Original Article

Health of Farming Communities Prior to Modification of the Occupational Environment through a Watershed Development Project in Kolar, India

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Abstract

Background: Watershed development (WSD) projects, aimed primarily at enhancing soil and water conservation and supporting livelihoods in semi-arid areas, have the potential to impact health by modifying the occupational and household environments in agrarian communities. To identify and address potential health concerns arising from a planned WSD project in Kolar district, India, a health impact assessment (HIA) was conducted. This necessitated understanding the health status and concerns in the project villages. **Objective:** To characterize the health of farmers and their household members in close proximity of the planned WSD project. **Methods:** We carried out a cross-sectional survey between April and July 2019. The study comprised: (i) a household survey covering the four project villages and two comparison villages (e.g. socio-demographic characteristics, occurrence of vector-borne diseases (VBDs), access to safe water, sanitation and hygiene, and utilization of healthcare); and (ii) an anthropometric survey for children under the age of 5 years in the four project villages and four comparison villages. **Results:** Respondents (n = 333) reported household-level occurrences of VBDs (chikungunya, 3.3%; and dengue, 1.5%), consuming unsafe water (54.5%) and frequent pesticide application in fields (26.7%). The prevalence of child underweight was 23.8%. **Conclusions:** VBDs, poor water quality and child undernutrition were found to be important local health concerns, amenable for preventive and promotive measures through the planned WSD project. Occupational environments in agricultural settings affect the workers and their households, and comprehensive projects such as WSD can seize the opportunity for improving health of farming and other rural households.

Keywords: Agriculture, health impact assessment, India, nutrition, vector-borne disease, watershed development

Introduction

Almost 55% of the total workforce and their households depend on agriculture for livelihood in India.[1] Agriculture is also a critical determinant of nutrition for this population.[2] Occupational health of farmers has received some attention in the National Health Policy 2017 with agricultural injuries indicated as a priority concern.[3] Most farmers depend on rainfall for cultivation, contributing to uncertainty and distress. Farmer suicides are the tip of the iceberg of the prevalent distress in the community.[4] Soil erosion and water insecurity have further affected agricultural productivity.[5] These, and other factors such as vulnerability to climate change,[6] have created a precarious occupational environment for farmers and wage labourers in semi-arid rural India.

In response to these challenges, watershed development (WSD) projects have been conducted with the support of governmental and development agencies towards soil and water conservation, and sustainable livelihoods.[7,8] Interventions include structures such as check-dams,[9] tree planting,[5] support for livestock rearing and creating local management institutions.[7] It was envisioned that WSD projects would integrate schemes from across sectors, including nutrition-related schemes.[7] Common guidelines for WSD projects were revised in 2008.[5]

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WSD projects have reportedly impacted positively on the health of local communities through improved sanitation and water access, enhanced dietary diversity and increased livelihood opportunities, leading to reduction in diarrhoeal disease, better nutrition and overall wellbeing.[10-13] However, modification of the occupational environment has led to some potential negative impacts, through changed vector ecology (e.g. increased surface water bodies), pesticide use (e.g. increase in commercial cropping) and accidents (e.g. drowning in farm ponds).[14]

A WSD project was proposed by a non-governmental organization (NGO), MYRADA Kolar Project, for four villages in Kolar district, India in 2019. While a baseline socioeconomic study is usually conducted prior to implementing WSD projects, the idea for conducting a health impact assessment (HIA) of this proposed WSD project arose through discussion between the first author (A.P.) and the NGO to (i) deepen the understanding of local health concerns; (ii) identify potential project-related health concerns; and (iii) recommend approaches to mitigate potential risks and maximize health promotion through the planned WSD project. The literature review during the HIA[15] revealed vector-borne diseases (VBD),[16,17] undernutrition[18] and fluorosis[19,20] as district-level concerns. However, due to inadequate village-level health data for conducting the HIA, primary data collection was carried out to estimate these key indicators prior to the WSD project. In this paper, we present the status of selected health indicators in the local population, as identified through primary data collection within the frame of the HIA prior to the planned WSD project.

