

Vitamins, electrolytes and haematological status of urban construction site workers in Bangkok

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Vitamins, electrolytes and haematological status of 106 construction site workers were investigated. Most of the workers were from the northeastern part of the country. 3.4% of male workers were found to be anaemic, however, an even higher percentage was detected for females. Thiamin deficiency in males was 10.3%, compared to a 5.2% deficiency in females. It has been suggested thiamin deficiency might be one of the nutritional factors contributing to sudden unexplained nocturnal death syndrome (SUNDS) as found in workers. High percentage of vitamin C, vitamin B₂ and B₆ deficiencies were observed, possibly related to insufficient dietary vitamin intake and the interference of drugs. Low serum potassium level or hypokalemia was found in about 10.3% of male and 5.6% of female workers.

Introduction

The rapid pace of socio-economic development in south-east Asia, especially, developing countries, has increased the demand for labour in building construction, manufacturing and shipbuilding industries. The change from a rural into an industry-oriented society has become prevalent. This condition is true throughout southeast Asia, ie Thailand, Singapore, Malaysia, Indonesia, etc. In Thailand, the majority of construction site workers, males and females, are from rural areas particularly the northeast and the north¹. The workers must alter their environment and lifestyle from rural farmer to labourer, requiring much strength and adaptation. Changes in habits, such as eating, drinking and smoking, therefore, occur frequently²⁻⁴. The effects of these changes on the health status of workers are unknown. However, reports of 'sudden unspecified nocturnal death syndrome (SUNDS)' from Singapore, Brunei and Middle-eastern countries have been reported⁵. Workers were particularly males from the northeast and the north of Thailand. The causes of these sudden deaths are still uncertain, nevertheless, nutritional factors (vitamin B₁, or thiamin deficiency) are thought to be one of the factors of heart arrest. Moreover, low activity of Na, K-ATPase, membrane transport enzymes for Na/K, was detected in certain northeast Thai populations⁶. So, lower intracellular erythrocytic potassium concentrations (RBC-K) and hypokalemia associated with low urinary potassium

excretion might also be a reason for sudden unexplained deaths among Thai workers⁷.

To get an overview of the health and nutritional status of construction site workers in Thailand, nutritional status, especially vitamins, electrolytes, and haematological status in construction site workers were investigated in a cross-sectional study. The results could afford recommended strategies to improve and maintain their health and nutritional condition.

Materials and methods

Subjects

106 workers (87 males and 19 females) from a construction site near Pattanakarn Road, Klongton district, Bangkok participated voluntarily in the study. Most of the workers were from the northeastern part of the country. Age, sex, marital status, residence of spouses, home province and district, as well as original occupation were recorded from each individual under investigation. Fasting venous blood was also collected.

Analytical method

Heparinized blood was used to determine haemoglobin

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and haematocrit (packed cell volume). Haemoglobin concentration in whole blood was determined by modified cyanmethemoglobin method⁸. Haematocrit was measured by micromethod using calibrated heparinized capillary tubes. The tubes of blood were centrifuged for 5 minutes at 1400 g (IEC MB microhaematocrit centrifuge). Haematocrit was measured by means of a microhaematocrit reader (Hawksley, England). Mean corpuscular haemoglobin concentrations (MCHC) were calculated by dividing the haemoglobin concentration (g/dl) with the haematocrit (%), multiplied by 100.

Red blood cell haemolysate was prepared and stored at -20°C for not longer than one week and used afterwards for vitamin B₁, B₂ and B₆ determinations.

Vitamin B₁ status was assessed using erythrocyte transketolase activity⁹. The values of 1.25 α ETK (activation coefficient) and above indicate a real deficiency in vitamin B₁ status.

Vitamin B₂ status was assessed using erythrocyte glutathione reductase activity¹⁰. Values of 1.5 α EGR and above indicate a deficiency in vitamin B₂ status¹¹.

Vitamin B₆ status was assessed using erythrocyte aspartate aminotransferase activity¹². Values of 2.00 α EAST and above indicate a deficiency in vitamin B₆ status.

Vitamin C status was determined according to the method described by Liu et al.¹³. Values below 5 $\mu\text{g/l}$ indicate a deficiency in vitamin C.

Serum sodium, potassium and chloride determination was conducted by $\text{Na}^+/\text{K}^+/\text{Cl}^-$ (CIBA-CORNING Diagnostics Ltd)¹⁴. The cut-off point of sodium, potassium and chloride were reading less than 135 mmol/l, 3.5 mmol/l and 98 mmol/l respectively.

