



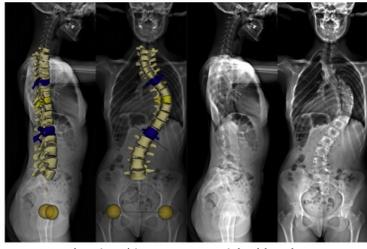
# The Innovation of “Integration of Medicine and Education” Model and Mobile Phone Intelligent System to Improve the Efficiency of Adolescent Scoliosis Screening Process and Prevention

## Abstract

The number of middle and elementary school students diagnosed with scoliosis, a spinal disease, has exceeded 5 million in China and has been increasing at a rate of 300,000 per year. What's more, scoliosis usually worsens the most rapidly during teenagers' peak growth period, aggravating their conditions. Therefore, it is critically important for the early screening and treatment of scoliosis. However, due to the size of the medical force, screening on a large scale proves to be a challenging task. This CTB group initiated the country's first innovative model, "Integration of Medicine and Education", to approach scoliosis screening: medical personnel first train school PE teachers the skills to conduct scoliosis screening and take assessments; PE teachers then accomplish screening. This methodology could effectively improve the efficiency and scale of screening. This group has adopted this screening methodology on a total of 12,803 students and analyzed the collected data to verify its effectiveness. In addition, this group proposed and built a mobile phone-based intelligent scoliosis screening applet (mini-program) with the support of a technical team. This phone program has completed 200 screening cases, and the analyzed data proved its extremely high accuracy, which improved the efficiency of scoliosis screening on a large scale.

## Introduction

Scoliosis, also known as "side convex to spines", is a three-dimensional deformity manifested by sequence abnormalities at axial, sagittal, and coronal positions. On a clinical level, scoliosis is defined when the COBB angle is greater than or equal to 10 degrees on the full spine anteroposterior X-ray when taken in a stand-up position. Scoliosis leads to uneven forces on two sides of the spine, resulting in spinal and neural compression, back and wrist pain, and damage to patients' respiratory and digestive systems. The worst-case scenario is paraplegia. But what affects students the most is that the abnormal appearance of spines always affects body posture, leading to students' psychological disorders. Furthermore, as scoliosis worsens the fastest during adolescence, the COBB angle will increase by over 10 degrees within just a year. The spinal deformity is only visible when the COBB angle exceeds 30 degrees. Therefore, it is easy to ignore scoliosis at a clinical level, and it is always severe when diagnosed. Thus, a large-scale screening process that can be widely applied to children and teenagers could effectively build a scheme for "early diagnosis, early treatment, and early recovery".



\*Authorized images provided by doctor.

## Essential Research

Scoliosis mainly occurs in teenagers, which constitutes 74.7% of all scoliosis patients. The prevalence of scoliosis among children and teenagers in China has been increasing every year, becoming the third major disease that negatively affects teenagers health aside from obesity and myopia. Severe scoliosis is a disabling disease; when the COBB angle exceeds 40 degrees, scoliosis severely affects the patient's physical and mental health, as well as their living qualities. Wherever the COBB angle exceeds 50 degrees, surgery is urgently needed. Conducting large-scale screening can promote early discovery, timely supervision, and effective treatment. According to Clinical Practice Guidelines and Path Guidelines for Scoliosis Screening in Chinese Adolescents ("The Guide"), schools are recommended as the major screening targets, and screenings should be done under the supervision of a professional orthopedic specialist with training in scoliosis screening.

After research, this CTB group concluded that currently, only very few cities like Shenzhou, Ningbo, and Changzhou have proceeded with large-scale scoliosis screening among teenagers, and other cities, especially economically underdeveloped ones, rarely adopt such a practice. Furthermore, as most screening processes are done directly by professional medical personnel, it is very challenging to scale this practice because of the busy schedule and limited number of clinical workers. Only a small portion of students can be screened, and not all students could be covered. Meanwhile, as the cost of scoliosis screening is supported by the local government, it becomes even more difficult to conduct scoliosis screening for all teenagers due to its high economic and labor costs.

Because of all the factors mentioned above, this CTB group proposed more innovative, effective, low-cost, and intelligent methodologies to address current difficulties with scoliosis screening, effectively increasing the screening scale and benefiting more children and teenagers.

## Innovative Design

### Innovative Design 1

#### The Model of "Integration of Medicine and Education" on Scoliosis Screening among Teenagers

##### Pre-requisites

- Middle and elementary school teachers possess a certain level of professional knowledge about human physiology.
- PE teachers acquire more familiarity with students' body postures and athletic postures than medical personnel.
- PE teachers are well capable of conducting the screening work if given the scoliosis measuring tape and training and assessment provided by professional medical teams.
- This model meets this specific requirement in The Guide: "The scoliosis screening has to be done under the guidance of an orthopedic specialist who has received professional training in scoliosis screening."

##### The Method of "Integration of Medicine and Education" Scoliosis screening among teenagers

Step 1 Doctors first provide scoliosis screening training to PE teachers at middle and elementary schools and conduct assessments.

Step 2 Certified PE teachers conduct the task of screening during PE class or students' s non-class time.

Step 3 Doctors are responsible for the quality of the screening process.



