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Effect of a multidisciplinary program with seven color balls on non-communicable diseases prevention in a Muslim community: A real-world study

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Abstract: Prevalence of diabetes and hypertension are increasing. Health promotion is needed for the diseases prevention. The objective of this study was to determine the impact of a multidisciplinary program and a seven-color balls on fasting blood glucose and blood pressure in a Muslim community. A one-group pre-post test of participatory action research was employed. The screening test was administered and assigned a color to each of seven health statuses. All participants made a commitment to improve their weekly performance. They were instructed and practiced for three weeks on six health information topics. Then, each village health volunteer reminded the participants of health information, and a religious leader declared (Kutbah) during Friday prayer that tobacco and alcohol are contrary to Islam. Utilizing frequency and percentage, the study outcome at the end of the program was compared to that at baseline. The results revealed that the mean age of the participants was 33.92 years, with a range of 15 to 82 years. Six months after program finish, 87.5% of those at risk and 93.3% of high risk for hypertension returned to normal blood pressure levels. For FBS level, risk for diabetes participants improved to a normal level by 57.6%, participants who were possibly for diabetes improved to better level by 50%, and third level illness decreased to a lower level by 50%. The program could improve participants' health status and encourage their self-esteem for health prevention. Prevention of hypertension, and diabetes is essential for promoting individual and community health.

Keywords: *7-color balls, Community health, Diabetes, Hypertension, Islam, Non-communicable diseases, PBRI.*

1. Introduction

About 74% of all global deaths are due to non-communicable diseases (NCDs). NCDs have been recognized as a major challenge for sustainable development in the 2030 agenda of Whorl Health Organization [1]. The mortality and morbidity rate resulting from NCDs are significant obstacle to growth in the 21st century. Annually, over 36 million individuals succumb to NCDs, with 15 million of them falling within the age range of 30 to 70, resulting in premature mortality. The disproportionate increase in burden is observed in low and lower middle income nations, especially in the poorest and vulnerable population [2]. In Thailand, NCDs are the top priority of the health care system. The prevalence rate of NCDs have increased in Thailand such that NCDs are now the most common cause of death, which is similar to the global situation [1,3,4]. The top three causes of death among NCDs in Thailand were stroke (61 per 100,000 population), cancers (42 per 100,000 population), and ischemic heart disease (40 per 100,000 population) [3].

The rise of NCDs is largely due to globalization of unhealthy behaviors and population aging. Prevention and control of NCDs should involve reducing the risk factors associated with these diseases.

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A comprehensive approach is needed to lessen the impact of NCDs on individuals and society. This approach requires all sectors to collaborate in order to reduce the risks associated with NCDs, and to promote interventions which prevent and control them [1]. A "4x4x4 model," which encompasses 4 risk factors, 4 physiological changes, and 4 disease areas, was recognized to control and prevent the risk of NCDs. The four key risk factors for NCDs are tobacco use, harmful use of alcohol, unhealthy diet, and physical inactivity. The four physiological changes that accompany NCDs are dyslipidemia, high blood pressure, high blood sugar, and being overweight and obese. The four disease areas resulting from NCDs are cardiovascular disease, diabetes, cancer, and chronic respiratory disease [1-3]. Before people reach an undesirable health status, their risk behaviors should be modified [5,6]. People need encouragement to avoid unhealthy behaviors in order to have good quality of life and well-being.

Praboromarajchanok Institute (PBRI) announced a policy for the control and prevention of NCDs among the health sciences colleges under their control and regulation. These colleges located throughout Thailand include 30 nursing colleges, 7 public health colleges, a Thai traditional medicine college, and a technology in medicine and health college. All colleges are required to integrate the 7-color balls concept into a program for health promotion and health prevention in diverse communities across the country. The 7-color balls concept is called PBRI model, and was formerly known as Vichai model [7,8].

