about drug resistance as a personal priority [11,35],[12] and the benefit of slowing the development of drug resistant bacteria lacks a clear demonstration effect [24]. If these arguments hold, then new ideas about antibiotic use would remain passive unless they threaten people personally (or: we would need to combine the content with "a spark"). However, other authors have cautioned against fear-based narratives of AMR [7,36], and the emergence of rumours associated within our activity in a Chiang Rai village also indicates that such strategies could have a serious backlash [23]. Problems like adverse behavioural reactions, stigma, or public resentment may be accentuated further in situations like ours where antibiotics cannot be easily identified and people might not actively distinguish between antibiotics and other types of pharmaceuticals [37].

5 Conclusion

In conclusion, we developed an educational activity following a year of qualitative health behaviour research in Southeast Asia, and deployed the activity between two rounds of complete adult population censuses in two peri-urban villages in Salavan. Difference-in-difference analysis of the survey data provided a detailed picture of the activity's outputs, outcomes, and impacts to inform awareness-centric global AMR agendas.

Our two-directional educational activity enabled us to learn about the medicine use of the participating villagers in peri-urban Salavan, and it permitted us to share antibiotic-related ideas

[12] We do not take a stance here whether people *should* see AMR as a personal priority.

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and messages albeit their outcomes on attitudes and their immediate behavioural impact was limited. As an antibiotic-related awareness-raising intervention at scale, however, our approach would face obstacles. On the one hand, the small-group format of our educational activity does not lend itself to deployment among an entire village population. On the other hand, the incomplete diffusion of the messages beyond the participants suggested that the beneficiaries of the activity would be more privileged groups. Other forms of awareness raising like hospital- or mass-media-led information campaigns may be able to reach out further, but they, too, may suffer from inequitable uptake and interpretation of messages across different socio-economic strata.

And yet, however encouraging the awareness-raising outcomes were, the weak and/or ambiguous link between awareness, attitudes, and behaviour should lower our expectations about antibiotic-related awareness raising to change treatment-seeking behaviour. Existing behaviour may rather be driven by such factors as personal experience, advice and help from family members and friends, despair, or uncertainty in an obscure and fragmented health system [38-42]. The continued antibiotic use among participants and villagers with already “desirable” attitudes, together with widespread poverty and the generally low access to public healthcare even in our peri-urban setting, suggest that solutions to problematic forms of antibiotic use do not necessarily reside in the domain of awareness raising but rather in more fundamental areas like access to healthcare and medicine. Our case does not render awareness-raising activities obsolete, but it suggests that they can at best be only a small facet of AMR-related behavioural policies.

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Appendix

Appendix Table 1. Interpretations of "Drug Resistance" Across Survey Rounds.

Variable	Direct Exposure (*n* = 58)		Indirect Exposure (*n* = 208)		Unexposed (*n* = 864)	
	R.1	R.2	R.1	R.2	R.1	R.2
			a) Due Yah			
Reference to antibiotics / drug-resistant germs	1.7%	3.5%	5.3%	1.0%	3.7%	2.4%
Medicine does not work	6.9%	17.2%	15.9%	15.9%	12.6%	10.0%
Taking medicine wrongly (e.g. wrong type, too much)	1.7%	6.9%	2.9%	1.9%	2.3%	2.2%
Stubborn patient, medicine restrictions/dislikes	5.2%	1.7%	11.1%	4.8%	10.1%	7.5%
Addicted to or strong preference for medicine	3.5%	0.0%	3.4%	4.3%	2.7%	2.7%
Side-effects, drug allergy, or a specific illness	13.8%	6.9%	7.2%	10.1%	8.2%	6.0%
''Lueng yah'	25.9%	55.2%	17.3%	41.4%	14.7%	30.6%
Other interpretation	3.5%	1.7%	1.9%	1.4%	2.1%	1.9%
Don't know / cannot or prefer not to answer	37.9%	6.9%	35.1%	19.2%	43.6%	36.8%
			b) Lueng Yah			
Reference to antibiotics / drug-resistant germs	19.0%	22.4%	17.8%	6.7%	9.6%	4.9%
Medicine does not work	48.3%	44.8%	44.7%	53.4%	43.1%	41.4%
Taking medicine wrongly (e.g. wrong type, too much)	3.5%	6.9%	2.9%	1.9%	2.2%	5.8%
Stubborn patient, medicine restrictions/dislikes	0.0%	0.0%	1.0%	1.0%	1.3%	1.0%
Addicted to or strong preference for medicine	20.7%	10.3%	21.6%	24.0%	20.8%	23.2%
Side-effects, drug allergy, or a specific illness	1.7%	3.5%	0.5%	0.0%	1.4%	1.6%
Other interpretation	3.5%	6.9%	2.4%	3.4%	4.3%	3.7%
Don't know / cannot or prefer not to answer	3.5%	5.2%	9.1%	9.6%	17.4%	18.4%

