นิพนธ์ต้นฉบับ

Prevalence of coliforms in drinking water and housewife's hygiene associated with the contamination : a community, Bangkok

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Objective : *To determine the prevalence of coliforms contaminated in drinking water in containers and housewife's hygiene associated with the contamination.*

Design : *A cross-sectional analytic study*

Setting : *A low socio-economic community located on the bank of the Chaophraya River (Charanvithi 74)*

Subjects/ Methods : *95 housewives were interviewed and samples of their containerized drinking water were collected for determining coliform bacteria presence. After the laboratory results, the studied households were divided into 2 groups. The first group consisted of households with coliform contamination in their drinking water and the second consisted of households without coliform contamination in the drinking water. The interview variables were analysed by odds ratio and X^2 -test.*

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Results : *64.21% (61/95 sample) of the drinking water samples were contaminated with coliform bacteria. The highest contamination was found in rain water (80.00%), followed by tap water (64.41%) and filtered water (61.29%). The hygienic risk factors to coliform contamination in drinking water were (a) storage of drinking water in containers without cover: OR = 16.05 (95% CI= 5.10-52.92) (b) no hand-washing after using the bathroom : OR = 3.08 (95% CI = 1.18-8.09) (c) no cleaning of the bathroom: OR = 5.01 (95% CI = 1.03-31.75) and (d) no cleaning household: OR = 29.76 (95% CI = 8.39-113.51)*

Conclusion : *The study showed high prevalence of coliforms contaminated in drinking water in containers and 4 hygienic risk behaviors were associated with the contamination.*

Key words : *Drinking water, Coliform bacteria, Risk hygiene to contamination.*

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พิพัฒน์ ลักษมีจรัลกุล, วราภรณ์ พุ่มสุวรรณ. ความชุกของโคลิฟอร์มในน้ำดื่ม และสุขอนามัยของแม่บ้านที่มีความสัมพันธ์กับการปนเปื้อน : ชุมชนแห่งหนึ่ง กรุงเทพมหานคร. จุฬาลงกรณ์เวชสาร 2539 กรกฎาคม;40(7): 567-576

วัตถุประสงค์ : *เพื่อหาความชุกของแบคทีเรียโคลิฟอร์มในน้ำดื่ม และสุขอนามัยของแม่บ้านที่มีความสัมพันธ์กับการปนเปื้อน*

รูปแบบการวิจัย : *การศึกษาภาคตัดขวางชนิดวิเคราะห์*

สถานที่ : *ชุมชนแม่น้ำเจ้าพระยาแห่งหนึ่ง กรุงเทพมหานคร (จรัลวิถี 74)*

ผู้เข้าร่วมการศึกษา- และวิธีดำเนินการวิจัย : *ทำการสัมภาษณ์แม่บ้าน จำนวน 95 ครัวเรือน พร้อมทั้งเก็บตัวอย่างน้ำดื่มของทุกครัวเรือน (95 ตัวอย่าง) ที่ใส่ในภาชนะสำหรับดื่ม เพื่อตรวจหาการปนเปื้อนแบคทีเรียโคลิฟอร์ม ผลจากการตรวจทางห้องปฏิบัติการจะแบ่งครัวเรือนออกเป็น 2 กลุ่มคือ กลุ่มที่มีการปนเปื้อนแบคทีเรียในน้ำดื่มและกลุ่มที่ไม่มีการปนเปื้อน นำปัจจัยด้านสุขอนามัยที่ได้จากการสัมภาษณ์ของ 2 กลุ่ม มาวิเคราะห์หาปัจจัยด้านสุขอนามัยที่มีความสัมพันธ์กับการปนเปื้อน โดยใช้ Odds Ratio และ X^2 -test*

ผลการศึกษา : *พบการปนเปื้อนเชื้อแบคทีเรียโคลิฟอร์มในน้ำดื่ม ร้อยละ 64.21 น้ำฝนมีการปนเปื้อนมากที่สุด ร้อยละ 80.00 รองลงมาเป็นน้ำประปาปนเปื้อน ร้อยละ 64.41 และน้ำกรองมีการปนเปื้อน 61.29 ตามลำดับ สำหรับปัจจัยด้านสุขอนามัยที่มีความสัมพันธ์กับการปนเปื้อนแบคทีเรียในน้ำดื่ม ได้แก่ (ก) ภาชนะใส่น้ำดื่มไม่มีฝาปิด มีโอกาสทำให้เกิดการปนเปื้อนมากกว่าภาชนะที่มีฝาปิด 16.05 เท่า (95% CI=5.10-52.92) (ข) การไม่ล้างมือหลังถ่ายอุจจาระมีโอกาส ทำให้เกิดการปนเปื้อน 3.08 เท่า (95% CI=1.18=8.09) (ค) การไม่ทำความสะอาดส้วมมีโอกาสทำให้เกิดการปนเปื้อน 5.01 เท่า (95% CI=1.03-31.75) และ (ง) การไม่ทำความสะอาดบ้านเรือน มีโอกาสทำให้เกิดการปนเปื้อน 29.76 เท่า (95% CI=8.39-113.51)*

