Thiamine deficiency is associated with ethnicity in a subtropical area of China

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Clinical signs which probably indicate thiamine (vitamin B_1) deficiency have been evident in the Meng Ding District of Yunnan province, China for decades. In 1990, 5979 people were surveyed using cluster sampling to investigate the association of signs of thiamine deficiency with potential causative factors.

Data on past and present symptoms of thiamine deficiency were collected from individual subjects, hospital records and health care personnel. Information on staple food intake over the previous three months was collected from both individual subjects and from commune administrations.

Signs of thiamine deficiency occurred most often in the Dai ethnic group. 5.1% of Dai males and 6.6% of Dai females had met criteria for thiamine deficiency at some time over the previous 7 years. In other ethnic groups, signs of thiamine deficiency occurred in only 0.1% of males and 0.2% of females over the same time period. The incidence of signs of thiamine deficiency did not vary with time during the 7 years prior to the survey, however the condition appeared to be more severe (resulting in more cases of hospitalization) in 1983–1985. Signs of thiamine deficiency showed a seasonal distribution with the highest rates occurring in the hot, dry season. Signs of thiamine deficiency were common among Dai women after childbirth.

The findings indicate that thiamine deficiency is strongly associated with ethnicity in this population. It is likely that thiamine undernutrition is associated with dietary intake and practices which differ by ethnic group. Public health measures to minimize thiamine undernutrition in the Dai group include education and supplementation.

Introduction

The Meng Ding District of Yunnan Province in Southern China is a sub-tropical area with a population of about 22 000. The population consists of five major cultural groups, the largest of which is the Dai minority. The Meng Ding District is the traditional home of the Dai people. The local legend of the 'Pippa Ghost' was heard by one of us (SL) on a visit to the region in 1987–88.

The 'Pippa Ghost' periodically visited the district and attacked people. If new born infants were attacked they did not survive. If adults were attacked, the 'Pippa Ghost' stole their hearts. They could not walk or stand up, and they developed swollen faces and feet ('moon face' and 'elephant feet'). The legend related that the ghost would attack one person first, and would be transformed to attack the whole village, and then the whole area. If local people found a person who had been attacked, they would isolate him or her in an remote place until they recovered or died. The 'Pippa Ghost' had last attacked the district in 1983–85 and had resulted in the deaths of at least 10 infants less than 5 months of age. The population was panicked by the mysterious 'Pippa Ghost' and both conventional and traditional medical treatment seemed ineffectual against the condition. In the course of many different treatments, a local medical officer tried intravenous injection of thiamine which was observed to be effective. Barefoot doctors in the district were issued thiamine in tablet form and in form suitable for injection.

Although an effective treatment for the condition had been found, unresolved questions remained regarding the epidemic nature of disease occurrence and the distribution of disease among the population of the district. The legend of the 'Pippa ghost' remained a strong local belief and threat.

This study was carried out to determine what specific factors were important in leading to the outbreaks of thiamine deficiency disorders. With the identification of such factors, it may be possible to implement cost-effective and appropriate public health measures for the primary prevention of future outbreaks. In this way the legend of the 'Pippa Ghost' could be put to rest.

Subjects and methods

Study population

A cross-sectional survey was undertaken in the Meng Ding district in 1990 using cluster sampling. Clusters were defined by residential villages, ethnic group, geographic factors, and socio-economic status.

The final sample contained 5979 people from five ethnic groups, ie about 25% of the population. Data were collected on past (dating to 1983) and present symptoms of thiamine deficiency from individual subjects by questionnaire, from hospital records and from health care personnel. The

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questionnaire was piloted, interviewers were trained in standardized interview procedures, and the completion of questionnaires cross- checked by the chief investigator.

Criteria for vitamin B_1 deficiency

A case of thiamine deficiency was defined as an episode where the following three criteria were met: (1) low dietary intake of thiamine for at least 3 months as measured by history of staple food intake; (2) clinical symptoms such as restlessness, vomiting, undue crying, some puffiness of face and feet and/or breathlessness with or without convulsions for infants; difficulty in rising from a squatting position, increasing heaviness, then weakness, effecting the lower limbs, complaint of cold or burning feet, tingling of the toes, cramping pains in the calves, and/or swelling of the face and the feet for adults; (3) effectiveness of thiamine administration within 3 days by injection or within 7 days by oral tablet.

Classification of cases was made by joint consultation between the chief investigator, the local medical officer and the interviewer.

Staple food intake over the previous 3 months was measured using a food history, and double-checked using the food allocation record from the commune to which that subject belonged. In China, during the study period, members of a commune were allocated staple food annually according to age, sex, labour category and the total production of the commune. Information was collected on cooking methods, dietary style, and cultural taboos associated with food and diet.

