

THESIS

**SCHOOL-BASED INTERVENTIONS
TO CONTROL DENGUE VECTOR
IN THE GAMPAHA DISTRICT**

Submitted by

N.M.L.Radhika

(FGS/05/PhD/17/2016/01)

A thesis submitted to the Faculty of Graduate Studies, University of Kelaniya

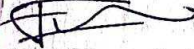
in fulfillment of the requirements for the degree of

Doctor of Philosophy in Public Health



August 2022

This thesis has been accepted by the University of Kelaniya for the award of the Degree of Doctor of Philosophy (2023). It is not allowed to publish this as a thesis accepted for the Degree of Doctor of Philosophy without the authority of the University



Deputy Registrar/Examinations



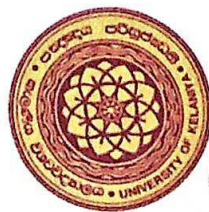
SCHOOL-BASED INTERVENTIONS
TO CONTROL DENGUE VECTOR
IN THE GAMPAHA DISTRICT

Submitted by

N.M.L.Radhika

(FGS/05/PhD/17/2016/01)

A thesis submitted to the Faculty of Graduate Studies, University of Kelaniya
in fulfillment of the requirements for the degree of
Doctor of Philosophy in Public Health



August 2022

DECLARATION

I declare that the work embodied in the thesis is my own and has not been submitted for any degree in the University or any other institute, and to the best of my knowledge and belief, it does not contain any material previously published or written or orally communicated by another person except where due reference is made in the text.



..... Signature of the candidate

To the best of our knowledge the above particulars are correct.

Main Supervisor Professor W. Abeyewickreme, Professor of Parasitology,




Department of Para clinical Sciences,

Faculty of Medicine,

General Sir John Kotelawala Defence University, Sri Lanka

Co- supervisor Professor K. T. A. A. Kasturiratne,

Department of Public Health,



Faculty of Medicine,

University of Kelaniya, Sri Lanka

Co- supervisor Professor P.A.D.H.Nayana Gunathilaka,

Department of Parasitology,



Faculty of Medicine,

University of Kelaniya, Sri Lanka

To

My Parents and Teachers

CONTENTS

TOPICS	PAGE
CONTENTS	i
LIST OF FIGURES	xi
LIST OF TABLES	xiv
LIST OF APPENDICES	xvi
LIST OF ABBREVIATIONS	xvii
ACKNOWLEDGEMENTS	xix
ABSTRACT	xxi

No:	Page
CHAPTER 1 - INTRODUCTION	01
1.1 Dengue as a mosquito borne virus disease	01
1.2 Dengue vector control strategies	03
1.3 Dengue vector control in school settings	06
1.4 Justification of the present study	08
1.5 Research Question	14
1.6 Research Hypothesis	14
1.7 Research Objectives	14
1.7.1 General objective	14
1.7.2 Specific objectives	14

CHAPTER 2 - LITERATURE REVIEW	15
2.1 History of dengue infection	15
2.2 Epidemiology of Dengue	16
2.3 Global situation of dengue	18
2.4 A global strategy for dengue prevention and control	20
2.5 Dengue in Sri Lanka	21
2.6 Sri Lankan initiatives for combating Dengue	22
2.7 Vectors of dengue transmission and their bionomics	25
2.8 Vulnerability of the school community for dengue infections	28
2.9 Risk factors for dengue hemorrhagic fever	32
2.10 Risk perception for dengue control	33
2.11 Implementation of vector control interventions at schools	33
2.12 Importance of health education and awareness programmes for vector control at schools	35
2.13 Guidelines of the Ministry of Education for health promotion in schools	37
CHAPTER 3 - METHODOLOGY	41
3.1 Work plan	41
3.2 Selections of study area	42
3.2.1 Study population	43
3.2.2 Study design	44

3.3	Baseline survey	44
	3.3.1 Collection of primary information	44
	3.3.2 Entomological surveys and vector identification	45
	3.3.3 Focus Group Discussions with school community	46
	3.3.4 Conducting awareness programmes at the school level	48
	3.3.4.i Conducting structured awareness programmes at school level	48
	3.3.4.ii Conducting awareness programmes for the whole school	50
	3.3.4.iii Conducting awareness programmes for parents at school level	50
	3.3.4.iv Conducting awareness programmes for Development Officers attached to the Ministry of Education	51
	3.3.4.v Conducting awareness programmes for Environmental Officers of the Central Environmental Authority.	52
3.4	Effectiveness of School-Based Health Education Programmes to improve Knowledge and Practices on dengue prevention	53
	3.4.1 Study design	53
	3.4.2 Data Collection	53
	3.4.3 Data Analysis and Interpretation	55
	3.4.4 Statistical Analysis	55

