財団法人日中医学協会
2005年度共同研究等助成金 −在留中国人研究者− 報告書

提出日　2006年2月20日

財団法人　日 中 医 学 協 会 御中

貴財団より助成金を受領して行った研究テーマについて報告いたします。

添付資料：　**研究報告書**

中国人研究者名：　**周　歓**　　　㊞

指導責任者名：　渡辺　知保　　　職名：教授

所属機関名：　東京大学大学院医学系研究科

〒 113-0033

所　在　地：　東京都文京区本郷7-3-1

電話：　03-5841-3531　　　内線：　23531

1．助 成 金 額　：　　　600,000 円

2．研 究 テ ー マ　中国・洞庭湖地域の小児にみられる成長遅延と要因の解明

3．成 果 の 概 要 （100字程度）

　中国・洞庭湖地域の学童274名を対象として，成長に関する縦断的調査を4年間にわたって行い，成長の個人差を明らかにするとともに，こうした個人差と寄生虫・栄養状態・居住条件との関連を見いだした。

4．研 究 業 績
　(1) 学会における発表　　　　無　・　　有（学会名・演題）

　(2) 発表した論文　　　　　　無　・　　有（雑誌名・題名）

中国・洞庭湖地域の小児にみられる成長遅滞とその要因の解明

研究者氏名　　　周　歓

中国所属機関　　中南大学湘雅医学院

日本研究機関　　東京大学大学院医学系研究科

指導責任者　　　教授　渡辺　知保

Abstract

To examine growth pattern of rural Chinese schoolchildren and clarify the related impact factors on growth pattern, a longitudinal study of 274 schoolchildren (138 boys and 136 girls) aged 10-12 years in the rural Dongting Lake region in south China were conducted for 4 years (2001-2005). For all participants, anthropometric measurements (height, weight, mid-upper arm circumference, and skinfold thickness at triceps, biceps, and subscapular) were conducted; eggs of parasites (*Schistosoma japonicum*, *Ascaris lumbricoides* and *Trichuris trichiura*) in the collected stool samples were counted by Kato-Katz thick smear technique; long-term dietary intake was assessed with a semiquantitative food frequency questionnaire. Based on the Chinese references established by Chinese National Survey on Students Constitution and Health in 2000, growth status of individual child was classified into adequate (Z score $\geq$ 0), moderately inadequate ($-1 \leq$ Z score < 0) and severely inadequate (Z score < -1) status. Change in the WAZ (weight-for-age Z score) between 2001 and 2005 was used to judge whether each participant maintained or changed growth status within a 4-year period. The results demonstrated that compared with the Chinese references the target schoolchildren as a whole were growth retardation. After the 4-year follow-up, about one third of the participants experienced change in growth statuses with significant differences of change in the Z scores among different growth patterns. Multiple stepwise regression analysis indicated that energy and protein intakes and improvement of schistosomiasis were positively related with change in the Z scores; infection of *T. trichiura* and school dormitory residence were inversely related with change in the Z scores. In conclusion, this longitudinal study revealed *intra*-population variation of adolescent growth pattern with marked differences of change in the Z scores within only 4-year duration and the differences were related with the environmental factors examined.

Key Words　longitudinal study, growth retardation, impact factors, rural Chinese schoolchildren

Introduction:

Any environmental stress, such as helminth infection and malnutrition, may reduce the maximal potential of bone, muscle, and fat tissue responses to hormonal action determining adolescent growth, with considerable intra-population variations.[1] To date, there have been a paucity of longitudinal data addressing how environmental factors affect intra-population differences in adolescent growth pattern.

Our previous research has revealed the simultaneous impacts of inadequate intakes of protein and energy and chronic schistosomiasis infection on retarded growth of preadolescents in the rural Dongting Lake region.[2,3] However, it has not been known whether such growth deficits subsequently affect adolescent growth.

Based on a 4-year longitudinal study in rural Chinese schoolchildren, the objectives of this paper were 1) to assess adolescent growth patterns, 2) to clarify impacts of dietary intakes, parasitic infections and other ecological or environmental factors on adolescent growth patterns.