สรุปผล : *การศึกษานี้พบความชุกของการปนเปื้อนโคลิฟอร์มในน้ำดื่มค่อนข้างสูง และพบสุขอนามัยของแม่บ้าน 4 ปัจจัยที่มีความสัมพันธ์กับการปนเปื้อน*

Water quality influences the health and well-being of the individual. Drinking water contaminated with pathogenic micro-organisms leads to several water-borne diseases, for example, cholera, typhoid fever, shigellosis, hepatitis A, and other diarrheal diseases.[1,2] Several outbreaks of these diseases reported in recent years were related to the low sanitary quality of the drinking water.[3-7] The determination of the micro-biological quality of drinking water is necessary to isolate this problem. It is typically expressed in terms of the presence of indicator bacteria. The most commonly used indicators are coliform bacteria.[1,8] If a sample of water is positive for coliform bacteria, it suggests the potential presence of pathogens being excreted by animal or human populations.[1] Improving the quality of drinking water is one preventive strategy for water-borne diseases. Another strategy involves improving the personal hygiene of members of a household, especially, the housewife who usually has the major role in water and food preparation. This study attempted to determine the prevalence of coliform bacteria contaminating drinking water and the housewife's hygiene associated with the drinking water contamination. The study results may be valuable for health planning by improving the quality of drinking water and in improving general household hygiene.

Materials and Methods

A cross-sectional study was carried out during September 1992 to March 1993 in a low socio-economic community (Charanvithi 74) located on the bank of the Chaophraya River, This community consisted of 112 households (Figure 1), only 95 households were participated and included in the study. The housewife of each studied household was interviewed via use of structured questionnaires. The interviews included socio-economic factors and hygienic behaviors (reliability of the questionnaire = 0.70). At least 1 specimen of containerized drinking water from each household was collected under a sterile technique and stored in an ice-box for transport to the microbiological laboratory for determination of the coliform bacteria by the Most Probable Number Technique (MPN).[8] If the household had 2 or 3 types of drinking water, the most frequent drinking water would be collected. In MPN method, a selective nutrient fluid medium (Brilliant Green Lactose Bile Broth) which contains bile salts, lactose, and a pH indicator is used. The bile salts inhibit the growth of most non-intestinal organisms but do not inhibit that of E. coli and allied organisms. The presumptive and confirmatory tests were then done and the results expressed as the concentration of bacteria per 100 ml. of water. The cut-off number for positive coliform bacteria contaminated drinking water was greater than 2.2 coliform per 100 ml, following the Thai Environmental Quality Standards Division recomendations.[9]

After the laboratory results the studied households were divided into 2 groups. The first group consisted of households with coliform in their drinking water and the second consisted of households without coliform in the drinking water. The variables of the housewive's hygiene in the two groups were compared and analysed