Materials and Methods

Study area

The WSD project site is located approximately 65 km east of Bengaluru city, and 30 km south of Kolar town (geographic coordinates: 12°53'-12°54' N latitude; 78°3'-78°6' E longitude). The planned WSD project will cover four villages [Figure 1]. People's primary occupation is agriculture, and the main produce is finger millet.[21] This semi-arid area is prone to climate change.[22]

Study design

A cross-sectional study design was used, and the modular survey approach suggested by Winkler and colleagues for HIA in tropical contexts was applied.[23] Two modules were included: (i) household survey; and (ii) anthropometric survey. The survey sites are depicted in Figure 1. The household survey was conducted in the four project villages (n = 195 households) and two comparison villages (n = 138 households). Comparison villages were chosen based on geographic proximity to study villages and similarities in socioeconomic conditions. In terms of sample size, all households were invited to participate, enabling a complete census of the included project and comparison villages. The anthropometric survey was conducted with children under the age of 5 years in the four project villages (n = 83 children) and four comparison villages (n = 77 children). All eligible children in these villages were included for the survey.

Data collection

The survey was conducted between April and July 2019. Women of age 15 years or more were requested to participate on behalf of their households. After obtaining written informed consent, the survey was administered on an electronic tablet using the Open Data Kit (ODK) platform[24] by a member of the trained survey team. The structured questionnaire contained questions on socioeconomic status, agriculture, water and sanitation, disease risk factors, experience of various diseases and access to health services. Some environmental observations were also made at each household (i.e. toilet condition, soap availability and open drains). The topics were based on needs identified in the scoping stage of the HIA.[15] Due to human resource constraints, a few data points were not covered in the comparison villages (indicated in the respective tables).

The anthropometric assessment was done at the local governmental crèches. Few home visits were made for children who could not be brought to the crèche at the time of the survey. Weight on the nearest 0.1 kg (digital scale, Eagle EEP1007A; Pune, India) and mid-upper arm circumference (MUAC) on the nearest mm (using a standard tape) were measured. In addition, sex, date of birth, date of measurement and village location of the child were noted. Data were directly entered into a template developed on ODK.

Statistical analysis

Data was analyzed using R statistical software version 3.5.1 (on RStudio version 1.1.456).[25] As the sample included all households and all children under the age of 5 years in the project and comparison villages, confidence intervals were not calculated and statistical tests were not performed between comparison groups. The household survey data were summarized descriptively for project and comparison villages using proportions, means and medians. The anthropometric survey data were analyzed using the "anthro package"[26] to determine z-scores for weight-for-age and MUAC-for-age based on the World Health Organization (WHO) Child Growth Standards. Moderate and severe undernutrition and undernourishment were defined as < -2 standard deviations (SD) and < -3 SD, respectively. The prevalence of underweight and undernourishment among children under the age of 5 years in the study population were estimated.

Ethical considerations

Ethical clearance was received from the Padmashree Institute of Clinical Research in Bengaluru, India (reference no. IEC-BIO-004; date of approval: 10 August 2018) and the Ethics Commission of Northwest and Central Switzerland (EKNZ; reference no. BASEC Nr Req-2018-00839, date of approval: 19 October 2018). Study details were provided to the participants and guardians, following which written informed consent was taken in the local language prior to administering the questionnaire and conducting the anthropometric assessment. An information sheet in the local language was given to

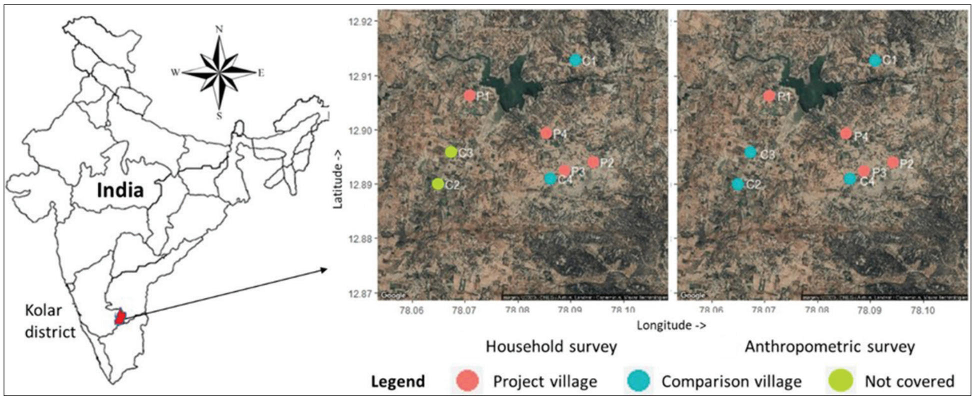

Figure 1: Study sites – location of project and comparison villages (source of satellite imagery: Google Earth (dated 29.03.2020, mapped using the 'ggmap' package in R statistical software)

participants. Data were stored in an anonymized manner on a server of the host institute.