Sirindhorn College of Public Health, Yala, is a public health college located in Yala province, which is the southernmost province of Thailand. This specific college is located in an area in which a majority of residents are Muslim. Because of the distinct religious composition of the community, we included Islamic aspects into the health promotion and prevention program. In addition, we designed the program to integrate multiple disciplines. We coordinated efforts and cooperated with researchers, a religious leader, a village leader, a primary health care unit, and village health volunteers. These different stakeholders were all essential people for the NCDs control and prevention program [9]. However, the current health care system was not yet sufficiently prepared to tackle all NCDs at the primary care level [10,11]. Therefore, only hypertension and diabetes were included for this study. Blood pressure and blood glucose levels were divided into seven levels. Throughout the study, we monitored blood pressure and blood glucose levels using the 7-color balls metric [7,8]. This study aimed to evaluate the effectiveness of the multidisciplinary prevention program with 7-color balls in preventing NCDs. In this study, we focused only on two physiological measures to assess presence of NCDs: blood sugar level to assess diabetes mellitus status and blood pressure level to assess hypertension status.

2. Materials and Methods

2.1 Study Design

In this study, we performed a pre-post evaluation for all study participants. We conducted this pilot study in a Muslim community in Yala, Thailand.

2.2. Population and Sample

Our population of interest included 845 people aged 15 years old and older and living in the 5th Village (*Moo* 5, which is the smallest administrative division in Thailand) of Ban Puerah village, Tasarp sub-district, Muang district, Yala Province (*Source*: Annual report of Tasarp Health Promotion Hospital). All study participants were required to be aged 15 years old or older. According to calculations using Krejcie & Morgan's formula, the sample size for this study was 265 participants. We conducted this pilot study to understand realistic conditions for recruiting participants. For recruitment, we used a volunteer sampling technique in which we invited the participants to volunteer and take part in this study. Two hundred and seventy two participants volunteered to participate in the study's activities. We recruited a greater sample size than expected. To account for participants possibly dropping out, we included all desired participants into this study. We assessed for the participants'

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blood pressure (BP) and fasting blood sugar (FBS) at different times during the study at scheduled appointments.

2.3. Research Tools

1) The 7-Color Balls System

Cutoff points according to the 7-color balls system were used to categorize the results from the screening tests for BP and FBS. We adapted the categories from the original source [12] (Table 1).

Table 1.
BP and FBS level, color ball, interpretation, and recommendation for each color.

Color		BP (mm.Hg)	FBS (mg/dL)	Interpretation	Recommendation
○	White	< 120/80	< 100	Healthy	Food: recommend consuming more fruits and vegetables, but consume less and avoid salty, sweet, and oily foods. Exercise: at least 3 times/Week, 30 minutes for each time Emotion: reduce stress and have a calm or positive attitude Risk reduction: no smoking, no alcoholic drinking, reduce weight gain and obesity
●	Light green	120/80 – 129/85	100 – 125	Risk for NCDs	White plus BP: measure BP every week FBS: measure blood sugar level every month
●	Dark green	130/86 – 139/89	126 – 139	High risk for hypertension / Possibly for diabetes	Light green plus -Behavior modification -follow up to see the doctor every months
●	Yellow	140/90 – 159/99	140 – 154	1st level illness	Dark green plus -Strictly use of anti-hypertension and/or blood sugar lowering medication -Screening for the complication of hypertension and diabetes at least once a year
●	Orange	160/100 – 179/109	155 – 182	2nd level illness	Yellow plus -follow up to see the doctor every months or when there are abnormal symptoms -Home visit
●	Red	≥ 180/110	≥ 183	3rd level illness	Recommendation as an orange level
●	Black	Complications		Illness with complications	Referred to doctor for medical care and case management

Note: Systolic BP was used in the case that BP was not in range for each level (color.)

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Table 2.
Program implementation.

Time		BP	FBS	3-hour session covering:	Remind by village health volunteer	Talk about abstaining from tobacco and alcohol by an Imam
1st month	1st week	✓	✓	1. Give a recommendation for each color status 2. Set a prefer color for better health status		
	2nd week	✓		1. Food 2. Exercise		
	3rd week	✓		1. Emotion 2. Tobacco and alcohol		
	4th week	✓		1. Medicine 2. Thai traditional massage		
2nd month	5th week	✓	✓		✓	✓
	6th week	✓			✓	✓
	7th week	✓			✓	✓
	8th week	✓			✓	✓
3rd – 8th month	1st week	✓	✓			
	2nd week	✓				
	3rd week	✓				
	4th week	✓				

2) ***Multidisciplinary Prevention Program*** (Table 2)

a. Screening BP and FBS – Based on the screening results for BP and FBS, the participant was assigned a color code based on 7-color balls system. A registered nurse screened each participant's blood pressure after the participant took a rest for 10 minutes. Another registered nurse tested the participants' blood sugar. All participants were instructed to refrain from eating after 10 p.m. before the appointment date. The measurements from the first screening was recorded as baseline data. Thereafter, the participants' blood pressure and fasting blood sugar were tested every week and every month, respectively. Each participant recorded their color health status in a record from (Figure 1).

