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Educational intervention to improve knowledge of healthcare workers in early recognition, diagnosis and management of Rheumatic Fever and Rheumatic Heart Disease in Far-western part of Nepal

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-059942
Article Type:	Original research
Date Submitted by the Author:	08-Dec-2021
Complete List of Authors:	Bhatt, Navin; Nyaya Health Nepal, Bayalpata Hospital Karki, Ashmita; Tribhuvan University Institute of Medicine, Central Department of Public Health Shrestha, Biplav; Nyaya Health Nepal, Bayalpata Hospital Singh, Amul; Nyaya Health Nepal, Bayalpata Hospital Rawal, Lal; HERD International Kumar Sharma, Sanjib; BP Koirala Institute of Health Sciences, Department of Internal Medicine
Keywords:	Valvular heart disease < CARDIOLOGY, EDUCATION & TRAINING (see Medical Education & Training), Cardiology < INTERNAL MEDICINE, Rheumatology < INTERNAL MEDICINE, Community child health < PAEDIATRICS, Paediatric cardiology < PAEDIATRICS

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2 **Educational intervention to improve knowledge of healthcare workers in early recognition,**
3 **diagnosis and management of Rheumatic Fever and Rheumatic Heart Disease in Far-western**
4 **part of Nepal**
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38 Word count: 2587 words
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ABSTRACT

Objectives: Rheumatic Fever (RF) and Rheumatic Heart Disease (RHD) continue to remain as one of the major heart problems among children in Nepal. Although these conditions are preventable and treatable, the lack of proper knowledge and resources to diagnose and manage them in rural health centers has been a major issue. This study assessed the impact of educational sessions to improve the knowledge of healthcare workers in early recognition, diagnosis, and management of RF and RHD in a rural part of Nepal.

Design, setting, and participants: This study used a pre- and post-test interventional design conducted among 64 healthcare workers working in two primary health care centers and a peripheral district-level hospital in Achham district located in the Far-western region of Nepal. A self-administered questionnaire was used before and after a teaching session to assess the knowledge of healthcare workers in early recognition, diagnosis, and management of RF and RHD.

Results: The overall test scores increased from 9.9 (SD = 2.4) pre-intervention to 13.7 (SD = 1.9) post-intervention (P-value <0.001). Similarly, their confidence (graded 1 – 5) in differentiating bacterial from viral sore throat rose from 3.6 (SD = 1.08) pre-intervention to 3.98 (SD = 1.09) post-intervention (p-value <0.05). Furthermore, their confidence in managing RF increased from 3.9 (SD = 0.88) pre-intervention to 4.30 (SD = 0.8) post-intervention (P-value <0.001).

Conclusion: The findings of educational sessions are promising in improving the knowledge and confidence of healthcare workers in early detection, diagnosis, and management of RF and RHD at the primary health care level. Further study with a larger sample size in different parts of the country will warrant the effectiveness and relevance of scaling up such educational interventions in the country.

KEYWORDS: Rheumatic Fever, Rheumatic Heart Disease, Healthcare workers, Primary Health Care, Nepal

STRENGTHS AND LIMITATIONS OF THIS STUDY

- Representation of rural Nepal and similar settings in rural Nepal
- A novel study assessing the impact of educational intervention to improve knowledge of health workers in early recognition, diagnosis and management of rheumatic fever and rheumatic heart disease in Nepal
- Conducted in primary health care settings of Far-western Nepal, and hence, it may not be generalizable to the whole country.
- May not be representative of all healthcare workers working in rural areas of Nepal as some participants had regular continuing medical education sessions, whereas some didn't.
- Knowledge gain may or may not translate into practice as a change in practice hasn't been evaluated in this study.

INTRODUCTION

Rheumatic heart disease (RHD) is a chronic heart condition caused as a sequel to Rheumatic fever (RF), which most often begins in childhood as a Streptococcal throat infection [1]. Although RHD is a preventable and treatable form of cardiovascular disease, it accounts for 33.4 million cases with 10.5 million disability-adjusted life-years and 0.3 million deaths globally [2]. RHD is a common problem in developing countries, including Nepal, with prevalence reported to be 0.9 to 1.35 per 1000 school-going children [3]. In the Nepalese population of 27 million, the incidence of RF is estimated to be 15000 per year and the incidence of RHD, 7500 per year [4]. As RHD is attributable to poverty and social inequality, most cases of RHD are concentrated in economically disadvantaged rural communities [5]. Though primary prevention of RF and RHD is ideal for reducing the mortality due to RHD, it is still challenging for countries like Nepal, where underlying risk factors such as overcrowding, poor hygiene, and limited access to health care are still prevalent [6].

In Nepal, the paramedical staff are usually the first contact points for rural population with RF/RHD. Hence, these primary health workers should be equipped with the knowledge and skill to prevent RF/RHD. However, they have limited training and experience in diagnosing and treating RF/RHD cases leading to underdiagnosis of the disease [7]. The government of Nepal (GoN) and the Nepal Heart Foundation (NHF) have taken some initiatives for delivering disease-specific health care while

1
2 developing the national program for control of RF and RHD [4]. NHF has achieved success in developing
3 an RF/RHD registry, training paramedics, publishing recommendations and guidelines, securing a supply
4 of Benzathine Penicillin G (BPG), and working on improving the quality and safety of BPG supplies and
5 piloting primary prophylaxis [4]. However, there is no evidence that those programs have penetrated the
6 rural population of Far-western Nepal. Lack of knowledge and skills to diagnose patients with RF/RHD
7 among the primary healthcare workers is a loss of opportunity to prevent the disease and its progression.
8 Globally, it is evident that interventions such as lectures and training can significantly increase the
9 knowledge and skills of healthcare workers in the prevention and treatment of RHD, which otherwise
10 remains low [8, 9]. The World Health Organization (WHO) has also stressed the importance of
11 conducting education and training programs for all health workers involved in the primary or secondary
12 prevention of RF/RHD [10]. So, our research aimed to study the effectiveness of educational intervention
13 in improving the knowledge of healthcare workers in early recognition, diagnosis and management of
14 RF and RHD in a Far-western district of Nepal.

25 **METHODS:**

26 **Study setting:** The study sites were primary health care facilities of Achham district, a rural hilly district
27 in the Far-western province of Nepal. Two primary health care centers (PHCC): Chaurmandu PHCC and
28 Kamalbazar PHCC, and one district-level hospital (Bayalpata hospital) were selected conveniently.

29 **Study population and sampling:** The study population included healthcare workers working in the
30 primary healthcare settings in Achham district of Nepal. The participants were chosen conveniently and
31 included Health Assistants (HA), Staff Nurse, Auxiliary Nurse Midwife (ANM), and Auxiliary Health
32 Worker (AHW) and Medical Officer (MO). Altogether 64 healthcare workers were enrolled in the study.
33 Of note, the participants of Bayalpata hospital regularly attended Continuing Medical Education (CME)
34 sessions on various topics throughout the year. However, the participants from other sites did not attend
35 such sessions.

36 **Intervention design:** This study involved a pre-test followed by a short educational session, and a post-
37 test conducted with 6 – 12 study participants per session (1 session each in Kamalbazar and Chaurmandu
38 PHCCs and 5 sessions in Bayalpata hospital). The educational sessions lasted approximately an hour
39 each. The educational session was based on the topics (i) introduction to Rheumatic Fever and Rheumatic
40 heart disease; (ii) pathophysiology of RF and RHD; (ii) clinical features and diagnostic criteria; (iv)
41 treatment; and (v) follow-up for RHD treatment and care. The pre- and post-test used the same questions
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2 and assessed the knowledge of clinical presentation, diagnosis, treatment, and primary and secondary
3 prevention of RF and RHD.
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7 **Study tools:** The study tools included pre- and post-test questionnaires and a PowerPoint presentation.
8 Prior to the development of these tools, a range of relevant tools, guidelines, and other published literature
9 were searched and reviewed. After reviewing the literature, a draft questionnaire and a PowerPoint
10 presentation were collaboratively prepared by the authors which were then reviewed by the study team
11 members, subject experts, researchers and policymakers in order to ensure content validity. While
12 developing the tools, greater emphasis was given to the information that was deemed relevant to
13 healthcare workers in rural areas. The questionnaire was pretested among 10 healthcare workers in a
14 primary health care center in a rural setting of Lalitpur district, Nepal. This district is different from the
15 one where the main study was conducted. Necessary edits, and amendments such as simplifying the
16 language, adding a few more questions (such as the prevalence of RF and RHD, the purpose of long-
17 term antibiotic prophylaxis of RF) were added in the final version. A total of 18 objective questions for
18 assessing knowledge and 2 Likert-scale-based questions for assessing confidence were included in the
19 questionnaire. Both the pre- and the post-test questionnaires had the same questions.
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31 **Study variables:** There were two types of variables in this study. One was the frequency counts
32 (categorical variable) of discordant pairs of correct and incorrect answers for each question in a 2 x 2
33 McNemar's table. The other variable was the participants' score (continuous variable; overall score, and
34 the scores for 2 Likert-scale-based responses). The variable range for the overall score was 0 – 18 and
35 the range for the Likert-based questions was 1 – 5.
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41 **Data analysis:** Data analysis was done on Statistical Package for Social Sciences (SPSS) version 21.
42 The descriptive analysis was performed using mean and standard deviation (SD) for continuous variables
43 and percentages for categorical variables. The objective questions had 1 mark each for correct response
44 (a total of 18 marks). The Likert-based questions were graded 1 – 5 for strongly disagree, disagree,
45 neutral, agree, and strongly agree respectively. Knowledge scores were calculated for every participant
46 and the mean knowledge score was calculated both before and after the educational session. The
47 McNemar test was employed to test the differences in marginal frequencies of categorical variables
48 between pre-test and post-test. Paired t-test was used to evaluate pre-post changes in knowledge scores
49 (for continuous data). For all statistical analyses, a P-value of less than 0.05 was considered statistically
50 significant and all tests were two-tailed.
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Ethics approval: An ethical approval of this study was obtained from the Ethical Review Board of the Nepal Health Research Council (#2702). Necessary coordination and communication with the administrative and the medical departments of respective health facilities were done in order to ensure the dissemination of accurate information about the educational sessions. Informed verbal consent was obtained from the participants prior to the data collection.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this study.

RESULTS

General characteristics of the participants:

A total of 64 healthcare workers from 3 health facilities (Bayalpata hospital, Kamalbazar PHCC and Chaurmandu PHCC) were included in the study as shown in **Table 1**.

Table 1: Health centers and total participants

Health centers	Participants (n)	Percent (%)
Bayalpata Hospital	41	64
Kamalbazar PHCC	15	23.5
Chaurmandu PHCC	8	12.5

The mean age of the participants was 27 ± 6.7 years. Among the participants, 50% were males and 50% were females. The mean working experience of the participants was 5.83 ± 4.6 years. As shown in **Table 2**, the majority of the participants (36%) were Auxiliary Health Workers (AHW), followed by Health Assistants (29.7%) and Staff Nurses (18.7%).