Statistical analysis

The results were expressed as median, range and 95% confidence interval (CI). The data were coded and

analysed by using a standard statistical method provided by the Minitab computer program¹⁵.

Results

Medians, ranges and 95% CI of all parameters including age, haematological values, vitamins status and electrolytes are given in Table 1. Haemoglobin concentration, haematocrit and MCHC were found to be higher in male than in female workers. No significant difference in vitamin B was observed between male and female workers. Serum vitamin C concentration in men was statistically lower than in women, however, there was no significant difference in electrolyte concentration between workers of either gender.

Table 2 shows the percentage of anaemia in male and female construction site workers. About 3.4% of anaemia was present in male workers using only haematocrit as an indicator, however a higher percentage of anaemia was found in females when using MCHC as an indicator of anaemia.

Vitamin status of construction site workers represented as deficiencies in percentage using the reference cut-off point was shown in Table 3. Vitamin B₁ deficiencies in males was 10.3% compared to a 5.2% deficiency in females. There were high percentages of vitamin B₂ (46% in males and 36.8% in females) and B₆ deficiencies in both sexes (23% in males and 26.3% in females) (Table 3). 83.9% of male and 55.5% of female workers were shown to be vitamin C deficient (Table 3).

Sodium concentration of workers was sufficient in both sexes (Table 4). About 10.3% of males and 5.6% of females were found to exhibit hypokalemia (Table 4).

Discussion

The economic expansion of Thailand has resulted in

Table 1. Medians, ranges and 95% confidence interval (CI) of haematological data, vitamin B, vitamin C and electrolyte value in construction site workers

Parameters	Male Median (ranges) (no.=87)	95% CI	Female Median (ranges) (no.=19)	95% CI	P-value
Age (yrs)	26 (16-68)	25-30	28 (15-59)	23.4-33.3	0.97
Haemoglobin (g/dl)	16.5 (13.5-19.8)	16.2-16.8	13.7 (12.3-15.2)	13.3-14.1	0.0000*
Haematocrit (%)	45 (36-50)	45.0-45.1	40 (36-42)	38.9-40.2	0.0000*
MCHC	36.7 (31.6-40.0)	36.2-37.2	35 (30.6-38.4)	33.7-36.1	0.0005*
α ETK	1.06 (0.74-1.55)	1.05-1.08	1.07 (0.79-1.22)	0.99-1.14	0.65
α EGR	1.42 (0.76-2.50)	1.33-1.54	1.36 (1.00-2.00)	1.16-1.54	0.53
α EAST	1.75 (1.00-3.50)	1.67-1.82	1.77 (1.38-3.07)	1.63-1.96	0.54
Vitamin C ($\mu\text{g/l}$)	2.90 (0.00-12.60)	2.30-3.50	4.75 (1.60-9.40)	3.81-6.39	0.0006*
Sodium (mmol/l)	143 (139-148)	143-144	143 (142-146)	142-144	0.96
Potassium (mmol/l)	3.9 (3.1-4.6)	3.8-4.0	3.9 (3.4-4.2)	3.7-4.0	0.89
Chloride (mmol/l)	105 (102-109)	105-106	106 (103-108)	105-107	0.39

*Mann-Whitney U Wilcoxon Rank Sum W Test (two-tailed)

Table 2. Haematological deficiencies in construction site workers indicated as non-anaemia and anaemia.

Parameters*	Male (no.=87)		Female (no.=19)	
	non-anaemia	anaemia	non-anaemia	anaemia
Haemoglobin (g/dl)	87(100%)	0 (0.0%)	19(100%)	0 (0.0%)
Haematocrit (%)	84(96.6%)	3 (3.4%)	19(100%)	0(0.0%)
MCHC	86(98.8%)	1 (1.2%)	17(89.5%)	2(10.5%)

*Values indicating haematological deficiencies are, for males: haemoglobin <13 g/dl; haematocrit <40%; MCHC <33 g/dl; and for females: haemoglobin <12 g/dl; haematocrit <36%; MCHC <33 g/dl.

Table 3. Vitamin B and vitamin C status in construction site workers indicated as acceptable values and deficiencies.

Parameters	Male (no.=87)		Female (no.=19)	
	acceptable	deficiencies	acceptable	deficiencies
B ₁ status (α ETK) (cut-off point <1.25)	78 (89.7%)	9 (10.3%)	18 (94.8%)	1 (5.2%)
B ₂ status (α EGR) (cut-off point <1.50)	47 (54.0%)	40 (46.0%)	12 (63.2%)	7 (36.8%)
B ₆ status (α EAST) (cut-off point <2.00)	67 (77.0%)	20 (23.0%)	14 (73.7%)	5 (26.3%)
Vitamin C status (cut-off point >5 μ g/l)	14 (16.1%)	73 (83.9%)	8 (44.5%)	10 (55.5%)

Table 4. Sodium, potassium and chloride values in construction site workers indicated as acceptable and deficiencies.

