Dietary Calcium Intake among Rural Thais in Northeastern Thailand

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Objectives: *The present study examined the amount and relative contribution of calcium from the habitual diet among rural Thais.*
Material and Method: *Calcium intake was assessed using 3-day food records and interviewer-administered quantitative food-frequency questionnaire, containing 73 food items.*
Results: *The authors recruited 436 healthy participants (181 men and 255 women), between 20 and 85 years of age. Averaged daily calcium intake among men and women were 378.6 and 265.6 mg, respectively. Sixty-seven percent of men and eighty seven percent of women had less dietary calcium intake than half of the recommended level (<400 mg/day) whereas only 6 and 3% had an intake more than 800 mg/day. The major food sources of dietary calcium was glutinous rice (32 percent) followed by small animals with edible bones (31 percent) and fresh and fermented fish (20 percent). Dairy products and vegetables constituted only 8 and 5% of dietary calcium, respectively.*
Conclusion: *The habitual diet among rural Northeast Thais does not meet the recommended calcium intake level. To promote more consumption of dairy products and locally-available calcium-rich foods would be beneficial to prevent osteoporosis among this population.*

Keywords: *Calcium, Diet, Epidemiology, Rural, Thais*

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Calcium intake, especially among women, has received more attention since several studies showed a significant relationship between low calcium intake and risk of osteoporosis as well as the relationship between increased calcium intake and maximizing peak bone mass during adolescent years[1-5]. Average calcium intake was low among East and Southeast Asians who had a low habitual intake of dairy products. The mean dietary calcium intake among Hong Kong and Chinese populations was between 350-450 mg/day [6,7], about half of that in Western populations. In Thailand, the average calcium intake of adults in urban areas was about 361 mg/day[8]. The authors' objective was to determine the habitual dietary calcium intake and its major food sources among rural Thai adults in Northeastern part.

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Material and Method

Study subjects

This cross-sectional study was conducted in a rural area of Khon Kaen, Northeastern Thailand. The present study participants were recruited from two subdistricts (Nongtoom and Koksri) of the Muang

district in Khon Kaen. Potential participants were randomly selected from a list of household members and invited to participate in the present study. Volunteers were recruited if they were between 20 and 85 years of age and were in good health, as judged by physical examination. The Ethical Committee of the Faculty of Medicine, Khon Kaen University, approved the present study and informed consent was obtained from all participants.

Estimation of calcium intake

A trained field worker conducted the interview at the participants' homes. A second interview was conducted at the study center (Department of Medicine, Faculty of Medicine, Khon Kaen University) to assist in verifying and validating the integrity of the responses. The habitual calcium intake was assessed using a 3-day food record and an interviewer-administered, quantitative, food-frequency questionnaire; comprising 73 calcium-rich, locally available food items, which commonly consumed in this area.

The frequency of consumption was reported in eight categories: Never, 1 time/month, 2-3 times/month, 1-2 times/week, 3-4 times/week, 5-6 times/week, 1 time/day, and 2-3 times/day. The participants were asked about the food items they consumed, the frequency of consumption during last month and the amount of consumed food. Real food models, weighing scale and standard measuring cups and spoons were used for portion size estimation during the interview.

The daily calcium intake was calculated by converting the amount of food consumed in household units to the amount consumed in grams (g) then multiplied by the calcium content obtained from the Thai Food Composition Table. In addition to the dietary intake questionnaire, the participants were asked about their history of milk consumption during childhood.

Body weight and height measurement

Body weight (including light indoor clothing) was measured using an electronic balance (accuracy 0.1 kg) and standing height (without shoes) with a stadiometer (accuracy 0.1 cm). Body mass index (BMI) was calculated as the ratio of weight (kg) over height (m^2).

Statistical analysis

Statistical analyses were performed using SPSS version 11.5 (SPSS, Inc, Chicago). The results were expressed as the mean, standard deviation (SD) and percentage. Descriptive statistics were computed for each sex separately. The Student t-test, Chi-square or Fisher-exact test was used where appropriate to compare between sexes. A p-value of less than 0.05 was considered significant difference between sexes.

Results

The present study recruited 181 men and 255 women averaging 49.1 and 50.6 years of age, respectively. Seven percent of both sexes were underweight according to their BMI classification, while a respective 14.4% and 37.6% were obese. Seventy-five and 58.6% of men were smokers and drinkers, respectively. Only 2% of men and none of the women had a history of regular milk drinking during childhood, a common observation among rural Thais (Table 1).

More than half of the participants had an average daily calcium intake less than 400 mg/day (Table 2) and only 6.1% of men and 2.8% of women met the Thai RDA level of 800 mg/day. The average calcium intake was significantly decreased with advancing age in both sexes. Within the same age group (*viz.*, 20-29, 40-49, 50-59, and $\geq$ 70 years of age), women had a significantly lower calcium intake than men.

The major food source for calcium among the study participants (Table 3) was staple glutinous rice (30.2% in men and 33.8% in women) and small animals (*e.g.*, frogs and bullfrogs), (34.9% in men and 28.1% in women). Locally available small fish (including fermented fish) was also a major source of calcium. The contribution of calcium from dairy products (the most bio-available calcium source) and vegetables was less than 10%.