Table 2: Characteristics of Participants:

Characteristics	Number	Percent
Sex	Male	50
	Female	50

Age	Mean (SD) years	27 (6.7) years	
Working experience	Mean (SD) years	5.83 (4.6) years	
Designation	Medical Officer	1	1.6
	Staff Nurse	12	18.7
	Health Assistant	19	29.7
	Auxiliary Health Worker (AHW)	23	36
	Auxiliary Nurse Midwife (ANM)	9	14

The participants' responses were tabulated under four main domains: Screening-related, diagnosis-related, management-related and miscellaneous, as shown in **Table 3**.

Table 3: Participants' responses

S.N.	Questions	Number of participants who gave the correct answers (N=64)		P-value
		Pre-test	Post-test	
Screening-related				
1	Most common cause of murmur in adolescents	60 (94%)	55 (86%)	0.13
2	Most common age for RF	52 (81%)	64 (100%)	0.001
3	Most common presentation of RF	50 (78%)	58 (91%)	0.04
4	Most likely cause of a sore throat	16 (25%)	16 (25%)	0.83
5	Not a feature of bacterial sore throat	43 (67%)	62 (97%)	< 0.001
6	Prevalence of RF/RHD	26 (41%)	55 (86%)	< 0.001
Diagnosis-related				
7	Natural history of RF	30 (47%)	51 (80%)	< 0.001
8	Confirmatory test for RF	7 (11%)	5 (8%)	0.69
9	RF patient with dancing movement	44 (69%)	60 (94%)	< 0.001
10	Complication of RF	8 (13%)	33 (52%)	< 0.001
Management-related				
11	Prevention of RF/RHD	58 (91%)	61 (95%)	0.51
12	Preferred antibiotic to treat GAS	22 (34%)	49 (77%)	< 0.001

13	Preferred antibiotic for prophylaxis of RF	49 (77%)	51 (80%)	0.75
14	Prophylaxis against RF prevents progression of	17 (27%)	40 (63%)	< 0.001
15	Serious adverse effect of penicillin	39 (61%)	57 (89%)	< 0.001
16	Drug of choice in penicillin-allergic patients	44 (69%)	56 (88%)	0.01
17	Prevention of anaphylaxis due to BPG	54 (84%)	62 (97%)	0.04
Miscellaneous				
18	Etiopathologic nature of RF	20 (31%)	47 (73%)	< 0.001
19	Confidence in differentiating bacterial from viral sore throat clinically	41 (64%)	59 (92%)	
20	Confidence in recognizing, evaluating and managing a case of RF/RHD	43 (67%)	60 (94%)	

Significant at P-value <0.05

Table 4 summarizes the change in overall knowledge and confidence of the participants before and after the teaching session. When asked about the most likely cause of murmur in a hypothetical situation of a 16-year-old male with shortness of breath on exertion, most of the health workers correctly identified Rheumatic Heart Disease (94% vs 86% on pre-test and post-test respectively) from the options given (Congenital heart disease, Rheumatic heart disease, Iron deficiency anemia and Endocarditis). Eighty-one percent of the participants knew that the most common age of getting RF and RHD is 5 to 15 years. After the session, all the participants knew about it. Fever and joint pain were correctly marked as the most common presentation of RF by the majority of the participants, both during the pre-test (78%) and post-test (91%). About 41% of the study participants correctly specified that the prevalence of RF/RHD is more common in low-income countries whereas, after the teaching session, this proportion increased to 86%.

Table 4: Changes in overall knowledge and confidence in managing RF and RHD using Paired T-test

Variables	Pre-test Mean (SD)	Post-test Mean (SD)	P-value
Overall knowledge	9.98(2.4)	13.78(1.9)	<0.001
Confidence in identifying sore throat etiology	3.66(1.08)	3.98(1.09)	0.01
Confidence in recognizing, evaluating, and managing RF	3.91(0.88)	4.30(0.84)	<0.001

Significant at P-value <0.05

The proportion of the health personnel who knew that RHD is a sequela of RF and many, but not all develop RHD after RF increased from 47% to 80% post-session. While less than half of the study participants incorrectly selected ASO titer as the confirmatory test for RF before the teaching session, this proportion increased to 72% post-session. Only about 11% pre-session and 8% post-session correctly identified that none of the given options were the confirmatory test for RF. While 13% correctly identified cardiac valve damage as a feared complication of RF, this proportion increased to 52% post session.

About 90% of the participants correctly reported that early recognition and management of streptococcal sore throat could prevent rheumatic fever (RF) and rheumatic heart disease (RHD), which increased by 5% after the teaching session. Almost half of the participants answered that the preferred antibiotic for treating Group A *Streptococcus* (GAS) was Amoxicillin. However, after the teaching session, more than three-quarters of them correctly identified that Benzathine penicillin G is instead, the preferred choice. About 61% of the participants were aware that anaphylaxis is the serious adverse effect of penicillin. The proportion increased to 89% after the teaching session.

About 69% of the participants correctly answered that the drug of choice for Rheumatic fever prophylaxis in Penicillin allergic patients is Erythromycin whereas, after the session, the percentage rose to 88%. Around 64% of the participants were confident in differentiating bacterial from viral sore throat clinically pre-session, which increased to 92% post-session. Similarly, while 67% of the healthcare workers were confident in recognizing, evaluating, and managing a case of RF before the teaching session, this proportion increased to 94% after the teaching session.

DISCUSSION

The findings of this study indicate that primary healthcare professionals had an average level of understanding on early recognition, diagnosis, and management of rheumatic fever and rheumatic heart disease, which improved significantly after an education intervention. The results create an opportunity to continue refining approaches to health education interventions for primary health workers, in order to ensure their increased knowledge and confidence in the early management of RF/RHD cases.

Screening of RF:

The health workers had a good knowledge of the common age for getting RF/RHD and its most common presentation as fever and joint pain. However, even after the teaching session, most of the healthcare workers believed that the most likely cause of sore throat is a bacterial infection, instead of viral. The fact that the teaching session emphasized differentiating bacterial from the viral sore throat rather than specifically on the most common cause of sore throat could explain this result. We need to emphasize that sore throat is mostly caused by viruses and that learning to differentiate between a viral and a bacterial sore throat is very important in minimizing the misuse of antibiotics. Similar findings were shown by a study done in Tanzania [11]. Before the session, most of the health professionals were unaware that RF/RHD is mostly prevalent in low-income countries. By the end of the session, more than 85% of them knew that most people suffering from RF/RHD live in low-income countries, which is a fact stated by WHO [12].

Diagnosis of RF/RHD:

The majority of the participants incorrectly identified ASO titer as the confirmatory test for RF. Ironically, this proportion increased after the teaching session. As we know, RF is a clinical diagnosis based on Jones' criteria and the ASO titer merely serves as supporting evidence [13]. It is actually a difficult question and to answer this correctly, one needs to have good background knowledge of RF. The short duration of the teaching session was sufficient to provide a brief introduction to the ASO titer but insufficient to convey the finer details. So, there might have been a response bias leading to more participants selecting the option containing 'ASO titer'.

Management of RF/RHD:

The knowledge on preferred antibiotics for treating Group A *Streptococcus* (GAS) improved significantly after the session. The participants' awareness about the second drug of choice when there is hypersensitivity to benzathine penicillin was good and increased substantially after the sessions. Based on our pretest questionnaires, we found that about 60% of the health professionals knew that anaphylaxis is a serious adverse effect of Penicillin. By the end of the session, the percentage rose significantly to 90%, hence suggesting the effectiveness and need for similar teaching sessions. Similar findings were shown by a study conducted in Malawi [14]. However, the increase in knowledge about the risk of severe adverse effects may discourage clinicians with less experience from providing a very effective medicine. To address this, we emphasized, in our teaching session, that anaphylaxis is rare and that the benefits far

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2 out-weighs the risks [15]. We also included ways to safely administer Benzathine penicillin injection and
3 management of anaphylaxis in our teaching session.
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7 In this study, the mean knowledge score of the health care workers significantly improved from 9.9 to
8 13.6 post-session. Our findings suggested that an educational intervention on RF/RHD can increase the
9 knowledge of healthcare workers, corroborating the findings of a study done in a similar lower-middle
10 income setting [9]. Similarly, teaching sessions like this are found to boost the confidence of health
11 service workers in differentiating bacterial and viral sore throat [16] and in proper diagnosis, evaluation,
12 and management of RF cases [14, 17]. The findings of this study have implications for policy, practice
13 and further research and support the evidence that educational interventions have a significant effect on
14 raising knowledge among health care workers in early recognition, diagnosis and management of RF and
15 RHD in primary healthcare settings. Conducting educational interventions with teaching modules
16 focusing on these components is imperative to curb the RF/RHD prevalence in a developing country like
17 Nepal [18].
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28 Our study had certain limitations. It was conducted in primary health care settings of Far-western Nepal,
29 and hence, it may not be generalizable to the whole country. Also, the participants from Bayalpata
30 hospital have regular CME sessions on various health-related topics, which is not common in other
31 healthcare facilities, and so, they may not be representative of all healthcare workers working in rural
32 areas. Similarly, knowledge gain may or may not translate into practice as a change in practice hasn't
33 been evaluated in this study. Further studies that assess the change in the practice of healthcare workers
34 in RF/RHD management after receiving an educational intervention are recommended.
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41 **CONCLUSIONS**

42 We conclude that the educational intervention implemented among the healthcare workers of the Far-
43 western part of Nepal improved their overall knowledge in terms of early recognition, diagnosis and
44 management of Rheumatic Fever and Rheumatic Heart Disease. These findings are promising to
45 introduce, institutionalize and strengthen the continuous professional development programs for
46 healthcare workers, especially focused on RF and RHD prevention and control at the primary care level.
47 Further, studies with larger sample size in different parts of the country are likely to help us better
48 understand the need for similar interventions in the country.
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56 **ACKNOWLEDGMENTS**

We would like to extend our sincere thanks to Dr. Preeti Bhatt and Dr. Sagar Khadka for their immense help during data collection. I would also like to thank Dr. Jeevan Thapa and Mr. Shiva Raj Mishra for their valuable support in statistical analysis.

FUNDING

This study was funded by the Nepal Health Research Council (Provincial Health Research Grant 2020, reference number 1584)

AUTHOR CONTRIBUTIONS

NB and AK shared equal contribution to the work and lead authorship of the study. NB and AK conceptualized the study and developed the study design upon consultation with BS, AS and SKS. BS and AS performed the data collection and data analysis. AK and NB wrote the first draft of the paper. BS, AS, SKS and LR contributed to further drafts.

