



## Original article

# Four-year musculoskeletal examinations among elementary and junior high school students across a single city

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## Abstract

**Objective:** In 2016, Japan started conducting musculoskeletal examinations that included “limb status” of students as an essential item. Our institution implemented a unified musculoskeletal examination for all public elementary and junior high schools in T-city. In this study, we aimed to report the progress in the past 4 years.

**Patients and Methods:** The Tsukuba Childhood Locomotive-Organ Screening Sheet (T-CLOSS), which is a questionnaire that includes some nationwide-recommended questions, was prepared and distributed to students. Results of the questionnaires were analyzed, and the orthopedic surgeon conducted examinations for the extracted items. From these questionnaires, the ratio of each item, rate of advisory for screening, and content of the advisory were investigated.

**Results:** During 2016–2019, musculoskeletal examinations were conducted in every public schools, with nearly 20,000 students in T-city. The consultation advisory rate was 6.7% in 2019. Of the 524 students who received the third screening recommendation, the actual consultation rate was 248 (40.8%). After the third screening, the proportion of students requiring treatment and outpatient visits was 46.7% (n=248), which accounted for 1.2% of all elementary and junior high school students in the city.

**Conclusion:** We reported the results of 4-year musculoskeletal examinations in a city. In our screening, we distributed a uniform questionnaire throughout the city, and orthopedic surgeons performed secondary examinations of identified students in all schools. This appears to be an advanced effort to prevent musculoskeletal impairment in students. We hope to conduct more sophisticated musculoskeletal examinations using our results, aiming at early detection, early treatment, and improvement of musculoskeletal function in elementary and junior high school students.

**Key words:** musculoskeletal examinations, elementary and junior high school students, questionnaire, locomotive-organ

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## Introduction

Following a partial revision of the School Health and Safety Law in 2016, a musculoskeletal examination that included the “limb status” of students as an essential item was introduced in the same year. With regard to musculoskeletal examinations, the contents of existing nationwide musculoskeletal examinations are not uniform, and the details are unclear; thus, there is a need for each local government to lead the planning for musculoskeletal examinations. Our institution have been using a system of musculoskeletal screening for several years before the legal revision, and the system could demonstrate the usefulness of musculoskeletal

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screening<sup>1)</sup>. In such circumstances, with the combined efforts of health educators including teachers, school doctors, nursing teachers, and medical associations and appropriate understanding of the health education system, we implemented a unified musculoskeletal examination for all public elementary and junior high schools in T-city<sup>2,3)</sup>. This examination is still ongoing in our institution. Herein, we aimed to report our progress achieved in the past 4 years.

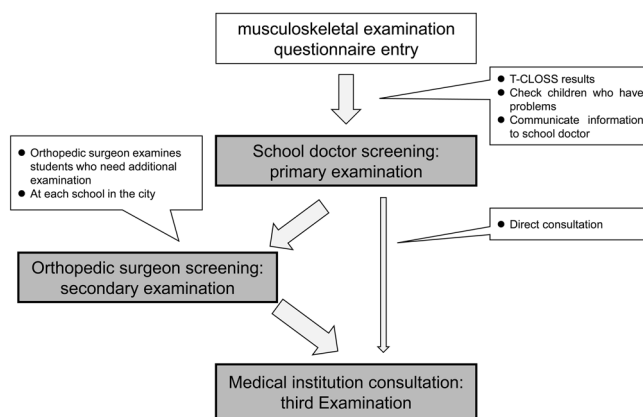
## Patients and Methods

All procedures were performed after informed consent was obtained from the participants.

Because musculoskeletal examinations were legally required, we created a medical examination system unique to this city in cooperation with the city's board of education, since 2016. According to the current law in Japan, health checkups are conducted at the beginning of the fiscal year, and this checkup can also be added as an extension. Figure 1 shows the flowchart of musculoskeletal examinations in this city. Under this basic flow, all students were examined uniformly, unless there was a special reason, such as a child who was unable to go to school.

The Tsukuba Childhood Locomotive-Organ Screening Sheet (T-CLOSS) (Figure 2), which is a questionnaire that includes some nationwide-recommended questions<sup>4)</sup>, was prepared and distributed to students at the beginning of the year. After the parents and students filled out the questionnaire at home, the questionnaires were collected, and individual results (Figure 3) were obtained. The questions were explained using figures so that even the general population (those without medical knowledge) can understand and respond to each item. In school, when conducting internal medical examinations such as a primary checkup, the necessity of a secondary checkup, which is a consultation with an orthopedic surgeon, was determined based on the results of the T-CLOSS. The results of these examinations are summarized in the results section.

For this study, we evaluated the presence of scoliosis, flat foot tendency, ability to bend the lumbar spine forward, and ability to squat down, which can be used as screening parameters for musculoskeletal injury. We explained that students should appropriately check each item. Scoliosis findings include different shoulder and scapula heights, waist-line inclination, and rib height differences between the left and right sides. If one finding was recognized or experienced, the item was described as “with findings”. Flat feet were observed while standing, and students without a foot arch were judged as “with flat foot findings”. With regard to lumbar flexion, if the student flexed forward and their fingers did not touch the floor, the item was judged to have “no forward flexion”. When the student tried to squat down but could not complete the task with their heels on



**Figure 1** Flowchart of city unified musculoskeletal examination.

the ground, this item was judged as “impossible”. We added explanations for each of the other items so that even those with little medical knowledge can understand them, and we distributed online videos. These videos showed how to perform a musculoskeletal examination, and the web address was written in the questionnaire. Everybody was instructed to check the details of the examination method at home, if necessary.