Parameters	Male (no.=87)		Female (no.=18)	
	acceptable	deficiencies	acceptable	deficiencies
Sodium (cut-off point >135 mmol/l)	87 (100%)	0 (0.0%)	18 (100%)	0 (0.0%)
Potassium (cut-off point >3.5 mmol/l)	78 (89.7%)	9 (10.3%)	17 (94.4%)	1 (5.6%)
Chloride (cut-off point >98 mmol/l)	87 (100%)	0 (0.0%)	18 (100%)	0 (0.0%)

ongoing building construction. This rapid growth of an industry-oriented society is occurring primarily in cities, in particular Bangkok. The increased building construction, manufacturing and shipbuilding requires many more labourers, resulting in a migration from rural areas of the northern and northeastern part of Thailand greater than in years passed. The ages of workers of both genders were 21–30 years. Yamwong and colleagues stated that the labourers able to work abroad were young people and the majority of them were from the north and the northeast¹. This might be attributed to the intent of the low socio-economic groups and this generation to seek work as a means of improving their economic status, thus achieving a better quality of life.

Anaemia can result from many nutritional mechanisms, singly or in combination. The principal nutrients depletion are iron, folic acid, and vitamin B₁₂¹⁶. To assess the nutritional status in terms of anaemia, haemoglobin estimations, haematocrit (packed cell volume and MCHC are the useful screening test for the diagnosis¹⁷.

Haemoglobin concentration, haematocrit and MCHC were quite high in males. This might be the consequence of the difference in job description. Male workers were usually carpenters, iron workers and foremen, whereas female workers were general labourers and office clerks. These observations could be due to the male workers

being directly exposed to heat at work, causing them to lose a large amount of water through sweating and resulting in haemoconcentration. Moreover, most of the female workers were of child-bearing age, higher iron loss may be the cause of lower level of their haematological parameter compared with male workers. It is more common in women, because of menstrual losses and the drain of repeated pregnancies¹⁸.

Using the cut-off point of haemoglobin concentration as an indicator of anaemia¹⁹ workers of neither sex were considered anaemic, however, haematocrit or MCHC values indicated an anaemic status of about 3.4% in male workers and 10.5% in female workers. It is shown in other reports that the prevalence of anaemia in Thai labourers was quite high (11.3% in males and 24.5% in females)²⁰. The lower percentage of anaemia in this study seems to be related to working conditions at the construction site.

In this study, about 10% of the workers exhibited thiamin deficiency, especially in males. It was previously postulated that thiamin deficiency could be a cause of these sudden deaths²¹. A low thiamin intake and consumption of raw fermented fish products containing thiaminase among northeastern Thais might contribute to thiamin deficiency²². Thiamin deficiency was also reported in 144 villagers living in Ubol province, north-

east Thailand²³. They suggested that the basis of their thiamin malnutrition was faulty energy intake, derived mainly from milled rice and consumption of foods containing anti-thiamin factors. Contrary to results from the study of Thai construction workers from north-eastern Thailand, those who have returned from Singapore have blood thiamin levels within normal limits⁵. It was also reported in a recent survey of Thai workers in Singapore that there was no association of thiamin deficiency and sudden unexplained nocturnal death syndrome (SUNDS)⁷. However, Munger et al.²⁴ suggested that thiamin deficiency was one of the nutritional factors for SUNDS when it occurred coincidentally with the other factors. Therefore, thiamin deficiencies may play an important role in developing and applying schemes for nutritional intervention.