COMPETING INTERESTS

None declared

PATIENT CONSENT FOR PUBLICATION

Not required

DATA AVAILABILITY STATEMENT

No additional data are available

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Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

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Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

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			Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	3, 4
Objectives	#3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	#4	Present key elements of study design early in the paper	4
Setting	#5	Describe the setting, locations, and relevant dates, including periods of	4

		recruitment, exposure, follow-up, and data collection	
1			
2	Eligibility criteria	#6a Give the eligibility criteria, and the sources and methods of selection of	4
3		participants.	
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6		#7 Clearly define all outcomes, exposures, predictors, potential	5
7		confounders, and effect modifiers. Give diagnostic criteria, if applicable	
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9			
10	Data sources /	#8 For each variable of interest give sources of data and details of methods	5
11	measurement	of assessment (measurement). Describe comparability of assessment	
12		methods if there is more than one group. Give information separately	
13		for for exposed and unexposed groups if applicable.	
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17	Bias	#9 Describe any efforts to address potential sources of bias	5
18			
19	Study size	#10 Explain how the study size was arrived at	4
20			
21	Quantitative	#11 Explain how quantitative variables were handled in the analyses. If	5
22	variables	applicable, describe which groupings were chosen, and why	
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25	Statistical	#12a Describe all statistical methods, including those used to control for	5
26	methods	confounding	
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29	Statistical	#12b Describe any methods used to examine subgroups and interactions	5
30	methods		
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32			
33	Statistical	#12c Explain how missing data were addressed	N/A
34	methods		
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37	Statistical	#12d If applicable, describe analytical methods taking account of sampling	N/A
38	methods	strategy	
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41	Statistical	#12e Describe any sensitivity analyses	N/A
42	methods		
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45	Results		
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47	Participants	#13a Report numbers of individuals at each stage of study—eg numbers	6
48		potentially eligible, examined for eligibility, confirmed eligible,	
49		included in the study, completing follow-up, and analysed. Give	
50		information separately for for exposed and unexposed groups if	
51		applicable.	
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55	Participants	#13b Give reasons for non-participation at each stage	N/A
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57	Participants	#13c Consider use of a flow diagram	6
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1	Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	6
2				
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6	Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	N/A
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10	Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	7
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14	Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
15				
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19	Main results	#16b	Report category boundaries when continuous variables were categorized	N/A
20				
21	Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
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25	Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	N/A
26				
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29	Discussion			
30				
31	Key results	#18	Summarise key results with reference to study objectives	10, 11
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34	Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	12
35				
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39	Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	10, 11
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44	Generalisability	#21	Discuss the generalisability (external validity) of the study results	12
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47	Other			
48	Information			
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51	Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12
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BMJ Open

Effectiveness of an educational intervention in improving healthcare workers' knowledge of early recognition, diagnosis and management of rheumatic fever and rheumatic heart disease in rural far-western Nepal: a pre-post intervention study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-059942.R1
Article Type:	Original research
Date Submitted by the Author:	21-Feb-2022
Complete List of Authors:	Bhatt, Navin; Nyaya Health Nepal, Bayalpata Hospital; Tribhuvan University Teaching Hospital, Institute of Medicine Karki, Ashmita; Tribhuvan University Institute of Medicine, Central Department of Public Health Shrestha, Biplav; Nyaya Health Nepal, Bayalpata Hospital Singh, Amul; Nyaya Health Nepal, Bayalpata Hospital Rawal, Lal; HERD International Kumar Sharma, Sanjib; BP Koirala Institute of Health Sciences, Department of Internal Medicine
Primary Subject Heading:	Public health
Secondary Subject Heading:	Cardiovascular medicine, Paediatrics
Keywords:	Valvular heart disease < CARDIOLOGY, EDUCATION & TRAINING (see Medical Education & Training), Cardiology < INTERNAL MEDICINE, Rheumatology < INTERNAL MEDICINE, Community child health < PAEDIATRICS, Paediatric cardiology < PAEDIATRICS

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2 1 **Effectiveness of an educational intervention in improving healthcare workers' knowledge of early**
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4 2 **recognition, diagnosis and management of rheumatic fever and rheumatic heart disease in rural**
5 3 **far-western Nepal: a pre-post intervention study**
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9 5 Navin Bhatt^{1, 2*}, Ashmita Karki^{3*}, Biplav Shrestha¹, Amul Singh¹, Lal Rawal⁴, Sanjib Kumar Sharma⁵
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ABSTRACT

Objectives: Rheumatic Fever (RF) and Rheumatic Heart Disease (RHD) continue to remain one of the major heart problems among children in Nepal. Although these conditions are preventable and treatable, the lack of proper knowledge and resources to diagnose and manage these conditions in rural health centers has been a major issue. This study assessed the impact of educational sessions to improve the knowledge of healthcare workers in early recognition, diagnosis, and management of RF and RHD in rural far-western Nepal.

Design, setting, and participants: This study used a pre- and post-test interventional design conducted among 64 healthcare workers in two primary health care centers and a peripheral district-level hospital in Achham district, located in the Far-western region of Nepal. A self-administered questionnaire was used before and after the educational sessions. Data were analyzed using SPSS version 21.

Results: The overall test scores increased from 10 (SD = 2.4) pre-intervention to 13.8 (SD = 1.9) post-intervention (P-value <0.001). Similarly, their confidence (graded 1 – 5) in differentiating bacterial from viral sore throat rose from 3.6 (SD = 1.08) pre-intervention to 3.98 (SD = 1.09) post-intervention (P-value <0.05). Furthermore, their confidence in managing RF increased from 3.9 (SD = 0.88) pre-intervention to 4.30 (SD = 0.8) post-intervention (P-value <0.001).

Conclusion: The findings of educational sessions are promising in improving the knowledge and confidence of healthcare workers in early recognition, diagnosis, and management of RF and RHD at the primary health care level. Further studies with a larger sample size and conducted in different parts of the country will warrant the effectiveness and relevance of scaling up such educational interventions in the country.

KEYWORDS: Rheumatic Fever, Rheumatic Heart Disease, Healthcare workers, Primary Health Care, Nepal

STRENGTHS AND LIMITATIONS OF THIS STUDY

- Representation of rural Nepal and similar settings
- A novel study assessing the impact of an educational intervention to improve knowledge of health workers in early recognition, diagnosis and management of rheumatic fever and rheumatic heart disease in Nepal
- May not be representative of all healthcare workers working in rural areas of Nepal as some participants had regular continuing medical education sessions, whereas some didn't.
- A control group was not included in the study which might have biased our interpretation of the results as some improvement in knowledge might have occurred just by being in an RHD research environment.
- Assessing the sustained effect of educational sessions by conducting a late post-test was out of the scope of this study.

INTRODUCTION

Rheumatic heart disease (RHD) is a chronic heart condition caused as a sequel to Rheumatic fever (RF), which most often begins in childhood as a group A β -hemolytic streptococcal (GAS) throat infection [1]. Although RHD is a preventable and treatable form of cardiovascular disease, it accounts for 33.4 million cases with 10.5 million disability-adjusted life-years and 0.3 million deaths globally [2]. RHD is a common problem in developing countries, including Nepal, with prevalence reported to be 0.9 to 1.35 per 1000 school-going children [3]. However, globalization and migratory flows have contributed to the resurgence of RF worldwide [4,5]. In the Nepalese population of 27 million, the incidence of RF is estimated to be 15000 per year and the incidence of RHD, 7500 per year [6]. As RHD is attributable to poverty and social inequality, most cases of RHD are concentrated in economically disadvantaged rural communities [7]. Though primary prevention of RF and RHD is ideal for reducing the mortality due to RHD, it is still challenging for countries like Nepal, where underlying risk factors such as overcrowding, poor hygiene, and limited access to health care are still prevalent [8].

In Nepal, the paramedical staff are usually the first contact points for a rural population with RF/RHD. Hence, these primary health workers should be equipped with the knowledge and skill to prevent

1
2 89 RF/RHD. However, they have limited training and experience in diagnosing and treating RF/RHD cases
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4 90 leading to underdiagnosis of the disease [9]. The government of Nepal (GoN) and the Nepal Heart
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6 91 Foundation (NHF) have taken some initiatives for delivering disease-specific health care while
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8 92 developing the national program for control of RF and RHD [6]. NHF has achieved success in developing
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10 93 an RF/RHD registry, training paramedics, publishing recommendations and guidelines, securing a supply
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12 94 of Benzathine Penicillin G (BPG), and working on improving the quality and safety of BPG supplies and
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14 95 piloting primary prophylaxis [6]. However, there is no evidence that those programs have penetrated the
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16 96 rural population of Far-western Nepal. Lack of knowledge and skills to diagnose patients with RF/RHD
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18 97 among the primary healthcare workers is a loss of opportunity to prevent the disease and its progression.
19
20 98 Globally, it is evident that interventions such as lectures and training can significantly increase the
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22 99 knowledge and skills of healthcare workers in the prevention and treatment of RHD, which otherwise
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24 100 remains low [10,11]. The World Health Organization (WHO) has also stressed the importance of
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26 101 conducting education and training programs for all health workers involved in the primary or secondary
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28 102 prevention of RF/RHD [12]. So, our research aimed to study the effectiveness of an educational
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30 103 intervention in improving the knowledge of healthcare workers working in healthcare facilities in rural
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32 104 settings in early recognition, diagnosis and management of RF and RHD in a Far-western district of
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34 105 Nepal.

33 107 **METHODS:**

34
35 108 **Study setting:** The study sites were primary health care facilities of Achham district, a rural hilly district
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37 109 in the Far-western province of Nepal. Two primary health care centers (PHCC): Chaurmandu PHCC and
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39 110 Kamalbazar PHCC, and one district-level hospital (Bayalpata hospital) were selected conveniently.

40 111
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42 112 **Study population and sampling:** The study population included healthcare workers working in the
43
44 113 primary healthcare settings in Achham district of Nepal. The participants were chosen conveniently and
45
46 114 included Health Assistants (HA), Staff Nurse, Auxiliary Nurse Midwife (ANM), and Auxiliary Health
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48 115 Worker (AHW) and Medical Officer (MO). Altogether 64 healthcare workers were enrolled in the study.
49
50 116 Of note, the participants of Bayalpata hospital regularly attended Continuing Medical Education (CME)
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52 117 sessions on various topics throughout the year. However, the participants from other sites did not attend
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54 118 such sessions.

55
56 120 **Intervention design:** This study involved a pre-test followed by an educational session, and a post-test
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58 121 conducted with 6 – 12 study participants per session. A total of 7 sessions, 1 each in Kamalbazar and
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1
2 122 Chaurmandu PHCCs and 5 sessions in Bayalpata hospital, were conducted. The educational session was
3
4 123 an hour-long interactive session facilitated by a trained doctor using a conventional PowerPoint
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6 124 presentation. It was based on the topics: (i) introduction to rheumatic fever and rheumatic heart disease;
7 125 (ii) pathophysiology of RF and RHD; (ii) clinical features and diagnostic criteria; (iv) prevention and
8
9 126 treatment; and (v) follow-up for RHD treatment and care. The educational intervention included practical
10
11 127 information relevant to rural healthcare settings to enable healthcare workers in healthcare facilities to
12 128 identify symptoms related to RF/RHD so that they could initiate appropriate treatment by themselves
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14 129 and refer to a nearby tertiary care center. The training material also contained information to help
15
16 130 healthcare workers use appropriate antibiotics to treat bacterial sore throat and to facilitate ongoing
17
18 131 secondary prophylaxis of RHD. The pre- and post-tests used the same questions and assessed the
19 132 knowledge of clinical presentation, diagnosis, treatment, and primary and secondary prevention of RF
20
21 133 and RHD.