### Innovative Design 2

#### The Development and Adoption of a Phone App to Improve the Accuracy and Efficiency of Scoliosis Screening



- This app uses the mobile phone as the hardware carrier and artificial intelligence as the computational core.
- During the piloting process of conducting scoliosis screening with this app, this CTB group has taken (with a license) pictures in stand-up positions and forward-bend 90 degrees of 500 students and uploaded their ATR data onto the system. The technical group will mark and document these data.
- This program analyzes the body positions in these pictures through a training model based on computer vision, artificial intelligence-

based computation, and convolutional neural networks.

- The final app version 1.0 was developed through training on ART data and taken online for wide use by teenagers.

## Results & Data

### I. "Integration of Medicine and Education" Improves the Efficiency and Scale of Scoliosis Screening among Teenagers

In September and December of 2023, this CTB group conducted the "integration of medicine and education" model for second grade students at Suzhou Technology City Experimental Elementary School and eighth graders at Suzhou North America High School. Please refer to Table 1 and Table 2 for the collected data:

#### Data for Second Graders at Suzhou Technology City Experimental Elementary School

Screening Execution Team	# of Screened Individuals	# of Positive Cases	Positive Rate
Medical Team	1193	16	1.34%
PE Teacher Team	1193	14	1.17%

Z - test figure :  $z = 0.2571$ ,  $p = 0.7973$ ,  $p > 0.05$ . The difference between these two groups are statistically insignificant.

#### Data for Eighth Graders at Suzhou North America High School

Screening Execution Team	# of Screened Individuals	# of Positive Cases	Positive Rate
Medical Team	77	9	11.69%
PE Teacher Team	77	7	9.09%

Z - test figure :  $z = 0.5282$ ,  $p = 0.5973$ ,  $p > 0.05$ . The difference between these two groups are statistically insignificant.

The statistical data shows that there is no significant difference between the screening efficiency of these two samples conducted by both the medical and PE teacher groups, verifying the feasibility of "integration of medicine and education" for adolescent scoliosis screening. This CTB group reported the results to the local government in Suzhou. The government recognized the efficiency, convenience, and economical aspects of this screening model, which provided wider coverage and an easier promotional prospect. Suzhou High-Tech District subsequently promoted this screening model. Up to now, 11,533 second-grade students in all 34 primary schools in the district have been screened by this model. Fifty-eight PE teachers participated in the training, assessment, and screening work and discovered 132 children with suspected scoliosis, which indicated a suspected positive rate of 1.14%. All of this work was done by PE teachers within just one week, greatly improving efficiency.

### II. The Intelligent Phone Program / App Further Improve Scoliosis Screening Efficiency

The phone applet screening methodology: After entering the program, users take three types of pictures - a standing back full body photo, an upper back profile Adam test photo, and a waist profile Adam test photo - and upload these pictures according to the guidance. The phone program will instantly generate screening results after intelligent data analysis.



This CTB group has completed scoliosis screening for 200 eighth graders at Suzhou High-Tech District Experimental Middle School - Technology City Campus. Please refer to Table 3 for the collected data:

#### "Spine Guardian for Teenagers" Phone Program Screening Data

#### Data for Eighth Graders at Suzhou High-Tech District Experimental Middle School - Technology City Campus

Screening Tool	# of Screened Individuals	# of Positive Cases	Positive Rate
Scoliosis Measuring Tape	200	17	8.5%
"Spine Guardian for Teenagers"	200	15	7.5%

Z - test figures :  $z = 0.3686$ ,  $p = 0.7124$ ,  $p > 0.05$ . The differences between these two groups are statistically insignificant. These figures verify that there is no significant difference in the

screening results between the mobile phone intelligent screening system and the scoliosis measuring tape. There is great value in promoting this mobile phone intelligent screening program.

## Discussion

### I. The Advantages and Drawbacks of "Integration of Medicine and Education" Screening Model

- Advantage
- Reduce the cost of professional medical resources and personnel
- Decrease the government's fiscal expenditure
- Improve the screening efficiency and coverage of scoliosis screening, greatly promoting the prevention and treatment of scoliosis

##### Drawback

- Increase the workload of on-campus PE teachers

### II. The Advantages and Drawbacks of the Mobile Phone Intelligent System

##### Advantage

- Images of children could be uploaded at home at any time to complete the screening
- Protect privacy by avoiding physical contact between children and the workers
- Receive immediate scoliosis evaluation reports and treatment recommendations for free
- Can regularly conduct screening to scientifically monitor changes

##### Drawback

- The shooting angle, lighting, ground flatness, and other factors are hard to control, leading to inaccuracies in the screening data
- Only 500 images were collected by version 1.0; more data is required for upgrading the machine learning model
- Currently missing an educational section to advocate for the scientific prevention of scoliosis among teenagers

## Conclusion

- The "Integration of Medicine and Education" Screening Model successfully improved the screening efficiency of adolescent scoliosis, reduced large economic and human resource costs, and expanded the scope of screening among teenagers.
  - The empirical effectiveness of the intelligent scoliosis screening system almost matches that of human experts.
  - This CTB group's research and innovative proposal were highly recognized by the Suzhou municipal government.
  - This CTB group has assisted the CPPCC members to complete the proposal and will continue promoting this model in the entire city of Suzhou and China as a whole.
- \* All other pictures were taken by this CTB team.

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