Discussion

Dietary requirements for calcium are determined by bone development and maintenance, which vary according to the stage of life, with greater needs during the growing periods (*i.e.*, in childhood and adolescence, during pregnancy and lactation) and in later life. Inadequate dietary calcium in early life impairs bone development; however, it is unclear whether adequate calcium early in life leads to optimization of peak bone mass in early adulthood[9-12]. However, in later years, inadequate dietary calcium accelerates bone loss and may contribute to osteoporosis[13-15]. Calcium supplementation in postmenopausal women and older men has been shown to reduce the rate of bone loss at various sites[15-17]. Recently, the result from a meta-analysis has shown that the combination of calcium

Table 1. Characteristics of the study subjects

	Men (n = 181)	Women (n = 255)
Age (yr)	49.1 ± 17.1	50.6 ± 15.9
Height (cm)	161.2 ± 5.9*	152.1 ± 5.2
Body weight (kg)	58.2 ± 8.8*	55.8 ± 10.5
Body mass index (BMI, kg/m^2)	22.4 ± 2.8*	24.1 ± 4.0
Nutritional status classified by BMI value	n (%)	n (%)
Underweight (< 18.5 kg/m^2)	12 (6.6)	17 (6.7)
Normal (18.5-22.9 kg/m^2)	103 (56.9)	87 (34.1)
Overweight (23.0-24.9 kg/m^2)	40 (22.1)	55 (21.6)
Obese (> 25.0 kg/m^2)	26 (14.4)	96 (37.6)
Cigarette smokers (%)	136 (75.1)	0 (0)
Alcohol drinkers (%)	106 (58.6)	2 (0.8)
Childhood milk drinking habit (%)		
No	118 (65.2)	181 (71.3)
Sometimes	59 (32.6)	73 (28.7)
Regular	4 (2.2)	-

Values are Mean ± SD, others are specified
* Statistical significant at $p < 0.05$

Table 2. Dietary calcium intake and sources of the study subjects by sex and age group

	Men (n = 181)	Women (n = 255)
Dietary calcium intake, mg/day		
Mean	378.6	265.57
Median	314.92	211.54
Standard deviation	258.76	208.42
Age group		
20-29 yr	442.8 ± 306.9	281.6 ± 156.3*
30-39 yr	437.5 ± 599.9	358.1 ± 343.3
40-49 yr	420.2 ± 239.5	290.6 ± 187.8*
50-59 yr	411.6 ± 306.9	256.2 ± 147.4*
60-69 yr	302.6 ± 165.5	229.3 ± 217.7
≥ 70 yr	250.6 ± 117.2	181.9 ± 103.0*
Number of subjects by level of intake (%)		
< 200 mg/day	33 (18.2)	119 (46.9)
200-400 mg/day	89 (49.2)	104 (40.9)
401-800 mg/day	48 (26.5)	24 (9.4)
> 800 mg/day	11 (6.1)	7 (2.8)

* Significant difference between sex within the same age group and $p < 0.05$

and vitamin D supplementation can reduce fracture risk in postmenopausal women; however, the effect was modest[18].

The dietary intake habit among our rural, Northeast, Thai participants reflected the traditional eating habit with limited food sources high in calcium. Milk drinking was not a common practice in the presented population. Forest foods as well as fish and small water animals were their daily sources of food[19]. The main sources of calcium were the edible bones from frogs, bullfrogs, ground and tree lizards, small fish, dried shrimp and fermented fish. However, the calcium bioavailability of these local foods has not been investigated; nevertheless, the amount is perhaps minimal since the average daily calcium intake (378.6 mg in men and 265.6 mg in women) was far less than the

Table 3. Percentage contribution of calcium intake from different food groups

	Men (n = 181)	Women (n = 255)	Total (n = 436)
Milk and products (%)	6.8	9.0	7.9
Meats (%)			
Small animals	34.9	28.1	31.5
Insects	0.5	0.6	0.6
Fresh and fermented fish	20.2	19.9	20.1
Eggs (%)	1.0	1.3	1.2
Vegetables (%)	5.2	5.7	5.5
Fruits (%)	0.9	1.2	1.1
Seeds and nuts (%)	0.3	0.4	0.4
Rice (%)	30.2	33.8	32.0

recommended value.

In the present study, most of the participants consumed less than 400 mg of calcium/day. Although average calcium intake in men was higher than women, their intake was still lower than the Thai recommended value of 800 mg/day, and only 6.1% of men and 2.8% of women reached the recommended level. These findings were consistent with previous studies among adult Thai subjects living in urban areas (Bangkok metropolitan), Hong Kong and Chinese populations[6-8], confirming that low dietary calcium intake persists in rural East and Southeast Asian populations. Moreover, lower calcium intake was observed with advancing age in both men and women, which would accelerate the rate of bone loss in postmenopausal women and the elderly.

An important component of osteoporosis prevention is to identify the modifiable risk factors. Dietary calcium intake is perhaps the most readily modifiable risk factor. For example, a variation in dietary calcium intake among Thais accounted for 8%, 5% and 6% of variance of femoral neck, lumbar spine, and distal radius BMD, respectively[20], a modest effect but comparable to that in Caucasian populations[21].