Subjects and Methods:

The participants were 445 students (227 boys and 218 girls) of grades 5 and 6 in 5 primary schools in the Dongting Lake region, who were 10–12 years old at the baseline survey in 2001. Among them, 274 children (138 boys and 136 girls) had participated in all anthropometric measurements (6 times), parasitological examinations (4 times) and dietary surveys (3 times) during 2001–2005. By the end of survey period, all of them became middle school students. Some of them stayed at the school dormitories in weekdays due to long distance from their villages. For all participants, anthropometric measurements were conducted height, weight, mid-upper arm circumference, and skinfold thickness at triceps, biceps, and subscapular, following the standard methods;[4] parasitological examinations were detected eggs of *Schistosoma japonicum, Ascaris lumbricoides* and *Trichuris trichiura* in the collected stool samples by Kato-Katz thick smear technique;[5] long-term dietary intake was assessed with a semiquantitative food frequency questionnaire developed by our previous study.[3]

In the data analyses, Z scores of height-for-age (HAZ), weight-for-age (WAZ) and BMI-for-age (BMIZ) were calculated based on the Chinese references established by Chinese National Survey on Students Constitution and Health in 2000.[6] Growth status of individual child was classified into adequate (Z score ≥ 0), moderately inadequate ($-1 \leq Z$ score < 0) and severely inadequate (Z score < -1) status. Change in the Z scores between the baseline and the last survey was used to judge whether each participant maintained or changed growth status, and then all children were divided into the 5 groups each representing different growth patterns, so called 5 growth-pattern groups: i) Trac-Ade group, adequate at the both surveys, i.e. tracking adequate status, ii) Trac-Mod group, moderately inadequate at the both surveys, i.e. tracking moderate status, iii) Trac-Sev group, severely inadequate at the both surveys; i.e. tracking severe status, iv) Move up group, changed to a better status; v) Move down group, changed to a worse status.

Results:

1) Baseline characteristics

The target children's characteristics at the baseline survey by sex and age are presented in Table 1. Mean energy intake/RDA was 82.4% for boys and 78.3% for girls, being considerably lower than the Chinese RDA. There were significantly lower energy/RDA and %protein in girls than in boys when all ages were pooled ($P < 0.05$). Regarding parasitic infections, 5.1% of boys and 11.0% of girls were infected with *S. japonicum,* and rate was significantly higher in 12 years than in other ages for either sex ($P < 0.05$ for any). The prevalence rate of *A. lumbricoides* and *T. trichiura* was, respectively, 34.8% for boys and 27.8% for girls, and 14.5% for boys and 18.4% for girls, without significant sex differences.

2) Change in growth status

For the target children as a whole, on the basis of the Chinese references the mean HAZ, WAZ and BMIZ was −0.69, −0.55 and −0.33, respectively; and all mean Z scores of the target children by age had negative values, reflecting the fact that the participants were retarded in height, weight and BMI, compared to the Chinese references.

Table 1 Baseline characteristics of the target children by sex and age

Age (years)	N	Anthropometry						Dietary intake						Parasitic infections					
		Height (cm)		Weight (kg)		BMI (kg/m^2)		Energy/RDA (%)		% protein (%)		%fat (%)		Schistosoma japonicum		Ascaris lumbricoides		Trichuris trichiura	
		Mean	SD	Mean	SD	Mean	SD	Mean*	SD	Mean*	SD	Mean	SD	n*	%	n*	%	n*	%
Boys																			
10	38	132.3	5.9	27.9	3.9	15.9	1.4	82.1	19.3	12.0	2.2	11.4	3.3	1	2.6	12	31.6	3	7.9
11	71	136.6	6.2	30.1	3.7	16.1	1.4	81.7	16.6	11.8	2.4	10.6	3.5	2	2.8	29	40.8	14	19.7
12	29	142.2	5.2	32.9	3.5	16.3	1.3	84.6	15.8	12.3	2.1	9.8	2.5	4	13.8	7	24.1	3	10.3
All	138	136.6	6.2	30.1	4.1	16.1	1.4	82.4	17.2	12.0	2.3	10.6	3.3	7	5.1	48	34.8	20	14.5
Girls																			
10	25	132.4	8.5	27.1	5.3	15.3	1.6	76.4	16.8	11.3	2.1	9.6	3.2	3	12.0	9	36.0	6	24.0
11	65	138.5	6.0	30.7	4.3	15.9	1.5	78.5	15.8	11.6	1.9	10.4	3.2	3	4.6	12	18.5	8	12.3
12	46	142.9	5.2	33.4	4.0	16.3	1.4	78.9	17.9	11.2	2.1	9.5	3.7	9	19.6	19	41.3	11	23.9
All	136	138.9	7.2	30.9	4.9	15.9	1.6	78.3	16.6	11.4	2.1	10.0	3.4	15	11.0	40	27.8	25	18.4