Data regarding socioeconomic factors were collected from commune administrations, and geographic and climatic information was obtained from local administrators.

Statistical analysis

In order to examine temporal trends of thiamine deficiency, the retrospective study period was divided into two 3-year periods and one period of 16 months. These were: period I (Jan 1983 to Dec 1985), period II (Jan 1986 to Dec 1988) and period III (Jan 1989 to April 1990).

Episodes of thiamine deficiency might occur more than once in a subject therefore the incidence was calculated using person-years of observation as the denominator. Confidence intervals were calculated for rates where appropriate, assuming a Poisson distribution for occurrences of thiamine deficiency[1]. Significance tests were double-sided, with a P-value of <0.05 being considered significant.

Results

Demographic structure of the study sample

The study sample was similar to the district population in

Table 1. Ethnic composition of the study sample (SS) compared to the district population (D).

Ethnic group	Males		Females		Total		Overall%	
	SS	D	SS	D	SS	D	SS	D
Dai	1932	8107	1952	8286	3884	16391	65.0	72.1
Han	459	1693	455	1558	914	3251	15.3	14.3
Wa	358	1324	370	1313	728	2637	12.2	11.6
Jinpo	99	99	102	102	201	201	3.4	0.9
Deang	109	109	143	143	252	252	4.2	1.1
Total	2957	11332	3022	11402	5979	22734	100.0	100.0

Table 2. Incidence of thiamine deficiency by ethnic group during 1983–90.

Ethnic group	Cases[a]	Person years (py)	Incidence (per 1000 py)	95% CI[b] Interval
Dai (Shui)	675	22504	30.0	(27.7–32.3)
Dai (Han)	121	10332	11.7	(9.6–13.8)
Han	4	5810	0.7	(0.2–1.8)
Wa	9	3901	2.3	(1.1–4.4)
Jinpo	0	1478	0	–
Deang	0	1341	0	–
Mixture	0	969	0	–
Others	0	12	0	–
Total	809	46347		

[a] Cases = occasions of thiamine deficiency; [b] CI = confidence interval

Table 3. Incidence of thiamine deficiency in Dai and Non-Dai ethnic groups over different calendar periods.

	Ethnic group					
	Dai			Non-Dai		
Period	Cases[a]	Person-years (py)	Incidence per 1000 py (95% CI)	Cases[a]	Person years (py)	Incidence per 1000 py (95% CI)
I	250	9611	26.0 (22.8–29.2)	5	4668	1.1 (0.3–2.5)
II	321	10378	30.9 (27.5–34.3)	7	5112	1.4 (0.5–2.8)
III	225	7477	30.1 (26.2–34.0)	1	3680	0.3 (0.0–1.5)
Total	796	27466	29.0	13	13460	1.0

[a] Cases = occasions of thiamine deficiency.

proportion from each ethnic group and from each gender (Table 1). The largest ethnic group in the district is the Dai minority. There was no significant difference in the age distribution of each ethnic group between the study sample and total district population (data not shown). The sample population was 26.3% of the total district population.

Ethnic groups

Most of the cases of thiamine deficiency occurred among the Dai ethnic group (Table 2). There are two subgroups of the Dai group in the district, Shui Dai and Han Dai. Comparison between these two subgroups indicated that the Shui Dai had a significantly higher incidence of thiamine deficiency than the Han Dai ($P<0.01$).

Few cases were observed in other ethnic groups. Nine cases were found in the Wa ethnic group and four cases in the Han group. No cases were observed in Han residential villages – the four cases among the Han group occurred in people married to Dai people and living in Dai villages. In contrast, no cases were observed among Dai people who intermarried with other ethnic groups and adopted a non-Dai lifestyle.

Calendar time

There was no significance difference in the incidence of thiamine deficiency between the three time periods analysed (Table 3). An examination of hospital admissions for thiamine deficiency (Table 4) suggests that the proportion of severe cases of thiamine deficiency admitted to hospital during the later time periods was decreased.

Table 4. Hospital admissions for suspected thiamine deficiency, 1983–1990.

Investigation period	Stay < 1 week		Stay > 1 week	
	n	%	*n*	%
I	133	85.8	22	14.2
II and III	171	93.4	12	6.6
Total	304		34	

Table 5. Thiamine deficiency in Dai males and females during period III.

	Male	Female
Cases (first occurrence only)	97	126
Total sample	1908	1898
Prevalence (per 1000)	50.8 (40.7–61.0)	66.4 (54.8–78.0)

From 1983 to 1990, the Meng Ding district hospital admitted 338 cases of suspected thiamine deficiency, 168 (49.7%) being admitted during the dry hot season (April to June).

Gender

In Dai subjects, the prevalence of thiamine deficiency for period III by gender is shown in Table 5. The prevalence for women was significantly greater than that for men ($P=0.04$).