The findings from the present study could be used to improve public health policy, as an education program on ways to increase dietary calcium intake would benefit the Thai population. A review of 139 reports investigating the role of calcium on bone mass clearly demonstrated the positive effects of calcium on bone mass across the life span[15]. A retrospective study also demonstrated a significant positive relationship between dairy product consumption in adolescence and BMD in young adult women[22]. In the United States, dairy products are the primary source of dietary calcium, representing approximately 70% of total calcium intake[23]. Thus, increasing the level of calcium consumed in the form of dairy products or supplements contributes to maximizing peak BMD and prevention of bone loss. In Thailand, particularly in the Northeast, local calcium rich foods (*i.e.*, small animals, fish and vegetables) are available and should be promoted, especially for those who have lactase deficiency or for whom dairy products are not easily available.

There are a number of limitations in the present study. Measurements of dietary calcium intake at a single time point may not reflect long-term effects. The results based on Thai ethnicity in the Northeast, may not be generalizable to other populations; notwithstanding, the present study was based on a random sample and direct observation. In the present study, dietary calcium intake was estimated using a 3-day food record and a quantitative food-frequency questionnaire, which arguably yields a better measure of long-term habitual intake than dietary records or 24-h recalls[24-26].

In conclusion, the rural, Thai population is more at risk of having an inadequate intake of calcium from their habitual diet. Promoting increased consumption of dairy products and local calcium-rich foods may be beneficial to prevent osteoporosis among this population.

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การศึกษาแคลเซียมจากอาหารในประชากรไทยที่อาศัยอยู่ในเขตชนบท ภาคตะวันออกเฉียงเหนือประเทศไทย

ฉัตรเลิศ พงษ์ไชยกุล, สมศรี เจริญเกียรติกุล, วงสวาท โกศัลยวัฒน์, นิภา โรจน์รุ่งวศินกุล, รัชตะ รัชตะนาวิน

วัตถุประสงค์: *เพื่อศึกษาปริมาณแคลเซียมที่ได้รับจากอาหารและแหล่งที่มาของแคลเซียมจากอาหารในประชากรไทยที่อาศัยอยู่ในเขตชนบท*

วัสดุและวิธีการ: *คำนวณปริมาณแคลเซียมจากอาหาร โดยการสัมภาษณ์และบันทึก โดยใช้แบบสอบถามการบันทึกอาหาร 3 วันร่วมกับใช้แบบสอบถามความถี่ของการบริโภคอาหาร ซึ่งประกอบไปด้วย หมวดหมู่ของอาหารจำนวน 73 หมวดหมู่*

ผลการศึกษา: *ทำการศึกษาในอาสาสมัครจำนวน 436 ราย เป็นผู้ชาย 181 รายและผู้หญิง 255 ราย อายุระหว่าง 20-85 ปี พบว่าปริมาณแคลเซียมที่ได้รับจากอาหารในผู้ชายและผู้หญิงเท่ากับ 378.6 และ 254.6 มิลลิกรัมต่อวัน ร้อยละ 67 ในผู้ชายและร้อยละ 87 ในผู้หญิงได้รับแคลเซียมน้อยกว่าครึ่งหนึ่งของปริมาณแคลเซียมที่ควรได้รับต่อวัน (น้อยกว่า 400 มิลลิกรัมต่อวัน) และเพียงร้อยละ 6 ในผู้ชายและร้อยละ 3 ในผู้หญิงเท่านั้นที่ได้รับแคลเซียมมากกว่า 800 มิลลิกรัมต่อวัน แหล่งของแคลเซียมจากอาหารส่วนใหญ่มาจากข้าวเหนียวคิดเป็นร้อยละ 32 รองลงมาได้แก่ สัตว์ตัวเล็ก ๆ ซึ่งสามารถรับประทานได้ทั้งกระดูกคิดเป็นร้อยละ 31 ของปริมาณแคลเซียมที่ได้รับทั้งหมด และอาหารจากปลาต่าง ๆ รวมทั้งปลาร้าคิดเป็นร้อยละ 20 ส่วนการได้รับแคลเซียมจากนม ผลิตภัณฑ์จากนมและจากผัก พบเพียงร้อยละ 8 และ 5 ตามลำดับ*

สรุป: *การศึกษานี้พบว่าประชากรที่อาศัยอยู่ในเขตชนบทภาคตะวันออกเฉียงเหนือส่วนใหญ่ยังได้รับแคลเซียมจากอาหารไม่เพียงพอ การส่งเสริมให้ปรับเปลี่ยนวิธีการบริโภคอาหาร เช่น การเลือกรับประทานอาหารที่มีแคลเซียมสูงจากนม ผลิตภัณฑ์จากนมและจากอาหารท้องถิ่น ร่วมกับการปรับเปลี่ยนพฤติกรรมในการดำรงชีวิต อาจจะช่วยป้องกันการเกิดโรคกระดูกพรุนในประชากรกลุ่มนี้ได้*