Results

Socio-demographic characteristics

A total of 195 households from four project villages and 138 households from two comparison villages were included in the household survey. The anthropometric survey included 83 children from project villages and 77 from comparison villages. Socio-demographic characteristics of the complete study population are summarized in Table 1. Most of the respondents were illiterate (57.1%) and a sizeable proportion were of Scheduled Tribes (35.7%).

Vector-borne diseases

The situation of VBD and related determinants and strategies have been summarized in Table 2. One quarter of the respondents reported that their households had ever experienced a VBD. During the year prior to the survey, some respondents claimed occurrences of malaria (10.5%), chikungunya (3.3%) and dengue (1.5%) in their households. Mosquitoes were perceived as a regular nuisance by one in five respondents. The most common approach to cope with mosquito menace was using repellent vaporizers (73.9%). Almost one in two households also reported using bed nets. Over 25% of households usually visited private practitioners for managing fever. Potential vector-breeding sites, such as domestic waste (36.4%) and stagnant water in open drains (16.9%) outside the household were observed in several situations.

Drinking water quality, sanitation and hygiene

The status of water, sanitation and hygiene (WASH), and related health characteristics are summarized in Table 3. Groundwater was the main source of drinking water for nine in ten households. Drinking water from a village-level water purifier was only utilized by 42.1% of the households. The quality of unfiltered groundwater was perceived as satisfactory for drinking by 31.2% of the respondents.

Members with teeth discolouration was reported in 12.3% households. Health impacts of chronic fluoride exposure were not known to 33% of the respondents. While most households in project villages had their own toilets (92.8%), soap was only observed at hand-wash facilities in 48.7% of the households.

Almost seven in ten households still occasionally used firewood or kerosene stoves for cooking, often alongside natural gas. Monthly pesticide spraying for agriculture was reported by 23.4% households, with a small proportion (3.3%) applying pesticides weekly.

Nutritional status and underlying determinants

The prevalence of underweight (based on weight-for-age) and undernourishment (based on MUAC-for-age) among children under 5 years of age across eight study villages were 23.8% and 11.3%, respectively [Table 4]. Over 64% households with eligible children regularly sent them to the governmental crèche, but some households did not, for reasons that the child was too young (15.6%) or because the crèche was located in a neighbouring village (15.6%).

Discussion

Our cross-sectional survey before the planned implementation of a WSD project in Kolar district, India revealed similar socio-demographic, VBD, WASH conditions and nutritional conditions in the designated project and comparision villages. Few indicators, such as prevalence of severe undernutrition, were slightly higher in project villages, although likely not beyond what can be attributed to random variation. This similarity between project and comparison villages before project initiation is ideal for longitudinal monitoring and evaluation of project impacts.[23] The availability of baseline health data from comparison villages will enable a trend analysis (increasing, decreasing or stagnant) or the application of the difference-in-differences approach for indicators that are dissimilar at baseline, after project completion.[27]

Influence of occupational environment on local health

Structures such as farm ponds, wells and troughs, created to sustain rainfed farming and livestock have been demonstrated to foster mosquito breeding in Kolar district,[17] and hence, are of concern for the planned WSD project. Malaria has

Table 1: Socio-demographic characteristics of participants in the household and anthropometric surveys conducted between April and July 2019 in the study villages, Kolar district, India

Household survey			
Variable	**Project (*n1* = 195), *n* (%)**	**Comparison (*n2* = 138), *n* (%)**	**Total (*n* = 333), *n* (%)**
Median age in years [P25 - P75]	35 [28 - 45]	39 [28 - 50]	35 [28 - 48]
Sex			
Female	182 (93.3)	111 (80.4)	293 (88.0)
Male	13 (6.7)	27 (19.6)	40 (12.0)
Education			
Illiterate	111 (56.9)	79 (57.2)	190 (57.1)
Up to 4th grade	27 (13.8)	15 (10.9)	42 (12.6)
5th - 10th grade	48 (24.6)	37 (26.8)	85 (25.5)
Pre-university and above	9 (4.7)	7 (5.1)	16 (4.8)
Caste			
General	120 (61.5)	43 (31.2)	163 (48.9)
Scheduled Tribe	60 (30.8)	59 (42.8)	119 (35.7)
Scheduled Caste	15 (7.7)	7 (5.1)	22 (6.6)
Other Backward Class	0 (0.0)	29 (21.0)	29 (8.7)
Anthropometric survey			
	Project (*n3* = 83), *n* (%)	**Comparison (*n4* = 77), *n* (%)**	**Total (*n* = 160), *n* (%)**
Age groups			
0 to 1 year	12 (14.5)	23 (29.9)	35 (21.9)
1 to 2 years	19 (22.9)	9 (11.7)	28 (17.5)
2 to 3 years	16 (19.3)	16 (20.8)	32 (20.0)
3 to 4 years	14 (16.9)	10 (13.0)	24 (15.0)
4 to 5 years	22 (26.5)	19 (24.7)	41 (25.6)
Sex			
Female	39 (47.0)	32 (41.6)	71 (44.4)
Male	44 (53.0)	45 (58.4)	89 (55.6)

