Preplanned Studies

Variations in Rope Skipping Counts Among Rural Primary and Secondary School Students — China, 2013–2021

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Summary

What is already known about this topic?

Physical fitness is closely associated with children's development. Limited research has been published on the changes in physical fitness among Chinese children during the implementation of the Nutrition Improvement Program for Rural Compulsory Education Students (NIPRCES).

What is added by this report?

This research utilized data from the NIPRCES between 2013 and 2021 to examine alterations in children's physical fitness levels. Over this period, there was a significant increase in the number of rope skipping counts among children. In 2021, variations in these counts were observed, which depended on factors such as age, gender, geographic location, and region.

What are the implications for public health practice?

Physical fitness has been linked to a multitude of non-communicable diseases. Enhanced nutritional measures for children lead to significant improvements in their overall physical fitness, as evidenced by NIPRCES findings. It is crucial for policymakers to implement comprehensive interventions aimed at promoting and advancing children's physical fitness.

Beginning in 2011, the Nutrition Improvement Program for Rural Compulsory Education Students (NIPRCES) was established to enhance the nutrition and health of students in rural areas and promote educational equity. The central government offers nutritional meal subsidies to compulsory education students, aged 6–15 years, in underdeveloped counties. Monitoring and evaluation have been conducted annually from 2012 to 2017 and in 2019 and 2021. Additionally, data regarding the nutritional and health status of students in the national pilot areas have been regularly collected from 2012 to 2021. NIPRCES has effectively mitigated growth retardation and anemia among rural children (*1*).

The current study also aimed to explore whether the implementation of NIPRCES has positively impacted children's physical fitness, which is strongly associated with their growth. Optimal physical fitness provides numerous physiological and psychological benefits, offers protection against potential stressors, and prevents many chronic diseases (*2*). The primary objective was to evaluate changes in physical fitness among Chinese rural children and adolescents during the implementation of NIPRCES. Utilizing rope skipping counts as the indicator, an increase in children's performance was observed from 2013 to 2021. In 2021, the counts varied among students based on age, gender, area, and region. This study offers valuable scientific evidence for policymakers to develop effective strategies aimed at improving the physical fitness of children and adolescents.

From 2012 to 2019, key monitoring was conducted in the rural areas of 50 national pilot counties of the NIPRCES across 22 provincial-level administrative divisions (PLADs) in western and central China. In 2021, both rural and urban areas of 70 national pilot counties, 60 local pilot counties of the NIPRCES, and 30 non-pilot counties conducted key monitoring in eastern, western, and central China. This study used data on students' physical fitness extracted from end-of-semester physical education class test results in 2013, 2014, 2015, 2016, 2017, 2019, and 2021. In each key monitoring county, two primary and two secondary schools were selected. For each grade, from 1st grade (children aged 6–7 years in primary school) to 9th grade (children aged 14–15 years in junior high school), one class of approximately 40 students was chosen. Exam items in physical education classes included the standing long jump, 50-meter dash, and rope skipping, among others. Rope skipping was selected as the physical fitness indicator in this study (recorded as counts/minute) since all students from 1st to 9th grade test rope skipping in China.

For cross-sectional analysis, all data in 2021 were used. For comparisons from 2013 to 2021, data in 2021 were selected as representing the rural areas in

key monitoring counties in central and western China. Rope skipping counts were described by median, 25th percentile (P25), and 75th percentile (P75) for each year. Non-parametric Wilcoxon or Kruskal-Wallis rank sum tests were employed to determine differences between groups. When differences between groups were statistically significant, the Dwass-Steel-Critchlow-Fligner test was used for pairwise comparisons between groups. The inspection level was set at α =0.05. All analyses were conducted using SAS (version 9.4, SAS Institute Inc., Cary, NC, USA).

Table 1 shows the median, P25 and P75 of rope skipping counts among students by gender, grade, and region for each year from 2013 to 2021. Students' rope skipping counts displayed a general increasing trend, from 77 counts/min in 2013 to 89 counts/min in 2021, marking an increase of 15.6%. Between 2013 and 2021, the counts for male improved by 14 counts, which was more than the improvement for female (11 counts). Ninth-grade students experienced an increase of 38 counts, considerably higher than students in other grades (7–29 counts). Moreover, students in the western regions demonstrated an increase of 14 counts, surpassing those in the central regions (8 counts).

In 2021, the number of rope-skipping counts demonstrated variation based on age, gender, residential area, and region. Among 1st to 6th grade primary school students, female exhibited higher counts than male, while counts appeared similar for both genders in 7th and 8th grades but were lower for female in the 9th grade (Figure 1A). First-grade students from urban areas demonstrated 11 more counts than their counterparts in rural areas, representing the largest difference among all grade levels (ranging from 2 to 7 counts; Figure 1B). Throughout the primary school years, students from eastern China consistently had higher counts compared to those from central and western China. In contrast, during the junior high school period, this difference was reversed (Figure 1C). All identified differences were deemed statistically significant (P<0.05).