3.5	Interventional and operational survey	56
3.6	Other activities implemented under the Dengue prevention programme at schools	58
3.7	Ethical considerations	61
3.8	Assessment of Significance of the study	61
	 CHAPTER 4 - RESULTS	 62
4.1	Basic information	62
	4.1.1 School profile information	62
	4.1.2 Environmental and demographic characteristics of the selected schools	64
	4.1.3 Existing infrastructure of selected schools	66
	4.1.4 Waste disposal mechanism followed by the school Communities	69
4.2	Entomological investigations	71
	4.2.1 Breeding habitat categories encountered at the schools in baseline and follow-up surveys	71
	4.2.2 Diversity of breeding habitats at the schools in baseline and follow- up surveys	71

4.3	Entomological Indices	74
4.4	Awareness of dengue and school-based health education programmes	74
4.4.1	Awareness among students on different aspects of dengue	75
4.4.1.i	Existing knowledge of students at different schools on dengue	77
4.4.1.ii	Variation of the existing knowledge after the awareness programme	81
4.4.2	Influence on the vector abundance	86
4.5	The children's activities towards finding solutions to address the problem of dengue	88
4.5.1	Group activities of school students	88
4.5.2	Activities conducted by the members of Dengue Prevention Task Force	89
4.5.3	The children's activities for addressing the dengue problem	91
4.5.3.i.	Solid waste management practices	91
4.5.3.ii.	Disseminating knowledge related to dengue prevention	92
4.5.3.iii.	Children's reflection by drawing pictures/posters, creative writing	94
4.6	The outcomes of intervention activities as practices	96
4.6.1	Improving waste management practices through proper disposal	96
4.6.2	Introducing composting and gardening activities at schools	97

4.7	Evaluation of the progress of the interventions after implementation	99
4.7.1.	Evaluation through best practices	99
4.7.1.i	Elimination of breeding habitats through environmental modification	99
4.7.1.ii	Cleaning of malfunctioning drainage systems	100
4.7.1.iii	Reusing discarded items to prevent dengue vector breeding	101
4.7.1.iv	Elimination of vector breeding with simple best practices	102
4.7.1.v	Filling the spaces of bamboo stumps and tree holes	103
4.7.1.vi	Rearranging and repacking of removed roof tiles	104
4.7.2	Evaluation through entomological findings	104
4.7.2.1	Diversity and abundance of containers observed at the baseline survey	105
4.7.2.2	Diversity and abundance of containers observed at the first follow-up survey	106
4.7.2.3	Diversity and abundance of containers observed at the second follow-up survey	107
4.7.2.4	Diversity and abundance of containers observed at the third follow-up survey	108

4.7.3	Comparison of the number of containers in control and intervention schools at baseline and each follow-up survey	109
4.7.3.1	Comparison of the number of containers found at control schools and intervention schools at the baseline and the first follow-up surveys	109
4.7.3.2	Comparison of the number of containers found at control schools and intervention schools at the baseline and the second follow-up surveys	111
4.7.3.3	Comparison of the number of containers found at control schools and intervention schools at the baseline and the third follow-up surveys	112
4.8	Perceptions of the school environment and dengue prevention activities	114
4.8.1	Cleanliness of the school environment	115
4.8.2	Information on breeding sites of dengue vector in the school premises	122
4.8.3	Important activities to reach a clean, green, and healthy school environment	125

4.9	Identification of barriers and promoting factors	129
4.9.1	Barriers for dengue prevention activities within the school	129
4.9.1.1	Inadequate community participation in waste management and dengue prevention initiatives to maintain a clean and healthy environment	130
4.9.1.2	Existing administrative issues that have an impact on waste management and dengue preventive strategies	131
4.9.1.3	Poor knowledge, attitudes, and practices about waste management and dengue control efforts	134
4.9.2	Promoting factors for dengue prevention activities within the school	135
4.9.2.1	Availability of opportunities for getting more community participation in waste management and dengue prevention initiatives to maintain a clean and healthy environment	136
4.9.2.2	Availability of strategies and resources for solving administrative issues that have an impact on waste management and dengue preventive strategies	139
4.9.2.3	Willingness of the school community to conduct programmes to uplift knowledge, attitudes, and practices about waste management and dengue control efforts	141