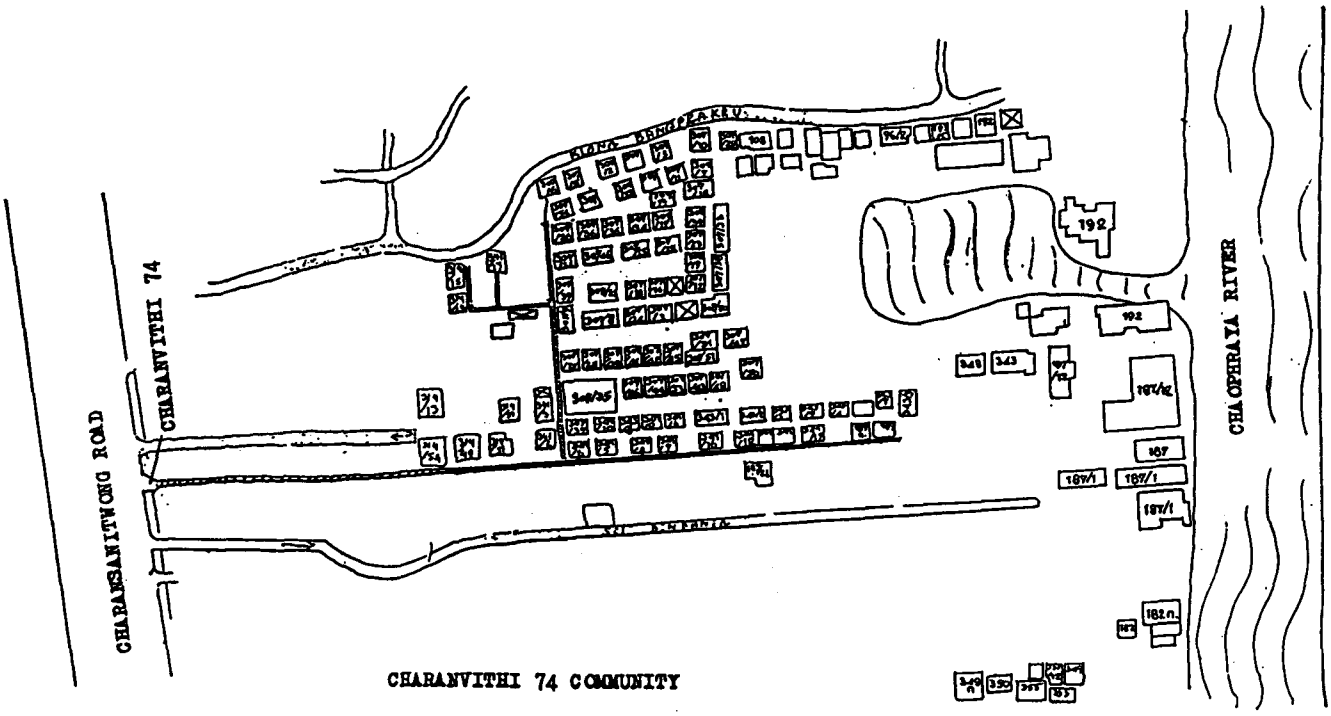

Figure 1. The studied community located on the bank of the Chaophraya River.

by odds ratio and x^2 -test for isolating hygienic risk factors to coliform contamination in the drinking water of this community.

Results

General characteristics of the studied housewives

Structural questionnaires about their general characteristics and hygienic behaviors were applied to 95 housewives. Their ages ranged from 18 to 75 years. About 45% were 21-40 years of age and almost 80% were 21-60 years of age. Most of them (69.47%) were married. About 65% had only primary education and about 58% did not work (housewives only). Most of them (74.74%) had lived in this community for more than 10 years. Almost 50% had only 1 to 2 children in their households. (Table 1)

Prevalence of coliform bacteria contaminated in drinking water.

Ninety-five specimens of containerized drinking water collected from 95 studied households (1 sample per 1 household) were analyzed to determine bacterial presence. The results revealed that prevalence of coliform bacteria in the drinking water was 64.21%. The highest contaminations were found in rain water (80.00%), followed by tap water (64.41%) and filtered water (61.29%), Running water had the least coliform contamination (1/34 specimens). Tap water, boiled water (in containers) and unboiled water (in containers) had nearly equal

Table 1. General characteristics of 95 studied housewives.

General Characteristics		Number	Per cent
Age (years)*	≤20	3	3.16
	21 - 40	43	45.26
	41 - 60	30	31.58
	≥61	19	20.00
Marital status	Married	66	69.47
	Single	11	11.58
	Widow,Divorced	18	18.95
Education	Nil	12	12.63
	Primary school	62	65.26
	Secondary school	11	11.58
	Vocational education and higher	10	10.53
Occupation	Housewife only	55	57.89
	Labourer	25	26.32
	Commerce	12	12.63
	Government official	3	3.16
Duration of living in this community	≤10 years	24	25.26
	≥10 years	71	74.74
Family income per month (baht)	≤3000	14	14.74
	3001 - 6000	43	45.26
	6001 - 9000	13	13.68
	≥9001	25	26.32
Number of children in family	0	11	11.58
	1 - 2	47	49.47
	3 - 4	23	24.21
	≥5	14	14.74

* Mean age was 41.62 years (Range = 18 - 75 years)

contamination rates (60.00% and 65.31%) (Table 2). These results indicated that the bacterial contamination probably occurred in the containers. The details of the coliform bacteria contamination in the drinking water (organisms/ 100 ml) are shown in Table 2.

Table 2. Coliform Contamination in Drinking Water of a Community Located on the Bank of the Chaophraya River, Bangkok.