DISCUSSION

This study indicated that the implementation of NIPRCES led to improvements in children's and adolescents' physical fitness, as evidenced by enhanced rope skipping performance. Nevertheless, there were still marked disparities in scores among students from different regions and areas.

In the present study, rope skipping counts were selected as a measure of students' physical fitness, given that this activity engages the entire body (upper and lower regions) and calls for rhythm, coordination, agility, speed, and strength. As students engage in rope skipping, they must maintain continuous arm rotation and coordinate their bodies during rhythmic, repetitive vertical hops (*3*). The body also needs to re-establish balance and generate propelling force throughout successive jumps. Previous research has demonstrated the benefits of rope skipping for both cardiovascular and respiratory systems (*4*).

In the NIPRCES study, our approach to enhancing students' health was through the implementation of school feeding programs. Evidence has demonstrated that these programs positively impact the physical fitness of children and adolescents, as well as their overall athletic performance. A two-year intervention that involved increasing children's intake of eggs and dairy products during school breakfasts effectively improved their strength (as measured by broad jump scores) and endurance [based on their performance in the 50 (8-meter round trip) test] of children and adolescents in China (*5*). Cintineo's research also indicated that protein supplementation led to increased muscle volume, muscle fiber cross-sectional area, muscle strength, and muscle explosiveness (*6*). By increasing the consumption of meat and eggs, which are rich sources of high-quality protein, NIPRCES's school feeding program may have aided in improving the muscle strength and rope-skipping performance of participating students.

In addition to NIPRCES, the Chinese government has placed significant emphasis on enhancing physical activity among compulsory education students. The national policy, "Notice on School Physical Education Under the Current Epidemic Situation," was introduced in 2023. This policy highlighted the need for public health practitioners to increase efforts in promoting nutrition and physical education to improve students' habits and overall physical fitness. Moving forward, NIPRCES will persist in its efforts to promote and maintain the nutritional and physical well-being of children in targeted counties throughout the nation.

This study faced several limitations. First, the investigation solely utilized rope skipping as an indicator of physical fitness. In future research, additional assessments, such as the 50-meter dash, standing long jump, and sit-and-reach, should be incorporated to provide a comprehensive evaluation of

TABLE 1. Rope skipping counts per minute among Chinese students in rural areas, 2013–2021.

Variable	2013				2014				2015				2016				2017				2019				2021				*P* value*
	N	M	P25	P75	*N*	M	P25	P75	*N*	M	P25	P75	*N*	M	P25	P75	*N*	M	P25	P75	*N*	M	P25	P75	*N*	M	P25	P75	
Total	42,107	77	49	102	43,534	81	56	108	37,641	85	58	109	24,709	81	56	105	31,519	86	61	108	45,710	82	59	107	100,243	89	60	118	<0.0001
Gender																													
Male	21,852	72	42	98	22,581	78	50	102	19,555	81	53	106	12,716	78	52	101	16,183	83	59	104	23,633	80	56	105	51,659	86	57	115	<0.0001
Female	20,255	81	56	107	20,953	86	62	112	18,086	88	62	112	11,993	86	61	109	15,336	87	65	110	22,077	85	61	110	48,584	92	65	120	<0.0001
Grade																													
1	5,276	36	20	60	5,512	43	21	71	4,492	44	21	73	3,117	46	25	75	3,676	47	27	75	6,160	48	24	75	12,052	50	28	77	<0.0001
2	6,230	56	32	79	6,253	62	36	84	4,759	62	35	87	3,611	64	38	85	4,345	68	42	89	6,360	68	45	88	13,996	68	44	91	<0.0001
3	6,119	73	46	94	6,482	77	55	98	5,473	77	53	98	3,671	78	56	98	4,90	79	59	99	6,608	78	56	99	14,480	80	56	102	<0.0001
4	6,333	82	59	105	6,579	87	68	108	5,371	86	64	108	3,785	85	64	104	4,724	86	65	108	6,620	85	64	105	14,701	89	65	111	<0.0001
5	6,300	89	65	112	6,645	92	72	120	5,499	94	72	116	3,716	92	68	113	4,921	90	70	114	6,300	90	69	111	14,894	99	77	123	<0.0001
6	6,414	88	68	113	6,639	96	76	124	5,644	96	75	120	3,773	96	75	118	5,113	97	77	120	6,475	95	74	115	14,753	104	81	130	<0.0001
7	1,849	97	78	129	1,815	104	78	133	2,232	103	79	133	982	100	76	121	1,327	105	89	123	2,408	117	82	148	4,982	126	95	150	<0.0001
8	1,861	102	78	137	1,762	106	79	142	2070	110	88	135	1,138	102	79	140	1,373	103	87	126	2,471	117	84	151	4,858	130	98	155	<0.0001
9	1,725	106	80	140	1,847	110	80	147	2,101	102	85	140	916	105	84	150	1,350	107	95	140	2,308	121	82	155	5,527	144	103	163	<0.0001
Region																													
Central	10,295	79	48	106	12,496	84	57	108	9,180	82	57	109	9,079	88	67	111	7,767	86	63	108	14,274	85	61	107	32,938	87	59	112	<0.0001
Western	31,812	76	49	100	31,071	80	55	108	28,461	85	58	109	15,630	78	50	101	23,752	85	60	108	31,436	81	57	107	67,305	90	62	120	<0.0001

Abbreviation: *N*=number; M=median; P25=25th percentile; P75=75th percentile.