Of the 338 cases admitted to Meng Ding District hospital from 1983 to 1990, 207 (61.2%) were female – 162 (78.3% of female cases) were admitted within three months post partum. During period III, 93 of 126 (73.8%) women in the study sample who gave birth were diagnosed with thiamine deficiency within three months of delivery.

Of 13 cases of thiamine deficiency observed in non-Dai ethnic groups during the study period, nine were Wa women living in Wa villages, and three were Han women married to Dai men and living in Dai villages. Only one case was male – a Han male married to a Dai women and living in a Dai village.

Age

The age distribution of cases of thiamine deficiency is shown in Table 6. Age groups were selected according to labour categories. The prevalence *of thiamine deficiency* in the 19 to 54 year age group was significantly greater than that in the 12 to 18 year age group ($P=0.03$).

Staple food

The incidence of thiamine deficiency was greater for people

Table 6. Age distribution of cases of thiamine deficiency in Dai and Non-Dai ethnic groups during period III.

	Ethnic group					
	Dai			Non-Dai		
Age group[a] (years)	Cases[b]	Sample	Prevalence (per 1 000)	Cases[b]	Sample	Prevalence (per 1 000)
0 – 11	0	1037	0.00	0	716	0.00
12 – 18	36	567	63.5 (44.4–87.8)	0	352	0.00 (0.5–2.8)
19 – 54	174	1884	92.3 (78.6–106.1)	2	940	2.1 (0.3–7.7)
55 –	13	318	40.9 (21.7–69.8)	1	165	6.1 (0.1–33.9)
Total	223	3806	58.6	3	2173	1.4

[a] Age groups were devised according to labour categories: 0 – 11 years: non labour, 12 – 18 years: half labour, 19 – 54 years: whole labour, 55 + years: half labour.
[b] First occurrence only.

Table 7. Incidence of thiamine deficiency in Dai and Non-Dai ethnic groups during the period Jan 1983-April 1990 in relation to usual staple food eaten.

	Ethnic group					
	Dai			Non-Dai		
Staple food (rice)	Cases[a]	PY[b]	Incidence (per 1 000 py)	Cases[a]	PY[b]	Incidence (per 1 000 py)
Mainly glutinous	95	3041	31.2 (25.0–37.5)	0	56	0.00
Mainly plain	189	8134	23.2 (19.9–26.5)	13	12375	1.0 (0.6–1.8)
Mixture of two	512	16291	31.4 (28.7–34.1)	0	1021	0.00
Total	796	27466	29.0	13	13460	1.0

[a] Cases = occasions of thiamine deficiency; [b] py = person years observed.

who ate mainly glutinous rice, or a mixture of glutinous and plain rice (Table 7). The incidence rate was significantly lower for people who ate mainly plain rice, however Dai plain rice eaters accounted for a large number of cases. When stratified into Dai and non-Dai ethnic groups, it is apparent that all 13 cases in the non-Dai group were mainly plain rice eaters.

Discussion

Thiamine deficiency was quite common in Asia at the turn of the century[2] mainly as a result of refining staple foods, in particular rice. In recent years, the appearance of widespread thiamine deficiency has been reported in Japan[3], Gambia[4] and Southern Africa[5, 7]. While thiamine deficiency appears to be associated with high alcohol intake in Southern Africa and in developed countries[8], this was not the case in Gambia or Japan where intake of refined carbohydrate was suggested to be the major factor.

The occurrence of thiamine deficiency over the period of this study (1983–90) in the Meng Ding district of Yunnan Province, China constitutes a considerable public health problem. The identification of 223 people in the study group with overt signs of thiamine deficiency over a 16-month period is likely to mask the presence of significant subclinical thiamine undernutrition in the district. The resulting illness and loss of work capacity[6] in the population can be expected to cause hardship which should be easily preventable by addressing factors associated with inadequate thiamine intake.

Episodes of thiamine deficiency occurred mainly in the Dai ethnic group, and were associated with age, gender, and consumption of glutinous rice. There are plausible explanations for the association of each of these factors with thiamine undernutrition.

The Dai people traditionally have only glutinous rice as their staple food. Glutinous rice is more difficult to husk,

therefore it is treated more intensively than plain rice. Highly refined rice is a symbol of status. In some villages, people compete to eat the finest rice. Glutinous rice also takes a longer time to cook. The method of preparation used by Dai people is to soak it overnight, and to wash it at least three times before cooking. It is cooked in large volumes of water which are discarded after the completion of cooking. These traditional methods of preparation of rice are also used by the Dai people for cooking plain rice. The intensive rice preparation methods result in a large loss of thiamine and have been associated with thiamine deficiency in other populations[2–4]. While other local foods, such as some green leaf vegetables, contain substantial amounts of thiamine, the production and consumption of these vegetables in the Meng Ding district is very limited, due to the hot climate and poor transportation.