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23 134
24 135 **Study tools:** The study tools included pre- and post-test questionnaires and a PowerPoint presentation.
25
26 136 Prior to the development of these tools, a range of relevant tools, guidelines, and other published literature
27
28 137 were searched and reviewed. After reviewing the literature, a draft questionnaire and a PowerPoint
29
30 138 presentation were collaboratively prepared by the authors which were then reviewed by the study team
31 139 members, subject experts, researchers and policymakers in order to ensure content validity. While
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33 140 developing the tools, greater emphasis was given to the information that was deemed relevant to
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35 141 healthcare workers in rural areas. For the questionnaire, we selected practical and frequently encountered
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37 142 questions based on our collective experiences working on RF/RHD in rural areas. The questionnaire was
38 143 pretested among 10 healthcare workers in a primary health care center in a rural setting of Lalitpur
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40 144 district, Nepal. This district is different from the one where the main study was conducted. Necessary
41
42 145 edits, and amendments such as simplifying the language, adding the Nepali translation of the
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44 146 questionnaire, adding a few more questions (such as the prevalence of RF and RHD, the purpose of long-
45 147 term antibiotic prophylaxis of RF) were done in the final version. A total of 18 objective questions for
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47 148 assessing knowledge and 2 Likert-scale-based questions for assessing confidence were included in the
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49 149 questionnaire. Both the pre- and the post-test questionnaires had the same questions.

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51 150
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54 151 **Sample size and power:** For sample size estimation, a previous study [11] was considered where the
55
56 152 overall knowledge of 87 participants regarding prevention of RF/RHD increased from about 54% before

1
2 153 the lecture to about 92% after the lecture (rough estimates derived by averaging the values in figures 1,
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4 154 2 and 3 in the article). Using this effect size and assuming no correlation between the pre-lecture and
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6 155 post-lecture observations, a sample size of 26 was obtained from a sample size calculator [13] with a
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8 156 power of 80% for a two-tailed test with 95% significance. To allow for differences in study settings
9
10 157 (tertiary vs primary level care) and study participants (specialists vs mid-level healthcare workers), the
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12 158 target sample size was doubled to 52. More participants were invited than our subjects. The power of this
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14 159 study was estimated to be greater than 80% at a 95% significance level.
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18 161 **Study variables:** There were two types of variables in this study. One was the frequency counts
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20 162 (categorical variable) of discordant pairs of correct and incorrect answers for each question in a 2 x 2
21
22 163 McNemar's table. The other variable was the participants' score (continuous variable; overall score, and
23
24 164 the scores for 2 Likert-scale-based responses). The variable range for the overall score was 0 – 18 and
25
26 165 the range for the Likert-based questions was 1 – 5. Our primary end-point was a change in the
27
28 166 participants' overall score (out of 18) before and after the educational intervention.
29

30 168 **Data analysis:** Data analysis was done on Statistical Package for Social Sciences (SPSS) version 21.
31
32 169 The descriptive analysis was performed using mean and standard deviation (SD) for continuous variables
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34 170 and percentages for categorical variables. The objective questions had 1 mark each for correct response
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36 171 (a total of 18 marks). The Likert-based questions were graded 1 – 5 for strongly disagree, disagree,
37
38 172 neutral, agree, and strongly agree respectively. Knowledge scores were calculated for every participant
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40 173 and the mean knowledge score was calculated both before and after the educational session. The
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42 174 McNemar test was employed to test the differences in marginal frequencies of categorical variables
43
44 175 between pre-test and post-test. Paired t-test was used to evaluate pre-post changes in knowledge scores
45
46 176 (for continuous data). For all statistical analyses, a P-value of less than 0.05 was considered statistically
47
48 177 significant and all tests were two-tailed.
49

50 179 **Ethics approval:** An ethical approval of this study was obtained from the Ethical Review Board of the
51
52 180 Nepal Health Research Council (#2702). Necessary coordination and communication with the
53
54 181 administrative and the medical departments of respective health facilities were done in order to ensure
55
56 182 the dissemination of accurate information about the educational sessions. Informed verbal consent was
57
58 183 obtained from the participants prior to the data collection.
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60

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this study.

RESULTS

General characteristics of the participants:

A total of 64 healthcare workers from 3 health facilities (Bayalpata hospital, Kamalbazar PHCC and Chaurmandu PHCC) were included in the study as shown in **Table 1**.

Table 1: Health centers and total participants

Health centers	Participants (n)	Percent (%)
Bayalpata Hospital	41	64
Kamalbazar PHCC	15	23.5
Chaurmandu PHCC	8	12.5

The mean age of the participants was 27 ± 6.7 years. Among the participants, 50% were males and 50% were females. The mean working experience of the participants was 5.83 ± 4.6 years. As shown in **Table 2**, the majority of the participants (36%) were Auxiliary Health Workers (AHW), followed by Health Assistants (29.7%) and Staff Nurses (18.7%).

Table 2: Characteristics of Participants:

Characteristics		Number	Percent
Sex	Male	32	50
	Female	32	50
Age	Mean (SD) years	27 (6.7) years	
Working experience	Mean (SD) years	5.83 (4.6) years	
Designation	Medical Officer	1	1.6
	Staff Nurse	12	18.7
	Health Assistant	19	29.7
	Auxiliary Health Worker (AHW)	23	36

	Auxiliary Nurse Midwife (ANM)	9	14
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The participants' responses were tabulated under four main domains: Screening-related, diagnosis-related, management-related and miscellaneous, as shown in **Table 3**.

Table 3: Participants' responses

S.N.	Questions	Number of participants who gave the correct answers (N=64)		P-value
		Pre-test	Post-test	
Screening-related				
1	Most common cause of murmur in adolescents	60 (94%)	55 (86%)	0.13
2	Most common age for RF	52 (81%)	64 (100%)	0.001
3	Most common presentation of RF	50 (78%)	58 (91%)	0.04
4	Most likely cause of a sore throat	16 (25%)	16 (25%)	0.83
5	Not a feature of bacterial sore throat	43 (67%)	62 (97%)	< 0.001
6	Prevalence of RF/RHD	26 (41%)	55 (86%)	< 0.001
Diagnosis-related				
7	Natural history of RF	30 (47%)	51 (80%)	< 0.001
8	Confirmatory test for RF	7 (11%)	5 (8%)	0.69
9	RF patient with dancing movement	44 (69%)	60 (94%)	< 0.001
10	Complication of RF	8 (13%)	33 (52%)	< 0.001
Management-related				
11	Prevention of RF/RHD	58 (91%)	61 (95%)	0.51
12	Preferred antibiotic to treat GAS	22 (34%)	49 (77%)	< 0.001
13	Preferred antibiotic for prophylaxis of RF	49 (77%)	51 (80%)	0.75
14	Prophylaxis against RF prevents progression of	17 (27%)	40 (63%)	< 0.001
15	Serious adverse effect of penicillin	39 (61%)	57 (89%)	< 0.001
16	Drug of choice in penicillin-allergic patients	44 (69%)	56 (88%)	0.01
17	Prevention of anaphylaxis due to BPG	54 (84%)	62 (97%)	0.04
Miscellaneous				

18	Etiopathologic nature of RF	20 (31%)	47 (73%)	< 0.001
19	Confidence in differentiating bacterial from viral sore throat clinically	41 (64%)	59 (92%)	
20	Confidence in recognizing, evaluating and managing a case of RF/RHD	43 (67%)	60 (94%)	

Significant at P-value <0.05

Table 4 summarizes the change in overall knowledge and confidence of the participants before and after the teaching session. As shown in Figure 1, the overall mean knowledge score improved from about 10 (out of 18) in the pre-test to about 13.8 in the post-test, an improvement of 38% ($p < 0.001$). When asked about the most likely cause of murmur in a hypothetical situation of a 16-year-old male with shortness of breath on exertion, most of the health workers correctly identified Rheumatic Heart Disease (94% vs 86% on pre-test and post-test respectively) from the options given (Congenital heart disease, Rheumatic heart disease, Iron deficiency anemia and Endocarditis). Eighty-one percent of the participants knew that the most common age of getting RF and RHD is 5 to 15 years. After the session, all the participants knew about it. Fever and joint pain were correctly marked as the most common presentation of RF by the majority of the participants, both during the pre-test (78%) and post-test (91%). About 41% of the study participants correctly specified that the prevalence of RF/RHD is more common in low-income countries whereas, after the teaching session, this proportion increased to 86%.

Table 4: Changes in overall knowledge and confidence in managing RF and RHD using Paired T-test

Variables	Pre-test	Post-test	P-value
	Mean (SD)	Mean (SD)	
Overall knowledge	9.98(2.4)	13.78(1.9)	<0.001
Confidence in identifying sore throat etiology	3.66(1.08)	3.98(1.09)	0.01
Confidence in recognizing, evaluating, and managing RF	3.91(0.88)	4.30(0.84)	<0.001

Significant at P-value <0.05

The proportion of the health personnel who knew that RHD is a sequela of RF and many, but not all develop RHD after RF increased from 47% to 80% post-session. While less than half of the study participants incorrectly selected ASO titer as the confirmatory test for RF before the teaching session,

1
2 231 this proportion increased to 72% post-session. Only about 11% pre-session and 8% post-session correctly
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4 232 identified that none of the given options were the confirmatory test for RF. While 13% correctly
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6 233 identified cardiac valve damage as a feared complication of RF, this proportion increased to 52% post-
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8 234 session.

9 235
10
11 236 About 90% of the participants correctly reported that early recognition and management of streptococcal
12
13 237 sore throat could prevent rheumatic fever (RF) and rheumatic heart disease (RHD), which increased by
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15 238 5% after the teaching session. Almost half of the participants answered that the preferred antibiotic for
16
17 239 treating Group A *Streptococcus* (GAS) was Amoxicillin. However, after the teaching session, more than
18
19 240 three-quarters of them correctly identified that Benzathine penicillin G is instead, the preferred choice.
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21 241 About 61% of the participants were aware that anaphylaxis is the serious adverse effect of penicillin. The
22
23 242 proportion increased to 89% after the teaching session.

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25 244 About 69% of the participants correctly answered that the drug of choice for Rheumatic fever prophylaxis
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27 245 in Penicillin allergic patients is Erythromycin whereas, after the session, the percentage rose to 88%.
28
29 246 Around 64% of the participants were confident in differentiating bacterial from viral sore throat clinically
30
31 247 pre-session, which increased to 92% post-session. Similarly, while 67% of the healthcare workers were
32
33 248 confident in recognizing, evaluating, and managing a case of RF before the teaching session, this
34
35 249 proportion increased to 94% after the teaching session.