* Comparison of rope skipping counts from 2013 to 2021.

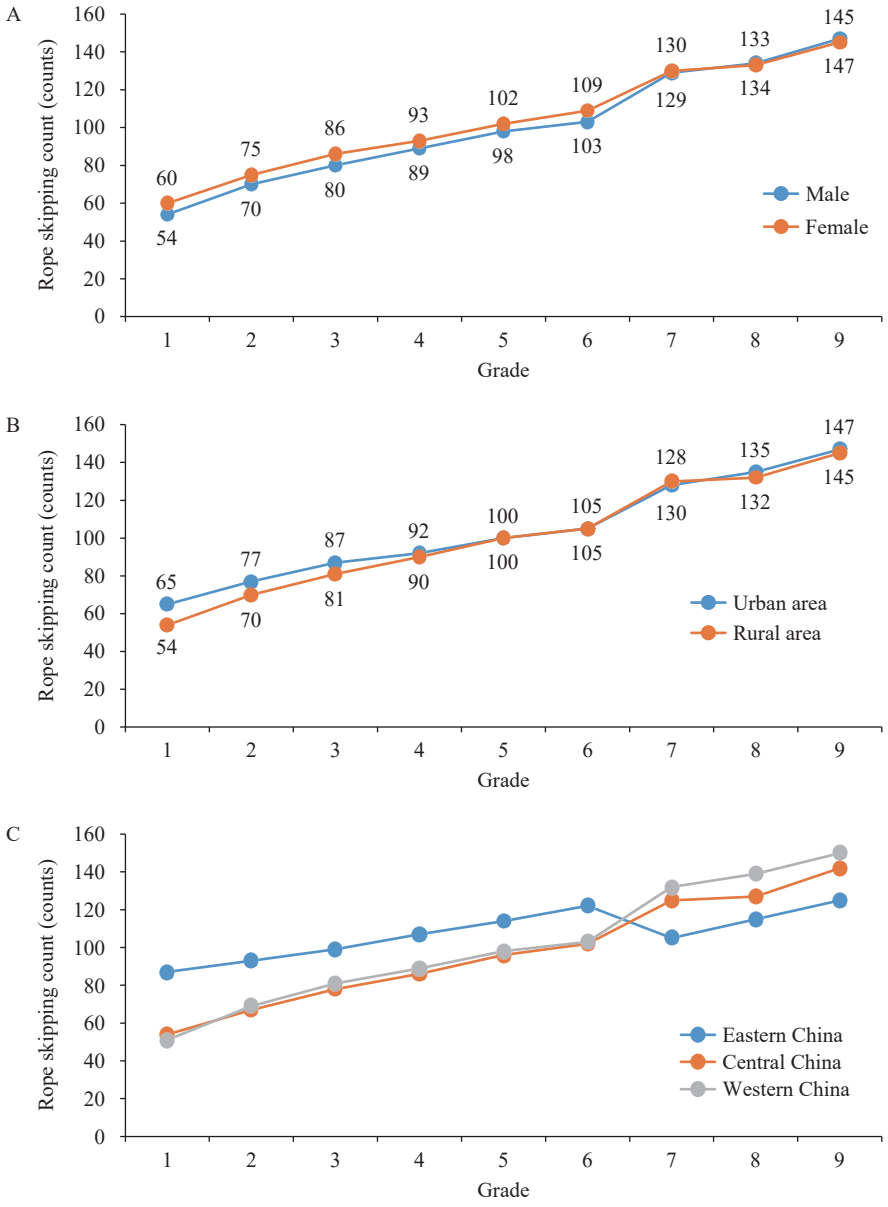

FIGURE 1. Rope skipping counts among students by gender, residential area, region, and age in 2021. (A) by gender and age; (B) by residential area type and age; (C) by region and age.

children and adolescents' physical fitness. Second, the accuracy of the results may be influenced by students' attitudes during the physical examinations, potentially leading to biased outcomes.

In conclusion, the findings from the present study suggest that children's and adolescents' physical fitness has improved during the NIPRCES period. Nonetheless, disparities in physical fitness levels were observed among children and adolescents across various regions and areas. Consequently, it is imperative that future policies implement comprehensive strategies aimed at enhancing children's health and reducing these discrepancies.

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