Types of Drinking Water in Containers	No. of Tested	No. of Specimens Contaminated with Coliform Bacteria by Organisms/100 ml					% of Contamination*
		0	3-10	11-100	101-1000	>1000	
Tap Water**							
boiled	10	4	0	2	1	3	60.00
unboiled	49	17	5	11	8	8	65.31
Sub-Total	59	21	5	13	9	11	64.41
Filtered Water							
commercial	20	10	5	3	2	0	50.00
non-commercial	11	2	1	1	5	2	81.82
Sub-Total	31	12	6	4	7	2	61.29
Rain Water	5	1	2	2	0	0	80.00
Total	95	34	13	19	16	13	64.21

* The cut-off number of positivity coliform contamination was greater than 2.2 organisms/100 ml for drinking water (Environmental Quality Standards Division, Thailand 1989)

** The running water had the least coliform contamination (1/34 samples)

Housewife's hygiene associated with drinking water contamination

After the laboratory results the studied households were divided into 2 groups. The first group consisted of 61 households with coliform contamination in their drinking water and the second consisted of 34 households without contamination. The variables about the hygienic behaviors of the housewives in the 2 groups were analysed by odds ratio and the x^2 - test to isolate hygienic factors associated with drinking water contamination. The results showed that hygienic risk factors were (a) storage of drinking water in containers without covers: OR = 16.05 ($p < 0.001$), (b) no hand-washing after using the bathroom : OR = 3.08 ($p = 0.011$), (c) no cleaning the bathroom : OR = 5.01 ($p = 0.032$) and (d) no cleaning of the household: OR = 29.76 ($p < 0.001$), respectively. These are shown in Table 3.

Table 3. Housewife's hygiene associated with the coliform contamination in drinking water of studied community.

Housewife's Hygiene	Households with Coliform in Drinking Water No. (%)	Households without Coliform in Drinking Water No. (%)	Odds Ratio (95 % CI.)	P-value (x^2 -test)
Storage of drinking water in containers				
without cover	52 (85.25)	9 (26.47)	16.05	<0.001*
with cover	9 (14.75)	25 (73.53)	(5.10-52.92)	
Hand-washing after using the bathroom				
never/seldom	40 (65.57)	13 (38.24)	3.08	0.011*
often	21 (34.43)	21 (61.76)	(1.18-8.09)	
Cleaning the bathroom				
never/seldom	58 (95.08)	27 (79.41)	5.01	0.032*
often	3 (4.92)	7 (20.59)	(1.03-31.75)	
Cleaning households				
never/seldom	54 (88.53)	7 (20.59)	29.76	<0.001*
often	7 (11.47)	27 (79.41)	(8.39-113.51)	
Method for drinking				
using small glass	43 (70.49)	20 (58.82)	1.67	0.251
direct drinking	18 (29.51)	14 (41.18)	(0.64-4.41)	
Washing the drinking water container				
never/seldom	51 (83.61)	23 (67.65)	2.44	0.074
often	10 (12.29)	11 (32.35)	(0.82-7.34)	
Hand-washing before preparing food				
never/seldom	34 (55.74)	22 (64.71)	0.69	0.397
often	27 (44.26)	12 (35.29)	(0.26-1.78)	
Using sanitary latrine				
never/seldom	22 (36.07)	9 (26.47)	1.57	0.342
often	39 (63.93)	25 (73.53)	(0.57-4.38)	

* Statistical significance at α = 0.05

Discussion

Two main laboratory methods may be used for determining bacterial presence in drinking water.[1] First, there is the Most Probable Number (MPN) method or the multiple tube method. The alternative method is the membrane filtration technique. Membrane filtration is rather more accurate because it allows the bacteria to be counted directly, but the MPN method is cheaper, requires less specialized equipment, and is easier to carry out.[1,8] A recent study showed that the use of combination tests such as the Presence-Absence test for Fecal Streptococci (PA-FS) and H2S test was a suitable multiple test to assess the microbiological quality of drinking water in tropical countries.[10] In our study, we used the MPN method for determining the quality of the drinking water since the drinking water quality standard in Thailand is required units of MPN/100 ml.[9] The results showed that the prevalence of coliform bacteria in drinking water (from containers) was 64.21%. The boiled tap water (in containers) and unboiled tap water had nearly equal contamination rates. There was no statistical difference in the contamination rates among tap water, filtered water and rain water (in containers). The likely reason for contamination was due to direct contamination of the water and/or contamination in containers. The latter possibility was feasibile than the former. However, a previous study showed that water temperature was an important rate-controlling factor in bacterial regrowth in drinking water. When the drinking water was warm, the bacterial growth increased.[11]

Improving environmental health and personal hygiene is a way as to reduce the transmission of water or food-borne infections.[4,12] The rates of some diarrheal diseases, especially shigellosis, decrease with the use of hand-washing before eating and before preparing food or water, but did not decrease significantly with improvements in the microbiological quality of the water.[5] Our results revealed that the housewife's hygiene habits associated with the coliform contamination in drinking water were (a) storage of drinking water in containers without covers, (b) no hand-washing after using the bathroom, (c) no cleaning the bathroom and (d) no cleaning the household. Some hygienic risk factors were similar to recent studies about diarrheal diseases.[4,5] Health education that includes face-to-face contact about improving personal hygiene should be integrated into other public health activities in the community, and the roles of housewives for preventing and controlling water-borne diseases should be emphasized.

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