36 250 37 251 38 252 **DISCUSSION**

39
40 253 The findings of this study indicate that primary healthcare professionals had an average level of
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42 254 understanding on early recognition, diagnosis, and management of rheumatic fever and rheumatic heart
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44 255 disease, which improved significantly after an education intervention. The results create an opportunity
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46 256 to continue refining approaches to health education interventions for primary health workers, in order to
47
48 257 ensure their increased knowledge and confidence in the early management of RF/RHD cases.

48 258 49 50 259 **Screening of RF:**

51
52 260 The health workers had a good knowledge of the common age for getting RF/RHD and its most common
53
54 261 presentation as fever and joint pain. However, even after the teaching session, most of the healthcare
55
56 262 workers believed that the most likely cause of sore throat is a bacterial infection, instead of viral. The
57
58 263 fact that the teaching session emphasized differentiating bacterial from the viral sore throat rather than

1
2 264 specifically on the most common cause of sore throat could explain this result. We need to emphasize
3
4 265 that sore throat is mostly caused by viruses and that learning to differentiate between a viral and a
5
6 266 bacterial sore throat is very important in minimizing the misuse of antibiotics. Similar findings were
7
8 267 shown by a study done in Tanzania [14]. Before the session, most of the health professionals were
9
10 268 unaware that RF/RHD is mostly prevalent in low-income countries. By the end of the session, more than
11
12 269 85% of them knew that most people suffering from RF/RHD live in low-income countries, which is a
13
14 270 fact stated by WHO [15].
15

16 272 **Diagnosis of RF/RHD:**

17
18 273 The majority of the participants incorrectly identified ASO titer as the confirmatory test for RF.
19
20 274 Ironically, this proportion increased after the teaching session. As we know, RF is a clinical diagnosis
21
22 275 based on Jones' criteria and there is no single test to diagnose RF. Positive GAS culture and rising ASO
23
24 276 titer serve as evidence of recent GAS infection, which is an essential criterion in the Jones' criteria [16]
25
26 277 but is not diagnostic of RF per se. It is actually a difficult question and to answer this correctly, one needs
27
28 278 to have a good understanding of RF. The short duration of the teaching session was sufficient to provide
29
30 279 a brief introduction to ASO titer but insufficient to adequately convey its role in the diagnosis of RF. So,
31
32 280 there might have been a response bias leading to more participants selecting the option containing 'ASO
33
34 281 titer'.
35

36 283 **Management of RF/RHD:**

37 284 The knowledge on preferred antibiotics for treating Group A *Streptococcus* (GAS) improved
38
39 285 significantly after the session. A single dose of Benzathine Penicillin G is preferred to oral penicillin or
40
41 286 amoxicillin (which have to be given for 10 days) to ensure compliance. Moreover, different studies have
42
43 287 shown that intramuscular penicillin reduced rheumatic fever recurrence and streptococcal throat
44
45 288 infections compared to oral penicillin [17]. The participants' awareness about the second drug of choice
46
47 289 when there is hypersensitivity to benzathine penicillin was good and increased substantially after the
48
49 290 sessions. Based on our pretest questionnaires, we found that about 60% of the health professionals knew
50
51 291 that anaphylaxis is a serious adverse effect of Penicillin. By the end of the session, the percentage rose
52
53 292 significantly to 90%, hence suggesting the effectiveness and need for similar teaching sessions. Similar
54
55 293 findings were shown by a study conducted in Malawi [18]. However, the increase in knowledge about
56
57 294 the risk of severe adverse effects may discourage clinicians with less experience from providing a very
58
59 295 effective medicine. To address this, we emphasized, in our teaching session, that anaphylaxis is rare and
60

1
2 296 that the benefits far out-weighs the risks [19]. We also included ways to safely administer Benzathine
3
4 297 penicillin injection and management of anaphylaxis in our teaching session.

5 298
6
7 299 In this study, the mean knowledge score of the health care workers significantly improved from 10 to
8
9 300 13.8 post-session. Our findings suggested that an educational intervention on RF/RHD can increase the
10
11 301 knowledge of healthcare workers, corroborating the findings of a study done in a similar lower-middle
12 302 income setting [11]. Similarly, teaching sessions like this are found to boost the confidence of health
13
14 303 service workers in differentiating bacterial and viral sore throats [20] and in proper diagnosis, evaluation,
15
16 304 and management of RF cases [18,21]. The findings of this study have implications for policy, practice
17
18 305 and further research and support the evidence that educational interventions have a significant effect on
19 306 raising knowledge among health care workers in early recognition, diagnosis and management of RF and
20
21 307 RHD in primary healthcare settings. Conducting educational interventions with teaching modules
22
23 308 focusing on these components is imperative to curb the RF/RHD prevalence in a developing country like
24 309 Nepal [22].
25

26 310
27
28 311 Our study had certain limitations. It was conducted in primary health care settings of Far-western Nepal,
29
30 312 and hence, it may not be generalizable to the whole country. Also, the participants from Bayalpata
31 313 hospital have regular CME sessions on various health-related topics, which is not common in other
32
33 314 healthcare facilities, and so, they may not be representative of all healthcare workers working in rural
34
35 315 areas. Similarly, knowledge gain may or may not translate into practice as a change in practice hasn't
36
37 316 been evaluated in this study. Further studies that assess the change in the practice of healthcare workers
38 317 in RF/RHD management after receiving an educational intervention are recommended. Another
39
40 318 limitation of this study was that there was no control group in the study; some of the participants might
41
42 319 have self-learned about RF/RHD after they knew that an RHD research was going on. This might have
43 320 biased our results. Moreover, a late post-test was not performed due to which we could not ascertain how
44
45 321 much of this gained knowledge is retained in the long run.
46

47 322 48 323 **CONCLUSIONS**

49
50 324 We conclude that the educational intervention implemented among the healthcare workers in the Far-
51
52 325 western part of Nepal improved their overall knowledge in terms of early recognition, diagnosis and
53
54 326 management of Rheumatic Fever and Rheumatic Heart Disease. These findings are promising to
55
56 327 introduce, institutionalize and strengthen the continuous professional development programs for
57 328 healthcare workers, especially focused on RF and RHD prevention and control at the primary care level.
58

1
2 329 Further studies with a larger sample size and conducted in different parts of the country will warrant the
3
4 330 effectiveness and relevance of scaling up such educational interventions in the country.

5 331 6 7 332 8 9 333 **ACKNOWLEDGMENTS**

10
11 334 We would like to extend our sincere thanks to Dr. Preeti Bhatt and Dr. Sagar Khadka for their immense
12 335 help during data collection. I would also like to thank Dr. Jeevan Thapa and Mr. Shiva Raj Mishra for
13
14 336 their valuable support in statistical analysis.

15 16 337 17 338 **FUNDING**

19 339 This study was funded by the Nepal Health Research Council (Provincial Health Research Grant 2020,
20
21 340 reference number 1584)

22 23 341 24 342 **AUTHOR CONTRIBUTIONS**

26 343 NB and AK shared equal contributions to the work and lead authorship of the study. NB and AK
27
28 344 conceptualized the study and developed the study design upon consultation with BS, AS and SKS. BS
29
30 345 and AS performed the data collection and data analysis. AK and NB wrote the first draft of the paper.
31 346 BS, AS, SKS and LR contributed to further drafts.

32 33 347 34 35 348 **COMPETING INTERESTS**

36 349 None declared

37 38 350 39 351 **PATIENT CONSENT FOR PUBLICATION**

40 352 Not required

41 42 353 43 44 354 **DATA AVAILABILITY STATEMENT**

45 355 All data relevant to the study are included in the article or uploaded as supplementary information.

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43 419 **LEGEND:**

45 420 **Figure 1: Mean knowledge score (total = 18) with 95% confidence interval**
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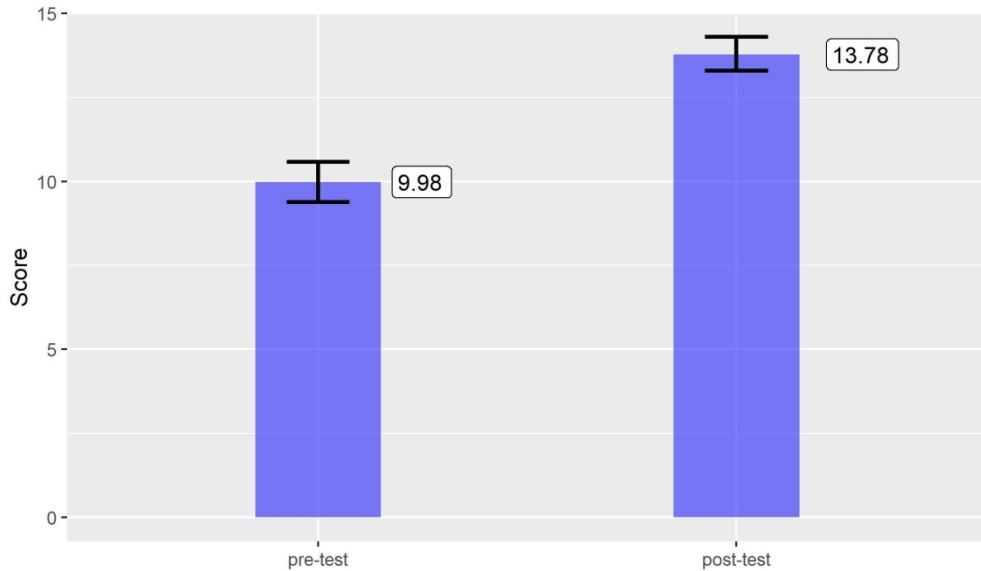


Figure 1: Mean knowledge score (total = 18)

Mean knowledge score (total = 18) with 95% confidence interval

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Reporting Item	Page Number
Title and abstract	
Title #1a Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract #1b Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction	
Background / #2 Explain the scientific background and rationale for the investigation being reported	3, 4
rationale	
Objectives #3 State specific objectives, including any prespecified hypotheses	4
Methods	
Study design #4 Present key elements of study design early in the paper	4, 5
Setting #5 Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4, 5

1	Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	4, 5
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4		#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give	5
5			diagnostic criteria, if applicable	
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8	Data sources /	#8	For each variable of interest give sources of data and details of methods of assessment (measurement).	5
9	measurement		Describe comparability of assessment methods if there is more than one group. Give information separately	
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14	Bias	#9	Describe any efforts to address potential sources of bias	5
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17	Study size	#10	Explain how the study size was arrived at	5, 6
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19	Quantitative	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings	6
20	variables		were chosen, and why	
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24	Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	6
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27	Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	6
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29	Statistical methods	#12c	Explain how missing data were addressed	N/A
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32	Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	N/A
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34	Statistical methods	#12e	Describe any sensitivity analyses	N/A
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37	Results			
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41			eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information	
42			separately for for exposed and unexposed groups if applicable.	
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46	Participants	#13b	Give reasons for non-participation at each stage	N/A
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49	Participants	#13c	Consider use of a flow diagram	7
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51	Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures	6
52			and potential confounders. Give information separately for exposed and unexposed groups if applicable.	
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56	Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	N/A
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1	Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	8
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5	Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
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10	Main results	#16b	Report category boundaries when continuous variables were categorized	N/A
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12	Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
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15	Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	N/A
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18	Discussion			
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20	Key results	#18	Summarise key results with reference to study objectives	10, 11, 12
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23	Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	12
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27	Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	12, 13
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36	Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13
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BMJ Open