[a]Number of the participants infected with either parasite.
*Significant difference between boys and girls in all ages pooled ($P < 0.05$).

Since change in the Z scores between HAZ and WAZ, between WAZ and BMIZ were significantly correlated ($P < 0.01$ for both), for comparisons of the 5 growth-pattern groups, only WAZ-based groups were analyzed as representing other indicators.

On the basis of the changes in WAZ from the baseline to the last survey, about one third of the participants experienced change in growth status. Among them, 20.3% of boys and 23.5% of girls changed to a better status; 15.2% of boys and 18.4% of girls changed to a worse status with significant change in Z scores. 64.5% of boys and 58.1% of girls kept tracking either one of the 3 statuses. In addition, differences of change in the Z scores among the 5 growth-pattern groups were significant, on which Move up and Trac-Ade groups showed the largest and second largest ΔZ scores, while Move down group showed the smallest.

3) Dietary intakes and parasite infections

Since Pearson's correlation coefficients between any pair of the 3 dietary data for each of the 3 dietary indicators, i.e. energy/RDA (energy intake relative to Chinese recommended dietary allowance), %protein and %fat (contributions of protein or fat to energy), were significant ($P < 0.01$), the 3 dietary data were averaged for analyses. For any dietary intake indicator for either sex, the 5 growth-pattern groups were ranked as Trac-Ade, Move up, Trac-Mod, Move down and Trac-Seve in the decreasing order.

The overall prevalence rate of the 3 parasites decreased at the follow-up. For schistosomiasis, 71% of infected children were infected at the baseline; there was no schistosomiasis infected person in Move up group for either sex at the follow-up although 17.9% (5/28) in boys and 34.4% (11/32) in girls were infected at the baseline. All of children reinfected with *A. lumbricoides* and *T. trichiura* were in Move down and Trac-Sev groups.

All change in the Z scores of dormitory students were negative values and were significantly lower than those of non-dormitory children ($P < 0.001$ for all).

4) Determinants of change in the Z scores over time

Multiple stepwise regression analyses demonstrated that energy and protein intakes, improvement of schistosomiasis were positively related with changes in Z scores, while dormitory residence and *T. trichiura* infection inversely affected changes in Z scores over time.

Table 2 Impact factors on change in the Z scores over time

Dependent factors	Significant independent variables	Beta	P	Adjusted R^2
ΔHAZ	Dormitory residence[a]	−0.21	< 0.001	0.36
	Energy/RDA	0.11	0.041	
ΔWAZ	Dormitory residence	−0.25	< 0.001	0.47
	Energy/RDA	0.21	< 0.001	
	Sex (boy = 0, girl = 1)	0.13	0.006	
	%protein	0.11	0.041	
	T. trichiura[b]	−0.10	0.045	
	S. japonicum[c]	0.09	0.047	
ΔBMIZ	Sex	0.23	< 0.001	0.42
	Dormitory residence	−0.17	< 0.001	
	Energy/RDA	0.13	0.011	
	T. trichiura	−0.08	0.049	

[a]Variable of dormitory residence was categorized into "no = 0" and "yes = 1".
[b]Each variable of *A. lumbricoides* and *T. trichiura* was categorized into 4: "0", uninfected, "1", infected one time, "2", infected 2 times, "3", infected 3 times.
[c]Variable of *S. japonicum* was categorized into "uninfected = 0" and "infected = 1".

