Prevalence of Vitamin D Insufficiency among Elderly Males Living in Rural Khon Kaen Province, Northeast Thailand

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Background: *Vitamin D is essential for bone strength. In our previous study of urban, elderly, males, the prevalence of vitamin D insufficiency was 48%, and they had a lower level of bone turnover marker than normal, young adult, Thai males.*
Objective: *To A) ascertain the prevalence of vitamin D insufficiency, B) to determine the bone turnover marker level in rural elderly males, and C) to compare urban and rural males with these parameters.*
Results: *The prevalence of vitamin D insufficiency among rural elderly males was 13.6%, while the level of bone turnover markers (β-CTx, and PINP) were in the normal Thai reference range. It was also found that rural elderly males had a significantly higher level of the calcidiol, iPTH, β-CTx, and PINP than their urban counterparts.*
Conclusion: *The prevalence of vitamin D insufficiency among rural elderly males was significantly lower than among urban males and rural males had a higher level of calcidiol, iPTH and bone turnover marker. The hypothesis was that differences in rural vs. urban lifestyle accounted for the discrepancy; possibly because elderly rural males performed strenuous outdoor labor while most urbanites stayed at home and/or had sedentary jobs.*

Keywords: *Vitamin D insufficiency, Prevalence, Rural elderly males, Calcidiol*

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Thailand is located in the tropics, which is warm and sunny throughout the year; not withstanding, direct exposure to the sun is not practical, and culturally people avoid direct and prolonged exposure to prevent: A) getting overheated, B) skin darkening, and C) skin cancer. Avoiding any exposure to the sun, however, will result in vitamin D insufficiency; since the principle source of vitamin D is what the body produces while the skin is exposed to the sun. An adequate supply of vitamin D from skin synthesis and/or dietary sources is considered essential for bone health. According to our previous studies on vitamin D status, vitamin D insufficiency among elderly Thai women in urban areas was higher than in rural areas (65.4% vs. 17.4% respectively), ostensibly, because of lifestyle differences[1]. The study also revealed a high prevalence of vitamin D insufficiency between both post-[2] (60%), and pre-menopausal women[3] (77.81%) having an urban lifestyle.

In our previous study of urban elderly males in Khon Kaen province in northeastern Thailand, nearly half of them (48%) had vitamin D insufficiency[4]. There are only a few studies about vitamin D status among rural elderly males. The objective of this study was, therefore, to ascertain the prevalence of vitamin D insufficiency among Thai elderly males living in rural Khon Kaen province, and to compare the relevance parameters with our previous study of urban, elderly males.

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Material and Method

Sixty-six healthy elderly males averaging 68 years of age were enrolled in this study. None of the participants took any kind of medicine affecting bone metabolism before the screening. At the screening visit, an overnight fasting blood sample was collected and kept frozen (-20°C) until analyzed.

Serum PINP (representative of the bone formation marker) and serum β-CTx (bone resorption marker) were measured using electro-chemilumine scence (ECLIA) on an Elecsys 2010. The %CV of the

PINP and the β-CTx in pooled human sera were between 2.3-3.7 and 1.6-4.7, respectively.

The serum intact parathyroid hormone and calcidiol samples were measured using electro-chemiluminescence (ECLIA) on an Elecsys 2010. The %CV of the PTH and calcidiol in the pooled human sera were between 4.3-5.9, and 6.9-9.9, respectively.

Statistical analysis

The population sample number of 66 elderly male cases was derived from the assumption that the prevalence of vitamin D insufficiency among elderly males was 20% and 10% error was acceptable at a *p*-value <0.05.

The continuous data (age, weight, height, BMI, calcidiol, PTH and the bone formation and bone resorption markers) were presented as means (SE), medians (SE), minima and maxima. The dichotomous data (vitamin D insufficiency) was presented as numbers and percentages.

The difference in the prevalence of vitamin D insufficiency among rural vs. urban elderly males was evaluated using the Chi-square test. The student t-test was used to compare differences between the means of the continuous variables (bone biochemical markers, calcidiol and PTH levels) between rural vs. urban elderly males. Pearson's correlation was used to evaluate the association among continuous variables. A *p*-value <0.05 was required to confirm statistical significance.

Results

The clinical characteristic baseline of all participants is presented in Table 1. The prevalence of vitamin D insufficiency among rural elderly males was 13.64% (using a serum calcidiol level of ≤40 ng/mL as the threshold), which was significantly lower than among urban counterparts (Table 2).

Table 3 shows the absence of any correlation between calcidiol and age, height, weight, BMI and serum iPTH in rural elderly males.