Effectiveness of an educational intervention in improving healthcare workers' knowledge of early recognition, diagnosis and management of rheumatic fever and rheumatic heart disease in rural far-western Nepal: a pre-post intervention study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-059942.R2
Article Type:	Original research
Date Submitted by the Author:	27-Mar-2022
Complete List of Authors:	Bhatt, Navin; Nyaya Health Nepal, Bayalpata Hospital; Tribhuvan University Teaching Hospital, Institute of Medicine Karki, Ashmita; Tribhuvan University Institute of Medicine, Central Department of Public Health Shrestha, Biplav; Nyaya Health Nepal, Bayalpata Hospital Singh, Amul; Nyaya Health Nepal, Bayalpata Hospital Rawal, Lal; HERD International Kumar Sharma, Sanjib; BP Koirala Institute of Health Sciences, Department of Internal Medicine
Primary Subject Heading:	Public health
Secondary Subject Heading:	Cardiovascular medicine, Paediatrics
Keywords:	Valvular heart disease < CARDIOLOGY, EDUCATION & TRAINING (see Medical Education & Training), Cardiology < INTERNAL MEDICINE, Rheumatology < INTERNAL MEDICINE, Community child health < PAEDIATRICS, Paediatric cardiology < PAEDIATRICS

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3 **1 Effectiveness of an educational intervention in improving healthcare workers' knowledge**
4 **of early recognition, diagnosis and management of rheumatic fever and rheumatic heart**
5 **2 disease in rural far-western Nepal: a pre-post intervention study**
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26 ABSTRACT

27 **Objectives:** Rheumatic fever (RF) and rheumatic heart disease (RHD) remain among the major
28 heart problems among children in Nepal. Although these conditions are preventable and treatable,
29 the lack of proper knowledge and resources to diagnose and manage these conditions in rural health
30 centers is a key concern. This study assessed the impact of educational sessions to improve the
31 knowledge of healthcare workers in the early recognition, diagnosis, and management of RF and
32 RHD in rural far-western Nepal.

33
34 **Design, setting, and participants:** This study used a pre- and post-test interventional design and
35 was conducted among 64 healthcare workers in two primary health care centers and a peripheral
36 district-level hospital in Achham district in the far-western region of Nepal. A self-administered
37 questionnaire was used before and after the educational sessions. Data were analyzed using SPSS
38 version 21.

39
40 **Results:** The overall test scores increased from 10 (SD = 2.4) pre-intervention to 13.8 (SD = 1.9)
41 post-intervention (P-value <0.001). Similarly, participant confidence (graded 1 – 5) in
42 differentiating bacterial from viral sore throat rose from 3.6 (SD = 1.08) pre-intervention to 3.98
43 (SD = 1.09) post-intervention (P-value <0.05). Confidence in managing RF increased from 3.9
44 (SD = 0.88) pre-intervention to 4.30 (SD = 0.8) post-intervention (P-value <0.001).

45
46 **Conclusion:** The findings suggest that the investigated educational sessions are promising with
47 respect to improving the knowledge and confidence of healthcare workers in the early recognition,
48 diagnosis, and management of RF and RHD at the primary health care level. Further studies with
49 a larger sample size and conducted in different parts of the country are warranted to assess the
50 effectiveness and impact of scaling up such educational interventions in Nepal.

51
52 **KEYWORDS:** Rheumatic Fever, Rheumatic Heart Disease, Healthcare workers, Primary Health
53 Care, Nepal

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8 60 **STRENGTHS AND LIMITATIONS OF THIS STUDY**

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10 61
- 11 • A novel study assessing the impact of an educational intervention to improve knowledge
12 of health workers in the early recognition, diagnosis and management of rheumatic fever
13 and rheumatic heart disease in Nepal.
 - 14 63
 - 15 64 • Representation of rural Nepal and similar settings.
 - 16
 - 17 65 • May not be representative of all healthcare workers working in rural areas of Nepal as some
18 participants had regular continuing medical education sessions, whereas some did not.
 - 19 66
 - 20 67 • A control group was not included in the study, which might have biased our interpretation
21 of the results as some improvement in knowledge might have occurred just by being in a
22 rheumatic heart disease research environment.
 - 23 68
 - 24 69 • Assessing the sustained effect of educational sessions by conducting a late post-test was
25 outside the scope of this study.
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32 73 **INTRODUCTION**

33
34 74 Rheumatic heart disease (RHD) is a chronic heart condition caused as a sequel to Rheumatic fever
35 (RF), which most often begins in childhood as a group A β -hemolytic streptococcal (GAS) throat
36 75 infection [1]. Although RHD is a preventable and treatable form of cardiovascular disease, it
37 76 accounts for 33.4 million cases with 10.5 million disability-adjusted life-years and 0.3 million
38 77 deaths globally [2]. RHD is a common problem in developing countries, including Nepal, with
39 78 prevalence reported to be 0.9 to 1.35 per 1000 school-going children [3]. However, globalization
40 79 and migratory flows have contributed to the resurgence of RF worldwide [4,5]. In the Nepalese
41 80 population of 27 million, the incidence of RF is estimated to be 15000 per year and the incidence
42 81 of RHD, 7500 per year [6]. As RHD is attributable to poverty and social inequality, most cases of
43 82 RHD are concentrated in economically disadvantaged rural communities [7]. Though primary
44 83 prevention of RF and RHD is ideal for reducing the mortality due to RHD, it is still challenging
45 84 for countries like Nepal, where underlying risk factors such as overcrowding, poor hygiene, and
46 85 limited access to health care are still prevalent [8].
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88 In Nepal, the paramedical staff are usually the first contact points for a rural population with
89 RF/RHD. Hence, these primary health workers should be equipped with the knowledge and skill
90 to prevent RF/RHD. However, they have limited training and experience in diagnosing and treating
91 RF/RHD cases leading to underdiagnosis of the disease [9]. The government of Nepal (GoN) and
92 the Nepal Heart Foundation (NHF) have taken some initiatives for delivering disease-specific
93 health care while developing the national program for control of RF and RHD [6]. NHF has
94 achieved success in developing an RF/RHD registry, training paramedics, publishing
95 recommendations and guidelines, securing a supply of Benzathine Penicillin G (BPG), and
96 working on improving the quality and safety of BPG supplies and piloting primary prophylaxis
97 [6]. However, there is no evidence that those programs have penetrated the rural population of Far-
98 western Nepal. Lack of knowledge and skills to diagnose patients with RF/RHD among the
99 primary healthcare workers is a loss of opportunity to prevent the disease and its progression.
100 Globally, it is evident that interventions such as lectures and training can significantly increase the
101 knowledge and skills of healthcare workers in the prevention and treatment of RHD, which
102 otherwise remains low [10,11]. The World Health Organization (WHO) has also stressed the
103 importance of conducting education and training programs for all health workers involved in the
104 primary or secondary prevention of RF/RHD [12]. So, our research aimed to study the
105 effectiveness of an educational intervention in improving the knowledge of healthcare workers
106 working in healthcare facilities in rural settings in early recognition, diagnosis and management of
107 RF and RHD in a Far-western district of Nepal.

109 METHODS

110 **Study setting:** The study sites were primary health care facilities of Achham district, a rural hilly
111 district in the Far-western province of Nepal. Two primary health care centers (PHCC):
112 Chaurmandu PHCC and Kamalbazar PHCC, and one district-level hospital (Bayalpata hospital)
113 were selected conveniently.

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115 **Study population and sampling:** The study population included healthcare workers working in
116 the primary healthcare settings in Achham district of Nepal. The participants were chosen
117 conveniently and included Health Assistants (HA), Staff Nurse, Auxiliary Nurse Midwife (ANM),

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3 118 and Auxiliary Health Worker (AHW) and Medical Officer (MO). Altogether 64 healthcare
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5 119 workers were enrolled in the study. Of note, the participants of Bayalpata hospital regularly
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7 120 attended Continuing Medical Education (CME) sessions on various topics throughout the year.
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9 121 However, the participants from other sites did not attend such sessions.

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12 123 **Intervention design:** This study involved a pre-test followed by an educational session, and a
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14 124 post-test conducted with 6 – 12 study participants per session. A total of seven sessions, one each
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16 125 in Kamalbazar and Chaurmandu PHCCs and five sessions in Bayalpata hospital, were
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18 126 conducted. The educational session was an hour-long interactive session facilitated by a trained
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20 127 medical doctor using a conventional PowerPoint presentation. The presentation topics included:
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22 128 (i) introduction to rheumatic fever and rheumatic heart disease; (ii) pathophysiology of RF and
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24 129 RHD; (iii) clinical features and diagnostic criteria; (iv) prevention and treatment; and (v) follow-
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26 130 up for RHD treatment and care. The details on each topic area were presented during the
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28 131 educational sessions. The educational intervention included practical information relevant to rural
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30 132 healthcare settings. The sessions aimed to enable healthcare workers in terms of available
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32 133 healthcare resources to identify symptoms related to RF/RHD so that they could initiate
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34 134 appropriate treatment for RF and RHD and if needed they could refer the patients to a nearby
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36 135 tertiary care health center. The training material also contained information to help healthcare
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38 136 workers to use appropriate antibiotics for treating bacterial sore throat and to facilitate ongoing
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40 137 secondary prophylaxis of RHD. We used the same set of questions for pre- and post-tests which
41
42 138 assessed the knowledge of clinical presentation, diagnosis, treatment, and primary and secondary
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44 139 prevention of RF and RHD.

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46
47 141 **Study tools:** The study tools included pre- and post-test questionnaires and a PowerPoint
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49 142 presentation. Prior to the development of these tools, a range of relevant tools, guidelines, and
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51 143 other published literature were searched and reviewed. After reviewing the literature, a draft
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53 144 questionnaire and a PowerPoint presentation were collaboratively prepared by the authors which
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55 145 were then reviewed by the study team members, subject experts, researchers and policymakers in
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57 146 order to ensure content validity. While developing the tools, greater emphasis was given to the
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59 147 information that was deemed relevant to healthcare workers in rural areas. For the questionnaire,
60 148 we selected practical and frequently encountered questions based on our collective experiences

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3 149 working on RF/RHD in rural areas. The questionnaire was pretested among 10 healthcare workers
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5 150 in a primary health care center in a rural setting of Lalitpur district, Nepal. This district is different
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7 151 from the one where the main study was conducted. Necessary edits, and amendments such as
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9 152 simplifying the language, adding the Nepali translation of the questionnaire, adding a few more
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11 153 questions (such as the prevalence of RF and RHD, the purpose of long-term antibiotic prophylaxis
12
13 154 of RF) were done in the final version. A total of 18 objective questions for assessing knowledge
14
15 155 and 2 Likert-scale-based questions for assessing confidence were included in the questionnaire.
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17 156 Both the pre- and the post-test questionnaires had the same questions.