The highest rate of thiamine undernutrition occurs in the age groups which provide the most labour in this labour-intensive society. Further evidence for the association of thiamine undernutrition with the group undertaking the hardest labour is the observation that the peak incidence period for signs of thiamine deficiency is April to June. This is the busiest and hottest season of the year, combining the harvest of the dry season crop and the planting of the next season's crops before the rainy season. Labourers work harder and longer hours in this season. Energy requirement is increased and typically the food intake for labourers is glutinous rice balls because they have appropriate keeping qualities for field work. A high intake of carbohydrate results in higher demand for thiamine because a primary role for thiamine is in the metabolism of carbohydrate[9].

The higher occurrence of thiamine deficiency among women may be related to cultural food taboos after childbirth. For 100 days after giving birth Dai women are not allowed to eat any staple foods other than glutinous rice with water and salt. A few animal foods such as pork, fish, chicken or beef are allowed as supplements but must be derived from pure coloured (except black) animals. This often makes supplementary foods nearly impossible to obtain. Marriages across ethnic groups in the study population support the important contribution of cultural food taboos in contributing to the development of thiamine deficiency. The nine cases of thiamine deficiency among the Wa ethnic group occurred in women who followed Dai cultural traditions either because their families had Dai cultural influences, or they could afford to follow Dai traditional practices in order to 'show off' within their village. Women from the Han ethnic group who married Dai men were found with thiamine deficiency, but none of the Dai women who married men from the Han or any other ethnic group were discovered to have had the condition. Marriages across ethnic groups are not common in the district.

We found that there was no significant change in the prevalence of thiamine deficiency with time over the period of the study, but that the severity of thiamine undernutrition seemed to be greater earlier in the study period. In 1986, floods caused a change of course of a major river resulting in the destruction of many agricultural fields. New fields were not suitable for glutinous rice planting, and the Dai people grew much more plain rice with a resultant change to their staple food intake.

The Shui and Han Dai are closely related ethnically and both groups had a high incidence of thiamine deficiency. Han Dai have adopted cultural practices that are closer to the Han ethnic group than the Dai group. The incidence of thiamine deficiency was more than doubled among the Shui Dai, providing further evidence that dietary and cultural practices are central to the difference in thiamine nutrition.

To reduce the incidence of thiamine undernutrition in the region, public health measures could be targeted at the Dai ethnic group. Glutinous rice is no longer widely used within the district. There is considerable potential for effective education strategies to result in non-traditional preparation methods for plain rice among the Dai minority, as evidenced by the large proportion of this population who have adopted Han cultural traditions. In addition, supplementation of the regular diet with foods rich in thiamine may be possible. Fortification of rice itself may be difficult because it is milled at village level. One strategy which has been suggested is to produce centrally a flavoured vitamin powder which would become a soft drink when mixed with water. This strategy has the advantage that it could easily target vulnerable groups. For example, it could be promoted as a drink for post-partum women and could be made available for workers during the hot dry harvest season. The vitamin powder drink could also contain other micronutrients and minerals that are likely to be insufficient for needs during vulnerable periods. Although supplementation may be one public health solution for vulnerable groups, efforts should be made to develop a post-partum diet and a worker's diet which is both culturally and nutritionally acceptable for these vulnerable groups.

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中國亞熱帶地區少數民族的硫胺素缺乏症

摘要

幾十年來在中國雲南省 Meng Ding 地區已有明顯的可能是硫胺素（維生素B_1）缺乏的臨床症狀。在 1990 年作者調查了 5979 人並研究了硫胺素缺乏及其可能病因的關係。

作者從個別對象、醫院記錄和健康護理的全體人員收集了過去和現在硫胺素缺乏症狀的數據。並從個別對象和公社行政機關收集了前 3 個月的主要飲食資料。

硫胺素缺乏症最常見於 Dai 族，過去 7 年來 Dai 族中的男性有 5.1%，女性有6.6% 在某些時期患有硫胺素缺乏症。在相同時期，其它少數民族的硫胺素缺乏僅有 0.1%（男性）和 0.2%（女性）。雖然在 1983-1985 年間缺乏情況更加嚴重（更多病例住院），但在調查的 7 年中硫胺素缺乏症狀並無改變。硫胺素缺乏症狀有季節性，炎熱和乾燥季節患病率最高。Dai 族婦女產後最常患硫胺素缺乏症。

這些發現指出硫胺素缺乏病與這些民族關係密切。硫胺素營養不良與飲食和習慣相關，具有民族間的差異。要減少 Dai 族硫胺素營養不良，公共衛生的措施應包括教育和補充硫胺素。