Discussion:

This study offered a new insight into dynamics of growth pattern from preadolescence to adolescence in a rural population of developing country. By examining change in growth status for the rural Chinese schoolchildren, the results demonstrated marked intra-population variation of growth pattern during adolescence.

Compared with Chinese references, the target children as a whole were retarded in growth, represented by lower HAZ, WAZ and BMIZ by age. It is interesting that about one third of the participants experienced changes in the 3 growth status with significant change in Z scores within only 4-year duration.

Regarding nutritional factors which may influence growth patterns, this study suggested that adequacy of energy intake played primary roles in determining change in the Z scores, while no effect of %fat and less effect of %protein might be attributed to small variation in the intake of animal foods.[3]

As for the effects of parasite infection, prevention and treatment effects of schistosomiasis were revealed in this longitudinal study, represented by decrease in prevalence rate and improvement in growth status. The similar treatment effect of *S. japonicum* on growth has been proved not only in the author's previous study[2] but also in a study for Filipino children.[7] The effects of repeated infection of *T. trichiura* on growth were considered to be decreased food intake and/or increased nutrient losses, both of should increase risk of chronic nutrition deprivation.[8] This consideration accorded with the fact that all the target children that were reinfected with *T. trichiura* belonged to Trac-Sev or Move down groups.

School dormitory living associated with poor diet, unsatisfactory sanitation, unsafe water supply, and the students ignoring health behavior, might result in malnutrition and helminth infection, and consequently, degraded growth.

In conclusion, the target schoolchildren as a whole were retarded in growth, compared with the Chinese references. Intra-population variation in adolescent growth pattern with marked differences of change in Z scores were revealed by longitudinal anthropometric measurements for the 4-year period. Such variations were primarily attributed to energy and protein intakes, improvement of schistosomiasis and *T. trichiura* infection, and school dormitory residence. As a health program in Chinese rural areas, improvement of living condition of school dormitory, adolescent health education including health behaviors and nutrition, and regular screening and treatment of parasites are suggested.

References:

1. McGarvey ST, Aligui G, Daniel BD, Peters P, Olveda R and Olds GR (1992) Child growth and schistosomiasis japonica in northeastern Leyte, the Philippines: cross-sectional results. *American Journal of Tropical Medicine and Hygiene*, 46: 571–581.

2. Zhou H, He YK and Ohtsuka R (2005a) Sex differences in the malnourished status of Chinese children due to schistosomiasis infections and inadequate dietary intake. *Environmental Sciences*, 12: 145–153.

3. Zhou H, Ohtsuka R, He YK, Yuan LP, Yamauchi T and Sleigh AC (2005b) Impact of parasitic infections and dietary intake on child growth in the schistosomiasis-endemic Dongting Lake region, China. *American Journal of Tropical Medicine and Hygiene*, 72: 534–539.

4. Weiner JS and Lourie JA (1981) *Practical Human Biology*. Academic Press, London.

5. Katz N, Chaves A and Pellegrino J (1972) A single device for quantitative thick-smear technique in schistosomiasis mansoni. *Revista do Instituto Medicina Tropica de Sao Paulo*, 14: 394–400.

6. Group of Students Constitution and Health (2002) *Report on the Physical Fitness and Health Surveillance of Chinese School Students*. Advanced Education Press House, Beijing. (in Chinese)

7. McGarvey ST, Aligui G, Graham KK, Peters P, Olds GR and Olveda R (1996) Schistosomiasis japonica and childhood nutritional status in northeastern Leyte, the Philippines: a randomized trial of praziquantel versus placebo. American Journal of Tropical Medicine and Hygiene, 54: 498–502.

8. Stephenson LS, Holland CV and Cooper ES (2000) The public health significance of *Trichuris trichiura*. Parasitology, 121: S73–S95.

作成日：2006 年 2 月 20 日