18 157 **Sample size and power:** For sample size estimation, a previous study [11] was considered where
19
20 158 the overall knowledge of 87 participants regarding prevention of RF/RHD increased from about
21
22 159 54% before the lecture to about 92% after the lecture (rough estimates derived by averaging the
23
24 160 values in figures 1, 2 and 3 in the article). Using this effect size and assuming no correlation
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26 161 between the pre-lecture and post-lecture observations, a sample size of 26 was obtained from a
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28 162 sample size calculator [13] with a power of 80% for a two-tailed test with 95% significance. To
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30 163 allow for differences in study settings (tertiary vs primary level care) and study participants
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32 164 (specialists vs mid-level healthcare workers), the target sample size was doubled to 52. More
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34 165 participants were invited than our target sample size. The power of this study was estimated to be
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36 166 greater than 80% at a 95% significance level.

37 167 **Study variables:** There were two types of variables in this study. One was the frequency counts
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39 168 (categorical variable) of discordant pairs of correct and incorrect answers for each question in a 2
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41 169 x 2 McNemar's table. The other variable was the participants' score (continuous variable; overall
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43 170 score, and the scores for 2 Likert-scale-based responses). The variable range for the overall score
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45 171 was 0 – 18 and the range for the Likert-based questions was 1 – 5. Our primary end-point was a
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47 172 change in the participants' overall score (out of 18) before and after the educational intervention.
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50 174 **Data analysis:** Data analysis was done on Statistical Package for Social Sciences (SPSS) version
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52 175 21. The descriptive analysis was performed using mean and standard deviation (SD) for continuous
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54 176 variables and percentages for categorical variables. The objective questions had 1 mark each for
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56 177 correct response (a total of 18 marks). The Likert-based questions were graded 1 – 5 for strongly
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58 178 disagree, disagree, neutral, agree, and strongly agree respectively. Knowledge scores were

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3 179 calculated for every participant and the mean knowledge score was calculated both before and
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5 180 after the educational session. The McNemar test was employed to test the differences in marginal
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7 181 frequencies of categorical variables between pre-test and post-test. Paired t-test was used to
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9 182 evaluate pre-post changes in knowledge scores (for continuous data). For all statistical analyses, a
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11 183 P-value of less than 0.05 was considered statistically significant and all tests were two-tailed.
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13 184

14 185 **Ethics approval:** An ethical approval of this study was obtained from the Ethical Review Board
15
16 186 of the Nepal Health Research Council (#2702). Necessary coordination and communication with
17
18 187 the administrative and the medical departments of respective health facilities were done in order
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20 188 to ensure the dissemination of accurate information about the educational sessions. Informed
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22 189 verbal consent was obtained from the participants prior to the data collection.
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24 191 **Patient and public involvement**

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26 192 Patients and/or the public were not involved in the design, or conduct, or reporting, or
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28 193 dissemination plans of this study.
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30 194

31 195 **RESULTS**

32 196 **General characteristics of the participants:**

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34 197 A total of 64 healthcare workers from 3 health facilities (Bayalpata hospital, Kamalbazar PHCC
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36 198 and Chaurmandu PHCC) were included in the study as shown in **Table 1**.
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40 200 **Table 1: Health centers and total participants**

Health centers	Participants (n)	Percent (%)
Bayalpata Hospital	41	64
Kamalbazar PHCC	15	23.5
Chaurmandu PHCC	8	12.5

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50 202 The mean age of the participants was 27 ± 6.7 years. Among the participants, 50% were males and
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52 203 50% were females. The mean working experience of the participants was 5.83 ± 4.6 years. As
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54 204 shown in **Table 2**, the majority of the participants (36%) were Auxiliary Health Workers (AHW),
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56 205 followed by Health Assistants (29.7%) and Staff Nurses (18.7%).
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207 **Table 2: Characteristics of Participants:**

Characteristics		Number	Percent
Sex	Male	32	50
	Female	32	50
Age	Mean (SD) years	27 (6.7) years	
Working experience	Mean (SD) years	5.83 (4.6) years	
Designation	Medical Officer	1	1.6
	Staff Nurse	12	18.7
	Health Assistant	19	29.7
	Auxiliary Health Worker (AHW)	23	36
	Auxiliary Nurse Midwife (ANM)	9	14

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210 The participants' responses were tabulated under four main domains: Screening-related, diagnosis-
 211 related, management-related and miscellaneous, as shown in **Table 3**.

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213 **Table 3: Participants' responses**

S.N.	Questions	Number of participants who gave the correct answers (N=64)		P-value
		Pre-test	Post-test	
Screening-related				
1	Most common cause of murmur in adolescents	60 (94%)	55 (86%)	0.13
2	Most common age for RF	52 (81%)	64 (100%)	0.001
3	Most common presentation of RF	50 (78%)	58 (91%)	0.04
4	Most likely cause of a sore throat	16 (25%)	16 (25%)	0.83
5	Not a feature of bacterial sore throat	43 (67%)	62 (97%)	< 0.001
6	Prevalence of RF/RHD	26 (41%)	55 (86%)	< 0.001
Diagnosis-related				

7	Natural history of RF	30 (47%)	51 (80%)	< 0.001
8	Confirmatory test for RF	7 (11%)	5 (8%)	0.69
9	RF patient with dancing movement	44 (69%)	60 (94%)	< 0.001
10	Complication of RF	8 (13%)	33 (52%)	< 0.001
Management-related				
11	Prevention of RF/RHD	58 (91%)	61 (95%)	0.51
12	Preferred antibiotic to treat GAS	22 (34%)	49 (77%)	< 0.001
13	Preferred antibiotic for prophylaxis of RF	49 (77%)	51 (80%)	0.75
14	Prophylaxis against RF prevents progression of	17 (27%)	40 (63%)	< 0.001
15	Serious adverse effect of penicillin	39 (61%)	57 (89%)	< 0.001
16	Drug of choice in penicillin-allergic patients	44 (69%)	56 (88%)	0.01
17	Prevention of anaphylaxis due to BPG	54 (84%)	62 (97%)	0.04
Miscellaneous				
18	Etiopathologic nature of RF	20 (31%)	47 (73%)	< 0.001
19	Confidence in differentiating bacterial from viral sore throat clinically	41 (64%)	59 (92%)	
20	Confidence in recognizing, evaluating and managing a case of RF/RHD	43 (67%)	60 (94%)	

214 **Significant at P-value <0.05**

215
 216 **Table 4** summarizes the change in overall knowledge and confidence of the participants before
 217 and after the teaching session. As shown in Figure 1, the overall mean knowledge score improved
 218 from about 10 (out of 18) in the pre-test to about 13.8 in the post-test, an improvement of 38% (p
 219 < 0.001). When asked about the most likely cause of murmur in a hypothetical situation of a 16-
 220 year-old male with shortness of breath on exertion, most of the health workers correctly identified
 221 Rheumatic Heart Disease (94% vs 86% on pre-test and post-test respectively) from the options
 222 given (Congenital heart disease, Rheumatic heart disease, Iron deficiency anemia and
 223 Endocarditis). Eighty-one percent of the participants knew that the most common age of getting
 224 RF and RHD is 5 to 15 years. After the session, all the participants knew about it. Fever and joint
 225 pain were correctly marked as the most common presentation of RF by the majority of the
 226 participants, both during the pre-test (78%) and post-test (91%). About 41% of the study

227 participants correctly specified that the prevalence of RF/RHD is more common in low-income
 228 countries whereas, after the teaching session, this proportion increased to 86%.

229

230 **Table 4: Changes in overall knowledge and confidence in managing RF and RHD using**

231 **Paired T-test**

Variables	Pre-test	Post-test	P-value
	Mean (SD)	Mean (SD)	
Overall knowledge	9.98(2.4)	13.78(1.9)	<0.001
Confidence in identifying sore throat etiology	3.66(1.08)	3.98(1.09)	0.01
Confidence in recognizing, evaluating, and managing RF	3.91(0.88)	4.30(0.84)	<0.001

232 ***Significant at P-value <0.05***

233

234 The proportion of the health personnel who knew that RHD is a sequela of RF and many, but not
 235 all develop RHD after RF increased from 47% to 80% post-session. While less than half of the
 236 study participants incorrectly selected ASO titer as the confirmatory test for RF before the teaching
 237 session, this proportion increased to 72% post-session. Only about 11% pre-session and 8% post-
 238 session correctly identified that none of the given options were the confirmatory test for RF. While
 239 13% correctly identified cardiac valve damage as a feared complication of RF, this proportion
 240 increased to 52% post-session.

241 About 90% of the participants correctly reported that early recognition and management of
 242 streptococcal sore throat could prevent rheumatic fever (RF) and rheumatic heart disease (RHD),
 243 which increased by 5% after the teaching session. Almost half of the participants answered that
 244 the preferred antibiotic for treating Group A *Streptococcus* (GAS) was Amoxicillin. However,
 245 after the teaching session, more than three-quarters of them correctly identified that Benzathine
 246 penicillin G is instead, the preferred choice. About 61% of the participants were aware that
 247 anaphylaxis is the serious adverse effect of penicillin. The proportion increased to 89% after the
 248 teaching session.