Notes. Pooled data set, using matched panel data. Single response per panel.

Appendix Table 2. Antibiotic-Related Attitudes and Knowledge Across Survey Rounds.

Variable	Direct Exposure (*n* = 58)		Indirect Exposure (*n* = 208)		Unexposed (*n* = 864)	
	R.1	R.2	R.1	R.2	R.1	R.2
% buy antibiotics over the counter (attitude)	48.3%	55.2%	32.2%	32.7%	28.5%	24.7%
% prefer antibiotics over alternatives (attitude)	32.8%	31.0%	29.8%	20.2%	28.0%	25.5%
% do not keep antibiotics for future use (knowledge)	27.6%	32.8%	19.7%	28.4%	22.2%	26.6%
% antibiotic resistance can spread (knowledge)	13.8%	13.8%	14.4%	0.5%	11.6%	2.1%
No. of desirable knowledge/attitude answers (0-4)	1.22	1.33	0.96	0.82	0.90	0.79

Notes. Pooled data set, using matched panel data.

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Appendix Table 3. Healthcare Access and Sources of Antibiotics Across Survey Rounds.

Variable	Direct Exposure		Indirect Exposure		Unexposed	
	R.1 (*n* = 18)	R.2 (*n* = 12)	R.1 (*n* = 89)	R.2 (*n* = 58)	R.1 (*n* = 337)	R.2 (*n* = 213)
% of illness episodes involving children	39%	58%	37%	34%	43%	34%
Average self-rated severity	1.56	1.67	1.80	2.03	1.80	1.85
% public healthcare access	22.2%	50.0%	25.8%	37.9%	26.7%	22.5%
% private healthcare access	27.8%	50.0%	56.2%	53.4%	51.9%	60.6%
% informal healthcare access	0.0%	0.0%	1.1%	6.9%	2.7%	5.2%
% family and self-care	94.4%	100.0%	94.4%	100.0%	97.0%	99.5%
% other healthcare providers	22.2%	8.3%	3.4%	6.9%	6.8%	7.0%
Av. no. of non-antibiotic medicines/treatment	1.28	1.42	1.56	1.41	1.39	1.27
Av. no. of confirmed antibiotics[a]	0.72	0.75	0.55	0.57	0.49	0.36
Av. no. of confirmed & possible antibiotics (ABx)[a]	0.33	0.42	0.79	0.97	0.86	0.69
ABx from formal sources[b]	0.50	1.08	1.11	1.29	1.06	0.95
ABx from informal sources[c]	0.22	0.00	0.20	0.14	0.20	0.05

Notes. Pooled data set using complete survey data; repeated cross-sections of illness episodes (*n* = 727). Multiple sources of antibiotic access per illness episode possible.

[a.] Based on reported medicines received during the illness and respondent's reported names and uses of antibiotics shown during the interview.