Table 2: Vector-borne diseases (VBD) occurrence, risk perception and strategies in selected villages of Kolar district, India from a survey conducted between April and July 2019

Variable	**Project (*n1* = 195), *n* (%)**	**Comparison (*n2* = 138), *n* (%)**	**Total (*n* = 333), *n* (%)**
Mosquitoes perceived as nuisance			
Always	37 (19.0)	31 (22.5)	68 (20.4)
During the rainy season	68 (34.9)	62 (44.9)	130 (39.0)
Sometimes	71 (36.4)	5 (3.6)	76 (22.8)
Never	19 (9.7)	40 (29.0)	59 (17.7)
Household member ever affected by a vector-borne disease (self-reported)			
One VBD	51 (26.2)	24 (17.4)	75 (22.5)
Two VBDs	4 (2.1)	0 (0.0)	4 (1.2)
Self-reported malaria occurrence past year	17 (8.7)	18 (13.0)	35 (10.5)
Self-reported chikungunya occurrence past year	10 (5.1)	1 (0.7)	11 (3.3)
Self-reported dengue occurrence past year	4 (2.1)	1 (0.7)	5 (1.5)
Measures used against mosquitoes			
Repellent vaporizer (liquid/mats/coils)	154 (78.6)	92 (65.7)	246 (73.9)
Bed net	95 (48.5)	64 (45.7)	159 (47.7)
Ceiling fan	79 (40.3)	63 (45)	142 (42.6)
Closing the windows	60 (30.6)	64 (45.7)	124 (37.2)
Insecticide spraying	2 (1.0)	19 (13.6)	21 (6.3)
Other methods	9 (4.6)	6 (4.3)	15 (4.5)
Nothing done	2 (1.0)	1 (0.7)	3 (0.9)
First choice of health service for fever			

Contd...

Table 2: Contd...

Variable	Project ($n1$ = 195), *n* (%)	Comparison ($n2$ = 138), *n* (%)	Total (*n* = 333), *n* (%)
Local government hospital	141 (72.3)	NR	-
Local private doctor	49 (25.1)	NR	-
Domestic waste around the house	71 (36.4)	NR	-
Open drain outside home	131 (67.2)	NR	-
Drain had stagnant water	33 (16.9)	NR	-

NR, not recorded

Table 3: Drinking water, sanitation and hygiene in selected villages of Kolar district, India from a survey conducted between April and July 2019

Variable	Project ($n1$ = 195), *n* (%)	Comparison ($n2$ = 138), *n* (%)	Total (*n* = 333), *n* (%)
Community bore-well as source of drinking water	176 (90.3)	119 (86.2)	295 (88.6)
Perceived adequacy of water for domestic use	166 (85.1)	122 (88.4)	288 (86.5)
Method used to purify drinking water			
Community RO filter	82 (42.1)	66 (47.8)	148 (44.4)
Personal filter	2 (1.0)	2 (1.4)	4 (1.2)
None	111 (56.9)	70 (50.7)	181 (54.5)
Perceived that unfiltered water quality is fine	53 (27.2)	51 (37.0)	104 (31.2)
At least one family member reportedly with teeth discoloration	21 (10.8)	20 (14.5)	41 (12.3)
Knowledge about at least one health effect of fluoride exposure	125 (64.1)	98 (71.0)	223 (67.0)
Ownership of latrine	181 (92.8)	125 (90.6)	306 (91.9)
Maintenance of latrine	167 (85.6)	NR	-
Soap was available at hand-wash facility	95 (48.7)	NR	-
Kitchen fuel			
Using only LPG	38 (19.5)	63 (45.7)	101 (30.3)
Using LPG and other fuels	134 (68.7)	53 (38.4)	187 (56.2)
Only using other fuels	23 (11.8)	22 (15.9)	45 (13.5)
Frequency of pesticide application			
> 4 times a month	6 (3.1)	5 (3.6)	11 (3.3)
Up to 4 times a month	62 (31.8)	16 (11.6)	78 (23.4)