Table 4 shows the comparisons of age, weight, height, BMI, β-CTx, PINP, calcidiol and PTH levels between urban and rural, elderly, males. Rural elderly males had significantly younger, and lower BMI, and significantly higher serum β-CTx, PINP, calcidiol and PTH ($p<0.05$).

Discussion

Vitamin D insufficiency in the elderly is one of the most important factors leading to the development

Table 1. Characteristics of participants at baseline (n = 66 cases)

	Mean (SE)	Median (SE)	Minimum	Maximum
Age (n = 66)	68.09 (0.81)	66.00 (0.81)	60.00	85.00
Weight (n = 66) kg	55.44 (1.35)	54.50 (1.35)	35.00	88.00
Height (n = 66) cm	161.64 (0.77)	160.00 (0.77)	150.00	176.00
BMI (n = 66) kg/m^2	21.18 (0.47)	21.27 (0.47)	14.76	29.78
PTH (n = 66) pg/mL	31.94 (1.26)	31.97 (1.26)	9.50	79.40
Calcidiol (n = 66) ng/mL	54.34 (1.37)	55.30 (1.37)	27.63	71.00
PINP# (n = 66) ng/mL	53.02 (3.11)	48.60 (3.11)	18.53	143.00
β-CTx* (n = 66) ng/mL	0.41 (0.03)	0.36 (0.03)	0.12	1.57

The reference mean (95% CI) of young Thai adult males aged between 20-45 year-old[5]
#PINP = 58.1 (48.00-68.60), *β-CTx = 0.412 (0.359-0.464)

Table 2. Number (%) of normal and vitamin D insufficiency between rural and urban elderly males

	Vitamin D insufficiency number (%)	Normal vitamin D Number (%)	Total
Urban elderly males	48 (48)	52 (52)	100
Rural elderly males	9 (13.64)	57 (86.36)	66

p<0.001 (Chi-square test)

Table 3. Pearson's correlations of calcidiol, age, height, weight, BMI and PTH

Pearson's correlation	Age	Height	Weight	BMI	PTH
Calcidiol	0.084	-0.104	-0.020	0.035	0.072
p-value	0.502	0.408	0.871	0.779	-0.568
n = 66					

Table 4. Comparison of age, weight, height, BMI, β-CTx, PINP, calcidiol and PTH between urban and rural elderly males

	Number	Mean (SD)	*p*-value
*Age			
Urban	100	70.73 (6.16)	0.009
Rural	66	68.09 (6.56)	
Weight			
Urban	100	58.63 (10.45)	0.061
Rural	66	55.44 (11.01)	
Height			
Urban	100	160.31 (5.73)	0.161
Rural	66	161.64 (6.23)	
*BMI			
Urban	100	22.75 (3.46)	0.007
Rural	66	21.18 (3.80)	
*β-CTx			
Urban	100	0.26 (0.23)	<0.001
Rural	66	0.41 (0.23)	
*PINP			
Urban	100	37.39 (21.86)	<0.001
Rural	66	53.02 (25.27)	
*Calcidiol			
Urban	100	42.04 (12.24)	<0.001
Rural	66	54.34 (11.09)	
*PTH			
Urban	100	24.80 (19.34)	0.002
Rural	66	31.94 (10.20)	

* *p*-value <0.05

of osteoporosis and fractures, especially of the femoral neck[6-9]. According to our studies, both elderly females (especially those living in urban areas) and young females have a high prevalence in vitamin D insufficiency (65.4%[1] vs. 77.8%[3], respectively). According to a previous study of urban elderly males, high prevalence of vitamin D insufficiency of 48%[4] was found (using the calcidiol level of 40 ng/mL as the threshold). In the current study of elderly, rural vs. urban males, the prevalence of vitamin D insufficiency was significantly lower than urbanites (13.6%), as was found for females (15.4%)[1]. The most important factors were differences in life style: rural folk spent the day farming under the sun, whereas urbanites worked indoors and avoided direct, unprotected exposure.

The correlation between serum calcidiol and PTH level among elderly, rural, males in the current study was not significant (n = 66 cases; r = -0.072; *p* = -0.57). By comparison, there was a modest negative correlation for these variables among elderly, urban, males (n = 100 cases; r = -0.217; *p* = 0.03). There was not, however, any significant correlation in the pooled data (total 166 cases; r = -0.058, *p* = 0.45). This finding was similar to that of Saquib et al (2006)[10] who examined the distribution and determinants of serum calcidiol and PTH in more than 400 cases of older men (mean age 74) living in southern California between 1970 and 2000. Their results showed no significant correlation between serum calcidiol and PTH (r = -0.05, *p* = 0.3), which they believed was due to the very low prevalence of vitamin D insufficiency (only 10% of cases).