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Name-Surname.....Number.....Village.....

Please mark (✓) to check your BP level each week, and FBS level once a month

Record form

Color, BP, and FBS level				1st month	2nd month	3rd month	4th month	5th month	6th month	7th month	8th month
White	○	BP (mm.Hg) Blood pressure	< 120/80								
		FBS (mg/dL) Blood sugar	< 100								
Light green	●	BP (mm.Hg) Blood pressure	120/80 – 129/85								
		FBS (mg/dL) Blood sugar	100 – 125								
Dark green	●	BP (mm.Hg) Blood pressure	130/86 – 139/89								
		FBS (mg/dL) Blood sugar	126 – 139								
Yellow	●	BP (mm.Hg) Blood pressure	140/90 – 159/99								
		FBS (mg/dL) Blood sugar	140 – 154								
Orange	●	BP (mm.Hg) Blood pressure	160/100 – 179/109								
		FBS (mg/dL) Blood sugar	155 – 182								
Red	●	BP (mm.Hg) Blood pressure	≥ 180/110								
		FBS (mg/dL) Blood sugar	≥ 183								
Black	●	Illness with Complications									

Note: BP and FBS were monitored by health professional for home visiting or hospitalization

Figure 1.
Participant record form for blood pressure and fasting blood sugar level.

b. Intention and evaluation – this activity based on self-esteem concept. Participants' intentions and evaluation of their test results – This activity was based on self-esteem concepts.

1) What color do you prefer? Each individual participant set goals for which color health status that they wanted to achieve after the program finished.
2) Success or not? They compared their current color health status with a previous screening in terms of both their blood pressure and fasting blood sugar. Generally, participants had two different perspectives:

- Stay in the white color (healthy): Those who were already healthy tried to keep themselves at that level.

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- Move to another healthier color (trying to have less risk or illness): Those who were unhealthy tried to reduce the severity of their health status and improve their health status by at least 1 level.

c. Recommendation for healthy

1) Food (a health academician)
2) Exercise (a health academician)
3) Emotional well-being (a psychiatric nurse)
4) Tobacco and alcohol (a health academician)
5) Medicine (a pharmacist)
6) Thai traditional foot massage (a Thai traditional medicine)

d. Just remind : Regular reminders

Village health volunteers walked around the community and visited approximately 10 – 20 households each week. They reminded residents about eating healthy food, getting good exercise, reducing stress and maintaining positive emotional well-being, correct usage of medicine, reducing or quitting smoking and drinking alcohol.

e. Emphasizing how smoking and alcohol are *Haram* (forbidden) in Islam – Friday prayer, Islamic religious leader declared (*Kutbah*) to remind participants who are practicing Muslims that their religion forbids drinking alcohol, and smoking is harmful to health.

3) Sphygmomanometer

We used an automatic blood pressure monitor (Omron, model HEM-7111) for blood pressure screening.

4) FBS test

We used a blood glucose test meter (Next Health + h, model IGM-1003A) to measure fasting blood sugar (FBS) levels.

5) Record form (Figure 1)

2.4. Tools Measurement

Following a consensus among researchers, the content validity of the research program was verified by five experts: a physician, a pharmacist, a health academician, a nurse, and an authority on Thai traditional medicine. A component of the program's activities pertaining to Islamic discipline was deliberated and agreed upon by three Imams prior to its utilization as a subject of declaring (*Kutbah*) during Friday prayer.