About 45% and 23.5% of workers seem to suffer from B₂ and B₆ deficiencies respectively in both sexes. However, no clinical signs of these vitamin deficiencies have been observed. This is not a special point of interest, because of the already known presence of B₂ and B₆ deficiencies in the Thai population²⁵. They reported that 22% and 4.4% of normal healthy persons age of 25–57 years were vitamin B₂ and B₆ deficient respectively²⁵. It has been stated that 50% of the mothers and 15% of the newborns from the northeast were B₂ deficient²⁶. Vitamin B₂ or riboflavin deficiency is also prevalent in the southern part of Thailand as reported by Panich & Pornpatkul²⁷ that 59% of school children under 15 years old in Songkhla province had biochemical riboflavin deficiency. Pongpaew et al.²⁸ also showed that the percentage of riboflavin deficiency in Thai elderly was notably high (37.3% in males and 33.6% in females). Vitamin B₆ or pyridoxine deficiency is also the major problem in northeast Thailand²⁹. A high prevalence of biochemical pyridoxine deficiency still exists in village preschool children and school children when compared with Bangkok and Khon Kaen healthy children respectively^{12,30}. Four per cent of Bangkok preschool children showed pyridoxine deficiency compared to 22% in village preschool children^{9,12}. These vitamin deficiencies in workers may be related to insufficient dietary vitamin intake. Further investigation concerning the requirements and the actual intake of vitamin B₂ and vitamin B₆ in different groups of Thai population are also necessary.

Median value of vitamin C concentration in both sexes was found to be below the normal value (5 µg/l) especially in male workers. In Thailand, fruits with a high vitamin C content are readily available. The interference of paracetamol and aspirin tablets with vitamin C absorption, however, might have occurred because of harsh physical demands and analgesic drug use. Thus, more information about drug and nutrient interaction should be required.

In our study, 10.3% of male and 5.6% of female workers were found to suffer from potassium deficiency. Potassium is an important trace element having a significant influence on cardiac rhythm and conduction³¹. Hypokalemia with distal renal tubular acidosis is common among women in northeast Thailand³². A recent paper reported that the low activity of Na, K-ATPase, membrane transport enzymes for Na/K, was detected in a certain northeast Thai population⁶. A five-year retrospective study of 35 patients identified as

having been treated for primary hypokalemic periodic paralysis (PHPP) in Khon Kaen Regional Hospital was performed, most of them being male workers, age 20–44 years³³.

It should be noted that fruit which is a good source of potassium is abundant in Thailand, however, potassium deficiency is still highly prevalent in these workers. The workers might prefer to purchase the tonic drink which is very popular among workers in Thailand to refresh themselves in order to regain their strength and vitality. It is interesting to note that some workers may drink this tonic drink more than eating fruit. Moreover, the distribution of fruit supply in the work areas might be scarce. Therefore, hypokalemia and potassium deficiency might be a potential problem of Thai workers. Dietary intake with high potassium or potassium supplementation should be recommended to the group of construction site workers.

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城市建築工地工人的維生素、電解質和血液狀況 摘要

作者研究了106位建築工地工人的維生素、電解質和血液狀況，絕大部分工人是來自泰國的東北部，他們發現3.4%男工人患有貧血，而女工人的發病率更高。硫胺素缺乏在男工人為10.3%，女工人為5.2%。作者指出硫胺素缺乏也許是工人們突然的、未能解釋的夜間死亡綜合症(SUNDS)的營養因素之一；作者觀察到工人們有高百分數的維生素C, B₂和B₆的缺乏，這可能與膳食維生素進食不足或藥物的干擾有關。作者亦發現低血清鉀水平或低血鉀在男工人占10.3%，女工人占5.6%。

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บทคัดย่อ

คณะผู้วิจัยได้ทำการศึกษาระดับ วิตามิน, อิเล็กโทรไลต์ และสถานะทางโลหิตวิทยาของคนงานก่อสร้าง 106 คน ในกรุงเทพฯ ซึ่งส่วนใหญ่จะมาจากภาคตะวันออกเฉียงเหนือของประเทศไทย พบภาวะโลหิตจางในคนงานชายประมาณร้อยละ 3.4 ส่วนในคนงานหญิงจะสูงกว่า การขาดวิตามินบีหนึ่ง ในผู้ชายมีประมาณร้อยละ 10.3 เมื่อเปรียบเทียบกับในคนงานผู้หญิงคือประมาณร้อยละ 5.2 การขาดวิตามินบีหนึ่งอาจจะเป็นปัจจัยทางโภชนาการปัจจัยหนึ่งที่มีส่วนร่วมในการทำให้เกิดโรคไหลตายขึ้นในกลุ่มคนงาน มีการขาดวิตามินซี, วิตามินบีสอง และวิตามินบีหกในปริมาณที่สูง ซึ่งอาจจะเกี่ยวเนื่องมาจากการได้รับวิตามินเหล่านี้จากอาหารไม่เพียงพอ หรือเป็นผลจากรบกวนจากการรับประทานยาต่างๆ ระดับโปแตสเซียมในซีรัมต่ำพบได้ในคนงานชายร้อยละ 10.3 และคนงานหญิงร้อยละ 5.6