LPG, liquefied petroleum gas; NR, not recorded; RO, reverse osmosis

Table 4: Prevalence of anthropometric failure among children under 5 years of age, and crèche utilization in selected villages of Kolar district, India from a survey conducted between April and July 2019

Indicator	Project, *n* (%)	Comparison, *n* (%)	Total, *n* (%)
Underweight	($n3$ = 83)	($n4$ = 77)	(*n* = 160)
Severe	8 (9.6)	3 (3.9)	11 (6.9)
Moderate	14 (16.9)	13 (16.9)	27 (16.9)
Not	61 (73.5)	61 (79.2)	122 (76.3)
Undernourished	($n3$ = 79)	($n4$ = 71)	(*n* = 150)
Severe	1 (1.3)	0 (0.0)	1 (0.6)
Moderate	10 (12.7)	6 (8.5)	16 (10.7)
Not	68 (86.1)	65 (91.5)	133 (88.7)
Households sending children to local crèche	29/45* (64.4)	NR	-
Reasons for not sending			
Crèche located in neighbouring village	7/45* (15.6)	NR	-
Child too young	7/45* (15.6)	NR	-
Food insecurity during past 2-year period	40/195 (20.5)	31/138 (22.5)	71/333 (21.3)

*Only 45 households with children aged under 5 years in the project villages; NR, not recorded largely been eliminated from these sub-districts in the past two decades,[28] but dengue and chikungunya outbreaks continue to occur.[15] While personal protective measures such as mosquito coils were mainly used here, similar to elsewhere in India,[29] the opportunity for source reduction in the occupational environment exists. Just over a quarter of households in the project villages reported using private healthcare services for managing fever, which is considerably lower than the rural average (63.2%) reported for all ailments in India.[30] This observation may indicate the presence of a functional governmental healthcare service.

A sizable proportion of households reported at least monthly application of pesticides (23.4%), probably for vegetable cultivation commonly done in the area.[14,15] WSD projects increased cultivation of commercial crops such as vegetables, due to enhanced irrigation capacity and land quality.[14] However, use of personal protective equipment was reported to be low from elsewhere in India.[31] This indicated an opportunity for awareness about safe pesticide application.

Occupational-household environment continuum influencing health impacts

Groundwater is the source for irrigation and domestic use, and reportedly contained high levels of fluoride.[15] Access to purified water was found to be limited (54.5%), and evidence of dental fluorosis were reported from a neighbouring sub-district.[20] The WSD project, besides increasing water for agriculture, would also improve water quality through rainwater harvesting and groundwater recharge,[14] which would contribute to better health.

The prevalence of underweight among children below the age of 5 years in the study area (23.8%) was slightly lower than for rural Kolar in 2016 (28.5%).[18] Over 64% households regularly sent their children to the governmental crèche, higher than the Indian rural average of 42.3% in 2016.[32] WSD projects are known to improve food security, access to vegetables, fruits and animal source foods,[12,14] and also access to sanitation, and so the planned WSD project can be expected to enhance local nutritional status.[15]

Limitations

A few eligible children could not be surveyed as they were unavailable despite two follow-up visits upon absence in the initial survey date. The reason provided was that they were visiting relatives in other areas. Few houses were also found to be locked during the survey and two follow-up visits. However, these numbers were small and so the potential bias on our results is negligible, even if these households were systematically different from those included in the survey. Additionally, most of the respondents were illiterate (56.9%). This may have impacted the accuracy of their responses on disease occurrence. Finally, as this was a pilot study with limited resources for a relatively small WSD project with potentially minor health implications, clinical examinations were not conducted and biological samples were not collected for testing infectious, chronic and nutritional diseases in the study population, as is typical for HIAs of large projects.[33]

Conclusions

The results of the cross-sectional baseline survey provided insights into various local health concerns relevant to the project context, including VBDs, water quality and child nutrition. These concerns reflected the seamless continuum of the occupational and household environments in agricultural communities, especially in the context of WSD projects. The data collected set a benchmark against which the project will be evaluated in the future. The modular survey approach adopted here holds promise for impact assessments of development projects in India, as is being done in other settings internationally,[34] towards contributing to environmental health decision-making and improving occupational and environmental health outcomes for India's large agrarian population.

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Conflicts of interest

There are no conflicts of interest.

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