Seeman (1995)[11] hypothesized that the age-related decline in testosterone, adrenal androgens, growth hormone and insulin like growth factor-1 may contribute to reduced bone formation and bone loss and cause osteoporosis in men. In the STRAMBO study, Chaitou et al (2010)[12] studied 1,149 men between 19 and 85 years of age and found that both bone formation and bone resorption markers in the men under 30 were high, but that these variables decreased until age 50, and thereafter remained stable. Accordingly, low bone turnover is usually the principle cause of osteoporosis in men, in contrast to females in whom high bone turnover is the principle cause.

The latter is consistent with our study of urban, elderly, males, which revealed low bone turnover (i.e., both bone formation and bone resorption) compared with normal, young adult, reference males (20-45 years)[4]. In the current study (Table 4), a higher level of bone turnover markers (both bone resorption and formation markers) were observed in rural, elderly, males than their urban counterparts, and within the reference range of normal, young adult, Thai males (20-45 years); indicating that the bone quality of rural elderly males is better than that of their urban counterparts.

These observations may be due to differences in lifestyle; as rural, elderly, males often do strenuous on-farm work, while urban, elderly, males usually work at an office or stay home. Vincent et al (2002)[13] confirmed this in a 6-month study on high- vs. low-intensity resistance exercise on bone mineral density (BMD) and biochemical marker of bone turnover in males and females 60-83 years of age. The subjects were divided into 3 groups (control (16 cases), low-intensity exercise (24 cases), and high-intensity exercise (22 cases)). The results showed that BMD of the femoral neck and bone specific alkaline phosphatase in the high intensity exercise group significantly (p<0.05) increased over the baseline. Similarly, osteocalcin significantly increased in both the low- and high-intensity exercise groups vs. baseline, while no significant changes occurred in either BMD or bone turnover markers in the control group. Their study suggests that resistance exercise could increase both BMD and bone turnover markers in the elderly.

Conclusion

Rural, elderly males in Khon Kaen had a markedly lower prevalence of vitamin D insufficiency and normal bone turnover markers than their urban counterparts (13.6% vs. 48%), suggesting better bone quality. The more physically demanding rural lifestyle may account for the differences.

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Potential conflict of interest

None.

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ความชุกของภาวะพร่องวิตามินดีในบุรุษสูงอายุที่อาศัยอยู่ในเขตชนบท จังหวัดขอนแก่น ประเทศไทย

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ภูมิหลัง: วิตามินดีมีความจำเป็นต่อร่างกายมนุษย์อย่างมากโดยเฉพาะต่อความแข็งแรงของกระดูก จากการศึกษาที่ผ่านมาพบว่าบุรุษสูงอายุในเขตเมืองมีภาวะพร่องวิตามินดีร้อยละ 48 และบุรุษสูงอายุเหล่านี้มีอัตราการหมุนเวียนของกระดูกที่ต่ำกว่าค่าปกติ

วัตถุประสงค์: เพื่อศึกษาหาความชุกของภาวะพร่องวิตามินดีและอัตราการหมุนเวียนของกระดูกของบุรุษสูงอายุในเขตชนบท และเปรียบเทียบกับบุรุษสูงอายุในเขตเมือง

ผลการศึกษา: ความชุกของภาวะพร่องวิตามินดีของบุรุษสูงอายุในเขตชนบทอยู่ที่ร้อยละ 13.64 บุรุษสูงอายุในเขตชนบทมีระดับของ calcidiol, iPTH, β-CTx และ PINP สูงกว่าบุรุษสูงอายุในเขตเมืองอย่างมีนัยสำคัญ ($p<0.05$) โดยที่ระดับของ bone turnover marker ทั้งการสร้าง (PINP) และการสลายกระดูก (β-CTx) ของบุรุษสูงอายุในเขตชนบทอยู่ในเกณฑ์ปกติ ขณะที่บุรุษสูงอายุในเขตเมืองอยู่ในระดับต่ำกว่าปกติ เมื่อเทียบกับค่าอ้างอิงของบุรุษหนุ่มช่วงอายุ 20-45 ปี ของประเทศไทย

สรุป: บุรุษสูงอายุในชนบทมีภาวะพร่องวิตามินดีต่ำและมีการสร้างกระดูกที่สูงกว่าบุรุษสูงอายุในเขตเมือง เชื่อว่าเนื่องจากมีการใช้ชีวิตประจำวันที่ต่างกัน