	CHAPTER 5 - DISCUSSION	145
5.1	Awareness of dengue and school-based health education programmes	145
5.2	Risk factors for dengue transmission and community participation activities	150
5.2.1	Effect of environmental and demographic characteristics on vector Indices	152
5.2.2	Effect of existing infrastructure at selected schools on vector indices	154
5.2.3	Effect of waste disposal mechanisms on vector indices	155
5.2.4	Effects of field surveillance and monitoring activities on dengue prevention	157
5.3	Effect of community participation on dengue control and solid waste management	159
5.3.1	Raising the level of awareness on dengue control	160
5.3.2	Strengthening Environmental Pioneers and School Development Officers for capacity building	162
5.3.3	Conducting solid waste management programmes to implement the 3R concept	164
5.3.4	Sustainability of community participation programmes in vector control interventions	167

5.4	Conducting activities for getting community participation in dengue control	168
5.5	Identification of the barriers and promoting factors for the school community to participate in dengue vector control	170
5.5.1	Barriers and promoting factors related to solid waste management in dengue control	172
5.5.2	Barriers and promoting factors related to administrative issues for dengue control	174
5.6	Public health implications of the present study	179
5.6.1	Delivering a sustainable health promotion programme	179
5.6.2	Contribution of the present project to the existing programmes in the county	182
5.7	Limitations and methodological issues	191
5.8	Conclusion and Recommendations	193
5.8.1	Conclusions	193
5.8.2	Recommendations	194
	CHAPTER 6 - REFERENCES	202
7.0	APPENDICES	232
8.0	RESEARCH PUBLICATIONS AND COMMUNICATIONS	250

LIST OF FIGURES

Figure No:		Page No:
Figure 3.1	Collection of larvae by dipping and pipetting methods	45
Figure 3.2	Conducting Focus Group Discussion at a selected intervention school	46
Figure 3.3	Conducting the structured awareness programme at intervention schools	49
Figure 3.4	Conducting awareness programmes for the whole school	50
Figure 3.5	Conducting the awareness programme for parents	50
Figure 3.6	Conducting training and awareness programme for Development officers	51
Figure 3.7	Conducting awareness programmes for Environmental Officers of the Central Environmental Authority	52
Figure 3.8	Distributing plant seeding to the intervention schools	59
Figure 3.9	Environmental Pioneers engaging in agricultural activities in the school	59
Figure 4.1	Mosquito breeding habitats predominantly encountered from school premises	73
Figure 4.2	Cumulative knowledge of students on dengue prior to and after the awareness programme	75
Figure 4.3	Percentage of students belonging to different knowledge categories based on the existing knowledge	79

Figure 4.4	Cluster analyses for overall existing knowledge levels	80
Figure 4.5	The dbRDA plot with clustering of schools based on the existing knowledge of students on different aspects of dengue	81
Figure 4.6	Percentage distributions of students into different knowledge categories after the awareness	83
Figure 4.7	Clustering of schools based on the post knowledge of students on different aspects of dengue	84
Figure 4.8	The dbRDA plot with clustering of schools based on the post-knowledge of dengue	85
Figure 4.9	Conducting field surveillance activities with student volunteers in interventional schools	89
Figure 4.10	Conducting <i>Shramadhana</i> programmes at two interventional schools	90
Figure 4.11	Creative work from discarded material practicing the Re-use concept	92
Figure 4.12	Conducting awareness programme for different strata in the school community	93
Figure 4.13	Children's reflection on dengue by creative work	95
Figure 4.14	Environmental management through waste management practices	97
Figure 4.15	Introduction of composting barrels to the intervention schools	98
Figure 4.16	Plant seedlings distributed to the school community for gardening activities	99

Figure 4.17	Removal of clogged roof gutters after the implementing interventions	100
Figure 4.18	Cleaning of blocked drainage systems after implementation of interventions	100
Figure 4.19	Reuse of removed roof gutters after the implementation of interventions	101
Figure 4.20	Reuse of discarded tyres after the implementation of interventions	101
Figure 4.21	Filling the water-retaining spaces in flower pots after the implementation of interventions	102
Figure 4.22	Filling the spaces of bamboo stumps and tree-holes after implementation of interventions	103
Figure 4.23	Rearrangement of roof tiles after the implementation of interventions	104