2.5. Data Collection

In May 2022, all 272 participants had their blood pressure and fasting blood sugar at baseline measured by a registered nurse and at the program finished. After that, the intervention program was implemented in the study community. Six topics of health information were discussed within 3 weeks (on Sunday). Four weeks later, health information reminded by village health volunteers, and informed (*Kutbah*) on Friday prayer by an Imam against smoking and alcoholic drinking. Between May and October 2022, blood pressure of all participants was tested every week, while participants' blood glucose level was tested every month. Participants marked their blood pressure and blood glucose level in their own assessment forms (Figure 1). Blood pressure level at every week, and blood glucose level at every month were used for their own assessment only. We also measured the BP and FBG for all participants when the program finished and 6 months after the program finished. To assess the effectiveness of the program, we utilized results from baseline and 6 months after the program finished (Table 2).

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2.6. Data Analysis

Descriptive statistics, including frequency and percentage, were used to describe the categorical data. Mean and standard deviation were used for continuous data.

3. Results of the Study

The participants were almost equally split between male and female (49.3%, and 50.7%, respectively). The highest proportion of participants was within the 25 – 44 years old age range (mean = 33.92, S.D. = 15.49, min = 15, max = 82). Based on the screening test for blood pressure and fasting blood sugar level, most participants were given the health status code of white ball. 76.1% had a healthy blood pressure (white) 75.8% had a healthy blood sugar level (White) (Table 3).

Table 3.
Demographic characteristics, BP, and FBS levels for study participants (n = 272).

Demographic, BP, and FBS			Frequency	%
Sex				
	Male		134	49.3
	Female		138	50.7
Age (years)				
	15 – 24		93	34.2
	25 – 44		113	41.5
	45 – 59		43	15.8
	60 and above		23	8.5
	mean = 33.92, S.D. = 15.49, min = 15, max = 82			
BP (mm.Hg)				
	< 120/80		207	76.1
	120/80 – 129/85		40	14.7
	130/86 – 139/89		15	5.5
	140/90 – 159/99		9	3.3
	160/100 – 179/109		1	0.4
	≥ 180/110		0	0
	Illness with complications		0	0
FBS (mg/dL)				
	< 100		206	75.8
	100 – 125		59	21.7
	126 – 139		2	0.7
	140 – 154		2	0.7
	155 – 182		1	0.4
	≥ 183		2	0.7
	Illness with complications		0	0

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Table 4.
BP and FBS based on 7-color balls at baseline compared to 6 months after the program finished (n = 272).

Baseline	← 6 months after the program finished →					
BP	○	●	●	●	●	●
○ n = 207	207 (100.0)	-	-	-	-	-
● n = 40	35 (87.5) [a]	4 (12.5) [b]	-	-	-	-
● n = 15	14 (93.3) [a]	1 (6.7) [a]	-	-	-	-
● n = 9	-	-	-	9 (100.0) [b]	-	-
● n = 1	-	-	-	-	1 (100.0) [b]	-
FBS	○	●	●	●	●	●
○ n = 206	206 (100.0)	-	-	-	-	-
● n = 59	34 (57.6) [a]	25 (42.4) [b]	-	-	-	-
● n = 2	-	1 (50.0) [a]	1 (50.0) [b]	-	-	-
● n = 2	-	-	-	2 (100.0) [b]	-	-
● n = 1	-	-	-	-	1 (100.0) [b]	-
● n = 2	-	-	-	-	1 (50.0) [a]	1 (50.0) [b]

Note: [a] Better, and [b] Stable.

Table 4 shows their blood pressure at 6 months after the program finished. For blood pressure, 87.5% changed from the risk group (light green) to healthy group (white). Almost participants (93.3%) in the 1st illness level (dark green) became healthy blood pressure (white). 6.7% reduced the severity of the 1st illness (dark green) into a lower risk group (light green). With respect to changing their fasting blood sugar, 57.6% from a risk group (light green) changed to healthy group (white). 50.0% from the 1st illness level (dark green) lowered their blood sugar to a lower severity risk group (light green). 50.0% reduced the severity from the 4th illness level (red) to the 3rd illness level (orange).