[b.] Includes public and private healthcare providers.

[c.] Includes traditional healers, grocery stores, retired doctors, itinerant medicine traders), and medicine stored at home and provided by family and friends.

Appendix Table 4. Sensitivity Analysis: Difference in Antibiotic Use from Formal and Informal Sources by Respondent's Attitude Towards Buying Antibiotics Over the Counter.

Variable	Undesirable Attitude	Desirable Attitude	Difference	
	Mean (Std. Dev)	Mean (Std. Dev)	Mean	*p*
Confirmed antibiotics from formal sources	0.36 (0.02)	0.45 (0.04)	+ 0.08	0.052
Confirmed antibiotics from informal sources	0.08 (0.01)	0.04 (0.01)	– 0.04	0.036
Confirmed & possible antibiotics from formal sources	1.02 (0.05)	1.05 (0.08)	+ 0.03	0.267
Confirmed & possible antibiotics from informal sources	0.17 (0.02)	0.07 (0.02)	– 0.10	0.003

Notes. Pooled data set using complete survey data; repeated cross-sections of illness episodes (*n* = 796). Hypothesis test using Wilcoxon rank-sum test.

Acknowledgements

We thank our project collaborators Romyen Kosaikanont, Pathompong Manohan, Pollavat Praphattong, Giacomo Zanello, Jeffrey P Lienert, Felix Reed-Tsochas, Caroline OH Jones, Mayfong Mayxay, Paul N Newton, Yoel Lubell, Direk Limmathurotsakul, Heiman FL Wertheim, Proochista Ariana, Rachel C Greer, Daranee Intralawan, Supalert Nedsuwan, Tri Wangrangsimakul for helpful inputs that shaped the development of the project. We also acknowledge gratefully the support we received in Salavan from Sommay Keomany, Sayasinh Kong, and Bounnak Keodonekhong, without whom this research would not have been possible. Particular thanks go to our volunteers and survey team Amphayvone Thepkhamkong, Nicksan Sithongdeng, Maipheth Keovilayvanh, Nid Khamsoukthavong, Phaengnitta Phanthasomchit, Chanthasone Phanthavong, Somsanith Boualaiseng, and Souksakhone Vongsavang. We further thank Thomas Althaus, Ernest R Guevarra, Eric Ohuma, Elizabeth Elliot, Deuansavanh Mahaxay, and for helpful discussions, feedback, and support during the survey design phase; Edward Gibbs, Lisa White, Nicholas Day, the Centre for Tropical Medicine and Global Health, and the Mahidol-Oxford Tropical Medicine Research Unit / Wellcome Trust Strategic Award for institutional support; Zoë Doran and the Clinical Trials Support Group at the Mahidol Oxford Tropical Medicine Research Unit for quality assurance during the protocol development process; Alison Brindle, Claire-Lise Kessler, and John Bleho for engaging communication work; and Karen Valentine, David Burton, Holly Blades, Kanchana Pongsaswat, Athirat Black, and Sengmany Symanivong for indispensable operational and logistical assistance.

This project is funded by the Antimicrobial Resistance Cross Council Initiative supported by the seven research councils in partnership with the Department of Health and Department for Environment Food & Rural Affairs (grant ref. ES/P00511X/1, administered by the UK Economic

 doi:10.20944/preprints201809.0034.v1

and Social Research Council). YKZ was further supported by internal research placement funding by the MSc International Health and Tropical Medicine (University of Oxford).

Author Contributions

Conceptualization, NC, TX, PW, YKZ, MJH; Methodology, MJH, NC; Formal Analysis, MJH, TX, NC; Data Curation, MJH; Investigation, MJH, TX, NC; Writing – Original Draft Preparation, MJH; Writing – Review & Editing, MJH, NC, TX, YKZ, PW; Supervision, MJH, NC; Project Administration, NC; Funding Acquisition, MJH.

Conflicts of Interests

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

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