LIST OF TABLES

Table		Page
Table 3.1	The line of the awareness programme	49
Table 3.2	Activities implemented under 3R concept	57
Table 4.1	Basic information of selected schools	63
Table 4.2	Environmental and demographic characteristics of selected schools	65
Table 4.3	Infrastructure facilities at selected schools	68
Table 4.4	Waste disposal practices in selected schools	69
Table 4.5	Mosquito breeding habitats examined with the percentage positive for <i>Aedes</i> larvae in baseline and follow-up surveys	72
Table 4.6	Entomological Indices at control and interventional schools in each survey	74
Table 4.7	Average mean scores for different knowledge categories and overall knowledge of students on dengue prior to and after the awareness programme	76
Table 4.8	Average mean scores for different knowledge categories and overall knowledge of students on dengue before the awareness programme	77
Table 4.9	Average mean scores for different knowledge categories and overall knowledge of students on dengue	82

Table 4.10	Summarized findings of the entomological surveillance activities conducted at schools	87
Table 4.11	Total numbers of dry, water-holding and infested containers at each entomological survey conducted in control and intervention schools	105
Table 4.12	The mean number of dry, water-holding, and infested containers present in the intervention (IG) and control (CG) groups in the baseline (BL) and first follow-up (1FU) surveys	110
Table 4.13	The mean number of dry, water-holding, and infested containers present in the intervention (IG) and control (CG) groups in the baseline (BL) and second follow-up (2FU) surveys	112
Table 4.14	The mean number of dry, water-holding, and infested containers present in the intervention (IG) and control (CG) groups in the baseline (BL) and third follow-up (3FU) surveys	114

LIST OF APPENDICES

Annexure		Page
Annexure 1	Ethical Clearance of the Faculty of Medicine	232
Annexure 2	Research information sheet	233
Annexure 3	School consent form	236
Annexure 4	Interviewer administered questionnaire	237
Annexure 5	Focus Group Discussion Guide	244
Annexure 6	List of school based interventions introduced to the intervention schools	245
Annexure 7	Letter of acknowledgement: CEA - 1	247
Annexure 8	Letter of acknowledgement: CEA - 2	248

LIST OF ABRIVIATIONS

Abbreviation	Description
<i>Ae.</i>	<i>Aedes</i>
A.D	Anno Domini
ANOSIM	Analysis of Similarities
BL	Base-Line
CEA	Central Environmental Authority
CG	Control Group
CI	Container Index
COMBI	Communication for Behavioral Impact
CSR	Cooperate Social Responsibility
DBRDA	Distance-Based Redundancy Analysis
DF	Dengue Fever
DHF	Dengue Hemorrhagic Fever
DPTF	Dengue Prevention Task Force
EPP	Environmental Pioneer Programme
F	Female
FGD	Focus Group Discussion
FM	Female and Male
FU	Follow-Up
GM	Gampaha
GLM	General Linear Model

Abbreviation	Description
HI	House index
IG	Intervention Group
IS	Intervention School
KAP	Knowledge, Attitudes and Practices
KE	Kelaniya
M	Male
PC	Provincial Council
PHI	Public Health Inspector
PET	Polyethylene Terephthalate
PI	Premise Index
MC	Municipal Council
WCLG	Waste Collected by Local Government
WHO	World Health Organization
1 FU	First Follow-Up
2 FU	Second Follow-Up
3 FU	Third Follow-Up
3R	Reduce, Reuse, Recycle

ACKNOWLEDGEMENTS

First and foremost, I'd like to express my gratitude to Professor W. Abeyewickreme of the Department of Para clinical Sciences, Faculty of Medicine, General Sir John Kotelawala Defence University, for permitting me to pursue my Ph.D. I am grateful to him for his profound knowledge, good advice, and constant encouragement given during the study.

I'd like to acknowledge my co-supervisor Professor K. T. A. A. Kasturiratne of the Department of Public Health, Faculty of Medicine, University of Kelaniya, for her kind guidance and encouragement during the study. Her extensive knowledge helped me to complete this academic work more meaningfully.