4. Discussion

The integrated health community program used for this study was adapted from the PBRI Model [13]. The PBRI model encouraged and promoted community health by screening and classifying participants' blood pressure and fasting blood glucose levels with seven color balls [6,14]. The program combined screening with participatory health promotion and risk awareness in order to reduce the diseases' prognosis as well as to prevent the incident cases of NCDs [13,15-17]. Patients, groups at risk for hypertension and/or diabetes, as well as healthy population from 15 years old and over gained tools for self-management of their health and experienced monitoring, analysis, evaluation, and reinforcement [14,18]. Using specific information about risks for different client groups, health providers could use targeted approaches to ensure that those most at risk of a specific threat are able to access sustained services [19]. In addition, this program was adapted and delivered through personnel already working in the community in order to provide health services [17,20]. This approach was particularly refined when there was limited access to health services during COVID-19 pandemic.

We used different colored balls to categorize blood pressure and blood sugar into seven levels. We linked these color codes to the interpretation of their health status. All participants knew their ball color from screening test results. Then, they were encouraged to commit and resolve to stay in white ball code for healthy group, or move at least a level lower from a higher risk group to a lower risk, healthier group.

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This study partnered with village health volunteers and an Islamic religious leader to be mentors for health communication [21] and assist with prevention and control of NCDs. Other studies assigned students or adolescents in this role as mentors for health communication [6,22]. Village health volunteers are a strength of Thai health system; they play an important part of health surveillance in each community. Feasibility and acceptability are important for population-wide interventions. Programs also should be specific and personalized in order to have an impact on health equity and sustainability [2,18,19,23]. The fact that this program was delivered through a primary health care approach helps strengthen early detection and timely treatment for NCDs.

The benefit and success of this intervention were due to good coordination and cooperation among related stakeholders and primary care unit. The intervention resulted in people having better health and well-being [8,23,24] because of the collaboration to reduce the risk factors associated with these diseases. The PBRI Model policy for the prevention of NCDs was implemented and suitably applied for the appropriate societal context in more than 30 provinces across Thailand. We utilized multi-sector platforms for NCD prevention [25,26] integrated with a cultural and Islamic approach. Our study's results were consistent with some studies that social norms have a positive effect on health outcomes [9,27-29]. Our efforts to prevent and reduce premature mortality, complications, and proportion of deaths caused by NCDs can help Thailand reach sustainable health promotion and prevention.

Many programs found in quasi-experimental research studies have influenced participants' daily habits and behavior. However, some of these programs involve participation in a program for long duration or are very time-consuming. These time-intensive programs can make participants feel uncomfortable and unlikely to complete the program. On the contrary, the integrated health community program of this study required a realistic time commitment that did not affect people's daily life too much. We only had one opportunity to invite all people in the community to participate in a health communication session. Not all people participated in the activity because of their work, other tasks, and personal obligations. However, we assigned village health volunteers and the religious leader to work with the participants that did sign up. Then, the village health volunteers played their routine roles for health surveillance in their community. They reminded participants about their health concerns and provided health information about avoiding risky health behaviors [30,31]. Village health volunteers also invited people to have weekly exercises [31]. In addition, the religious leader had reminded participants about health concerns and gave health information [21,31] at Muslim prayer time on Fridays. Not all participants in this study received the same activities; participants took part in each activity for a different number of times and received health information at different times. However, instead of this variability being a limitation of this study, we found that these conditions reflect a realistic program for health promotion and health prevention in the community.

5. Limitations

This study examined the psychological effects of the program on participants' behaviors. We did not assess the amount and quality of food consumption and exercise, adherence of participants to medications, drug use or treatment, level of nicotine addiction, tobacco cessation efforts, etc. Lastly, we only used BP and FBS to measure the effectiveness of our program. We did not collect data about other symptoms of high blood pressure or measurements of hemoglobin A1C to confirm diabetes status.

6. Conclusion

The screening tests for hypertension and diabetes prevention and categorization of results with the 7-color balls systems are effective for health education and encouraging patients to improve their health. The prognoses of the hypertension and diabetes mellitus based on the screening test results should be confirmed with further study.

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Ethical Considerations:
This study was approved by Institutional Review Board of Sirindhorn College of Public Health, Yala (Certificate of approval: SCPHYLIRB-028/2565).

Authors' Contributions
Wichan Phiban was responsible for project administration and supervision, study conceptualization, and methodology. Kamonwan Wanitchanon, Uraiwan Sirithammaphan,
and Ubontip Chaisang, supported research resources. Awirut Singkun worked for data curation, analyzed the data and wrote the original draft. All authors had participated in program implementation. We all proofread and approved the published version of this manuscript.

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