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3 250 About 69% of the participants correctly answered that the drug of choice for Rheumatic fever
4 251 prophylaxis in Penicillin allergic patients is Erythromycin whereas, after the session, the
5 252 percentage rose to 88%. Around 64% of the participants were confident in differentiating bacterial
6 253 from viral sore throat clinically pre-session, which increased to 92% post-session. Similarly, while
7 254 67% of the healthcare workers were confident in recognizing, evaluating, and managing a case of
8 255 RF before the teaching session, this proportion increased to 94% after the teaching session.
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258 **DISCUSSION**

19 259 The findings of this study indicate that primary healthcare professionals had an average level of
20 260 understanding on early recognition, diagnosis, and management of rheumatic fever and rheumatic
21 261 heart disease, which improved significantly after an education intervention. The results create an
22 262 opportunity to continue refining approaches to health education interventions for primary health
23 263 workers, in order to ensure their increased knowledge and confidence in the early management of
24 264 RF/RHD cases.
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31 266 **Screening of RF:**

32 267 The health workers had a good knowledge of the common age for getting RF/RHD and its most
33 268 common presentation as fever and joint pain. However, even after the teaching session, most of
34 269 the healthcare workers believed that the most likely cause of sore throat is a bacterial infection,
35 270 instead of viral. The fact that the teaching session emphasized differentiating bacterial from the
36 271 viral sore throat rather than specifically on the most common cause of sore throat could explain
37 272 this result. We need to emphasize that sore throat is mostly caused by viruses and that learning to
38 273 differentiate between a viral and a bacterial sore throat is very important in minimizing the misuse
39 274 of antibiotics. Similar findings were shown by a study done in Tanzania [14]. Before the session,
40 275 most of the health professionals were unaware that RF/RHD is mostly prevalent in low-income
41 276 countries. By the end of the session, more than 85% of them knew that most people suffering from
42 277 RF/RHD live in low-income countries, which is a fact stated by WHO [15].
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53 279 **Diagnosis of RF/RHD:**

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3 280 The majority of the participants incorrectly identified ASO titer as the confirmatory test for RF.
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5 281 Ironically, this proportion increased after the teaching session. As we know, RF is a clinical
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7 282 diagnosis based on Jones' criteria and there is no single test to diagnose RF. Positive GAS culture
8
9 283 and rising ASO titer serve as evidence of recent GAS infection, which is an essential criterion in
10
11 284 the Jones' criteria [16] but is not diagnostic of RF per se. It is actually a difficult question and to
12
13 285 answer this correctly, one needs to have a good understanding of RF. The short duration of the
14
15 286 teaching session was sufficient to provide a brief introduction to ASO titer but insufficient to
16
17 287 adequately convey its role in the diagnosis of RF. So, there might have been a response bias leading
18
19 288 to more participants selecting the option containing 'ASO titer'.
20

21 290 **Management of RF/RHD:**

22 291 The knowledge on preferred antibiotics for treating Group A *Streptococcus* (GAS) improved
23
24 292 significantly after the session. A single dose of Benzathine Penicillin G is preferred to oral
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26 293 penicillin or amoxicillin (which have to be given for 10 days) to ensure compliance. Moreover,
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28 294 different studies have shown that intramuscular penicillin reduced rheumatic fever recurrence and
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30 295 streptococcal throat infections compared to oral penicillin [17]. The participants' awareness about
31
32 296 the second drug of choice when there is hypersensitivity to benzathine penicillin was good and
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34 297 increased substantially after the sessions. Based on our pretest questionnaires, we found that about
35
36 298 60% of the health professionals knew that anaphylaxis is a serious adverse effect of Penicillin. By
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38 299 the end of the session, the percentage rose significantly to 90%, hence suggesting the effectiveness
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40 300 and need for similar teaching sessions. Similar findings were shown by a study conducted in
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42 301 Malawi [18]. However, the increase in knowledge about the risk of severe adverse effects may
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44 302 discourage clinicians with less experience from providing a very effective medicine. To address
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46 303 this, we emphasized, in our teaching session, that anaphylaxis is rare and that the benefits far out-
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48 304 weighs the risks [19]. We also included ways to safely administer Benzathine penicillin injection
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50 305 and management of anaphylaxis in our teaching session.
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53 307 In this study, the mean knowledge score of the health care workers significantly improved from
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55 308 10 to 13.8 post-session. Our findings suggested that an educational intervention on RF/RHD can
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57 309 increase the knowledge of healthcare workers, corroborating the findings of a study done in a
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59 310 similar lower-middle income setting [11]. Similarly, teaching sessions like this are found to boost

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3 311 the confidence of health service workers in differentiating bacterial and viral sore throats [20] and
4 312 in proper diagnosis, evaluation, and management of RF cases [18,21]. The findings of this study
5 313 have implications for policy, practice and further research and support the evidence that
6 314 educational interventions have a significant effect on raising knowledge among health care
7 315 workers in early recognition, diagnosis and management of RF and RHD in primary healthcare
8 316 settings. Conducting educational interventions with teaching modules focusing on these
9 317 components is imperative to curb the RF/RHD prevalence in a developing country like Nepal [22].
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17 319 Our study had certain limitations. It was conducted in primary health care settings of Far-western
18 320 Nepal, and hence, it may not be generalizable to the whole country. Also, the participants from
19 321 Bayalpata hospital have regular CME sessions on various health-related topics, which is not
20 322 common in other healthcare facilities, and so, they may not be representative of all healthcare
21 323 workers working in rural areas. Similarly, knowledge gain may or may not translate into practice
22 324 as a change in practice hasn't been evaluated in this study. Further studies that assess the change
23 325 in the practice of healthcare workers in RF/RHD management after receiving an educational
24 326 intervention are recommended. Another limitation of this study was that there was no control group
25 327 in the study; some of the participants might have self-learned about RF/RHD after they knew that
26 328 an RHD research was going on. This might have biased our results. Moreover, a late post-test was
27 329 not performed due to which we could not ascertain how much of this gained knowledge is retained
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36 330 in the long run.

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39 332 **CONCLUSIONS**
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41 333 We conclude that the educational intervention implemented among the healthcare workers in the
42 334 Far-western part of Nepal improved their overall knowledge in terms of early recognition,
43 335 diagnosis and management of Rheumatic Fever and Rheumatic Heart Disease. These findings are
44 336 promising to introduce, institutionalize and strengthen the continuous professional development
45 337 programs for healthcare workers, especially focused on RF and RHD prevention and control at the
46 338 primary care level. Further studies with a larger sample size and conducted in different parts of the
47 339 country are warranted to assess the effectiveness and impact of scaling up such educational
48 340 interventions in Nepal.
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5 343 **ACKNOWLEDGMENTS**

6 344 We would like to extend our sincere thanks to Dr. Preeti Bhatt and Dr. Sagar Khadka for their
7
8 345 immense help during data collection. I would also like to thank Dr. Jeevan Thapa and Mr. Shiva
9
10 346 Raj Mishra for their valuable support in statistical analysis.

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12 34713
14 348 **FUNDING**

15 349 This study was funded by the Nepal Health Research Council (Provincial Health Research Grant
16
17 350 2020, reference number 1584).

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19 35120
21 352 **CONTRIBUTIONS**

22 353 NB and AK shared equal contributions to the work and lead authorship of the study. NB and AK
23
24 354 conceptualized the study and developed the study design upon consultation with BS, AS and
25
26 355 SKS. BS and AS performed the data collection and data analysis. AK and NB wrote the first
27
28 356 draft of the paper. BS, AS, SKS and LR contributed to further drafts.

29 357

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31 358 **COMPETING INTERESTS**

32 359 None declared.

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34 36035 361 **PATIENT CONSENT FOR PUBLICATION**

36 362 Not required.

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40 364 **DATA AVAILABILITY STATEMENT**

41 365 No additional data are available.

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3 430 tuberculosis control then and now. *Am J Public Health* 2008;**98**:44–54.

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5 431 doi:10.2105/AJPH.2007.110841

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10 434 **LEGEND:**

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13 435 **Figure 1: Mean knowledge score (total = 18) with 95% confidence interval**

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For peer review only

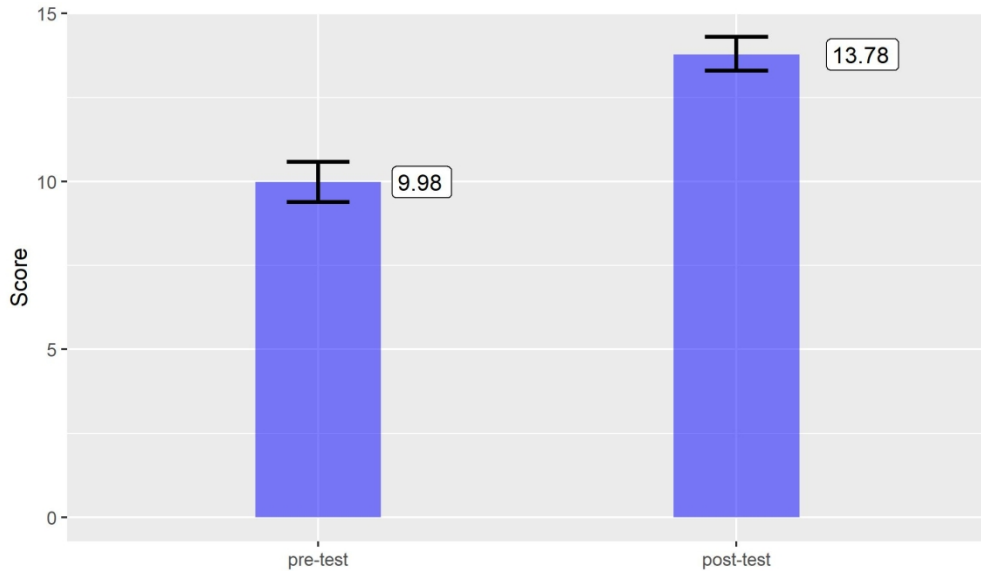


Figure 1: Mean knowledge score (total = 18)

Figure 1: Mean knowledge score (total = 18) with 95% confidence interval

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Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cross sectional reporting guidelines, and cite them as:

von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.

Reporting Item	Page Number
Title and abstract	
Title #1a Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract #1b Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction	
Background / #2 Explain the scientific background and rationale for the investigation being reported	3, 4
rationale	
Objectives #3 State specific objectives, including any prespecified hypotheses	4
Methods	
Study design #4 Present key elements of study design early in the paper	4, 5
Setting #5 Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4, 5

1	Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	4, 5
2				
3				
4		#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give	5
5			diagnostic criteria, if applicable	
6				
7				
8	Data sources /	#8	For each variable of interest give sources of data and details of methods of assessment (measurement).	5
9				
10	measurement		Describe comparability of assessment methods if there is more than one group. Give information separately	
11			for for exposed and unexposed groups if applicable.	
12				
13				
14	Bias	#9	Describe any efforts to address potential sources of bias	5
15				
16				
17	Study size	#10	Explain how the study size was arrived at	5, 6
18				
19	Quantitative	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings	6
20			were chosen, and why	
21	variables			
22				
23				
24	Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	6
25				
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27	Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	6
28				
29	Statistical methods	#12c	Explain how missing data were addressed	N/A
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31				
32	Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	N/A
33				
34				
35	Statistical methods	#12e	Describe any sensitivity analyses	N/A
36				
37	Results			
38				
39				
40	Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for	7
41			eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information	
42			separately for for exposed and unexposed groups if applicable.	
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46	Participants	#13b	Give reasons for non-participation at each stage	N/A
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49	Participants	#13c	Consider use of a flow diagram	7
50				
51	Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures	6
52			and potential confounders. Give information separately for exposed and unexposed groups if applicable.	
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56	Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	N/A
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1	Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and	8
2			unexposed groups if applicable.	
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5	Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95%	N/A
6			confidence interval). Make clear which confounders were adjusted for and why they were included	
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10	Main results	#16b	Report category boundaries when continuous variables were categorized	N/A
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12	Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
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15	Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	N/A
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18	Discussion			
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20	Key results	#18	Summarise key results with reference to study objectives	10, 11, 12
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23	Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both	12
24			direction and magnitude of any potential bias.	
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27	Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from	12, 13
28			similar studies, and other relevant evidence.	
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31	Generalisability	#21	Discuss the generalisability (external validity) of the study results	12
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34	Other Information			
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36				
37	Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original	13
38			study on which the present article is based	
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