I extend my heartiest gratitude to my co-supervisor, Professor.P.A.D.H.Nayana Gunathilaka, Department of Parasitology, Faculty of Medicine, University of Kelaniya for his kind supervision and an endless support throughout the study. His insightful comments, suggestions and encouragement were immensely helpful for me to complete my thesis.

I would be grateful to National Research Council for providing the necessary financial support through NRC TO 14-04 fund. I appreciate and acknowledge for the kind support given by the Authorized officials of NRC.

I'm sincerely grateful to Professor Lal Mervin Dharmasiri, the former Chairman of the CEA, Mr. Muthukudaarachchi, the former Director General of the CEA, Mr. Hemantha Jayasinghe, the present Director General of the CEA for giving their consent to conduct my research. I acknowledge other supportive officers of CEA, specially Ms. Lakmali Kalpage, and Mr. Nalindra Maduwala for supporting me. I'd like to express my gratitude to the National Dengue Control Unit personnel and Finlay's Company for their support.

With many thanks I'd like to remind the Head of the Molecular Medicine Unit, members of academic staff, and members of the non-academic staff for providing the required laboratory facilities and technical assistance during the research. Dr. Asha Dilrukshi, Dr. Lahiru Udayanga, Dr. Tharaka Ranathunga, Mr. Udaya, Mr. Thushara, field assistants and all the other supportive colleagues deserve my sincere gratitude for their support.

I take this opportunity to acknowledge the authorized officials in the Ministry of Education who gave me the permission to conduct this research in the selected schools belonging to the Gampaha district. I extend my acknowledgements to the Principals, teachers, other members of Dengue Prevention Task Force, student groups of the selected schools and Public Health Inspectors for their enthusiastic participation in the execution of the planned interventions. I would like to thank each and every person who assisted me in any way during the research, even though I have not given their names.

I really would like to convey my heartiest gratitude to the examiners of the thesis. I do not forget to thank the authors of the references as well. I appreciate the supportive lecturers of the academic staff and supportive members of the non-academic staff of the Faculty of Medicine. I'd like to extend my thanks to Mr.R.M.Kapila Jayasinghe and other members of Faculty of Graduate studies of the University of Kelaniya for their kind coordination and support.

Despite the numerous challenges I had during my studies, I believe my parents are the driving force behind all of my academic endeavors. I'd be grateful, and I'd like to express my greatest gratitude to my parents for their endless blessings.

ABSTRACT

This study was conducted to determine the effectiveness of school-based interventions to control dengue vectors in the Gampaha District, Sri Lanka. Sixty schools were selected randomly from the school registry in four selected educational zones (15 each) as interventional (Kelaniya and Gampaha) and control (Negombo and Minuwangoda). A baseline and three follow-up entomological surveys were conducted in all selected schools at 6-months intervals during 2016-2018. The intervention consisted an activity plan with entomological field surveys, larval control interventions followed by a structured awareness programme of dengue covering general epidemiology, clinical symptoms, prevention, vector control and waste management. Focus group discussions were conducted with stakeholders at 30 intervention schools to identify limitations in current control approaches. The level of awareness of dengue disease was assessed before and after the awareness programme using a structured questionnaire. Awareness levels were categorized as very poor (< 20%), low (21-40%) moderate (41-60%), good (61-80%) and excellent (> 80%). The change in awareness level was determined using General Linear Model. The effectiveness of the vector control interventions were assessed by the total number of dry, water-holding, and infested containers at follow-up survey compared to the baseline. Over, 46.31% (n=1016) of students had good level of awareness prior to the structured awareness programme and reached to the excellent level (41.84%; n=918) after the awareness programme. The improvement of the awareness level was identified as statistically significant according to the chi-square test of independence. At the base-line survey, *Aedes albopictus* was the predominant species in both control (60%; n=18) and intervention (63.33%; n=19) groups. Leaf axils were the leading breeding habitat followed by discarded plastic and metal containers in the control group. The number of discarded containers was reduced drastically in the interventional schools in the follow-up surveys. There was a statistically significant difference in dry ($p<0.001$), water-holding ($p=0.027$), and infested ($p=0.006$) containers after the last follow-up survey at interventional schools compared to the controls. This study warrants the need of sustainable participation of school community for dengue control. Therefore, strengthening Environmental Pioneer Programme will improve the capacity in dengue control interventions.

Keywords: Dengue, vector breeding, vector control, school-based interventions