For the students identified, the orthopedic surgeon will mainly work together with physiotherapists and trainers to visit all schools in the city and conduct examinations for the extracted items of the identified students. For students who require further examination, such as examinations at medical institutions, we recommended a third screening and prepared a letter of introduction.

After all the examinations were completed, T-CLOSS and examination results were collected. We excluded the questionnaires that did not have sufficient answers. From these questionnaires, we investigated the ratio of each item in the questionnaire, rate of advisory for third screening, content of the advisory, and rate of the third screening.

## Results

Table 1 shows the number of schools and students. During 2016–2019, musculoskeletal examinations were conducted in every public elementary and junior high school, with 19,244, 19,675, 20,207, and 20,634 students in each year in T-city. Table 2 shows the sex and grade ratios.

Figure 4 shows the results of the T-CLOSS. Of the analyzed students, 4.9–5.2% had scoliosis findings, 8.1–16.2% had flat foot findings, 20.0–25.8% had no forward flexion, and 5.8–6.4% could not squat down.

The consultation recommendation rates, which have been evaluated since 2017, were 5.4%, 6.7%, and 6.7% in 2017, 2018, and 2019, respectively. The recommendation rate was positively correlated with the grade, and approxi-

### Musculoskeletal Screening in 2020

Name of School: \_\_\_\_\_ name: \_\_\_\_\_ QR code

SEX:  M  F Grade: \_\_\_\_\_ Class: \_\_\_\_\_ Number: \_\_\_\_\_

1. **Scoliosis**  
 Applicable item?  No  Yes  
 ① Is there a difference in height between the left and right shoulders?  
 ② Is there a difference in the heights of the left and right shoulder blades?  
 ③ Is there a tilt to the waistline?  
 ④ Is there a tilt the height of the ribs?  
 With the child standing up straight, (①-④) Next, ask the child to slowly bend forward so that the left and right palms come together between the left and right feet. (⑤)

2. **Low back pain and motion**  
 Yes  No Does your finger bow forward and stick to the floor? (Pain when flexing = No)  
 Yes  No Do you have pain in the back during forward and back flexion?  
 When the child fingers do not stick while bending forward, the flexibility of the muscles such as the hamstrings at the back of the thigh may be diminished. Pain after back flexion may indicate lumbar spondylolisthesis.

3. **Lower limb muscle strength, balance ability**  
 Yes  No Can you stand for more than 5 seconds with your eyes open?  
 Even if only a single leg is not made, please mark "No". This procedure tests hip joint function.

4. **Leg range of motion, balance**  
 Yes  No Can you completely squat down in the state that you added a heel to?  
 Mark "No" if the child does not completely crouch or falls back. This procedure tests the functions of the hip joint, knee joint, and ankle joint as well as muscle hardness.

5. **Elbow range of motion**  
 Not applicable  Not reach the shoulder  Not fully extended  pain  
 Can you extend an elbow with turning a palm to the top? And you bend an elbow, and can you touch the shoulder?  
 If the elbow does not stretch completely or the fingers do not touch the shoulder, old fractures may not be well cured or issues such as baseball elbow may be present.

6. **Shoulder movement**  
 Yes  No When you stretch your both elbows and send to your overhead, can the arm touch the ear?  
 If the upper arm cannot completely touch their ear, a shoulder joint disease such as baseball joint may be present.

7. **One-year medical history**  
 No  Yes Did any injuries or illnesses occur between April 2018 and the present?  
 If "Yes", fill the part below  
 ankle sprain  dislocation  fracture  fatigue fracture  
 baseball elbow  lumbar spondylolysis  osgood disease  
 others \_\_\_\_\_

8. **History (Hole life)**  
 No  Yes Has the child had any locomotive sickness or injury since birth?  
 If "Yes", fill the part below  
 scoliosis  torticollis(oblique cervical spine)  congenital dislocation hip  
 club foot  others \_\_\_\_\_

9. **Previous screening result**  
 No  Yes Are you told to go to hospital after screening from 2016 through 2019?  
 If "Yes", fill the part below  
 still continuing  lumbago  knee pain  O-leg  X-leg  Flat feet  
 foot deformity  others \_\_\_\_\_  
 If "Yes", how many times did you go to the Hospital? fill the part below  
 still continuing  visited several times  visited once but no problems  
 self-interruption  no visit  
 others \_\_\_\_\_

10. **Pain**  
 No  Yes Does the child have continuing pain?  
 If "Yes", did you go to the hospital? fill the part below  
 continuing  visited several times  self-interruption  no visit  
 others \_\_\_\_\_

11. **Activity other than physical education in school**  
 How many hours a week does the child exercise(physical activity with sweating or shortness of breath) other than physical education at school?  
 not at all  30 minutes  1 hour  2 to 3 hours  4 to 6 hours  
 7 hours or more This question is for one week.

12. **Activity other than physical education in school**  
 Yes  No Does the child participate in sports other than physical education at school?  
 If Yes, please check one or two sports participating in mainly.  
 baseball  swimming  athletics  basketball  soccer  tennis  
 volleyball  gymnastics  dance  ballet  table tennis  kendo  judo  
 karate  handball  badminton  dodge ball  tag  sports chanbara  
 others \_\_\_\_\_

13. **Others**  
 Yes  No Do you have any other anatomical matters, and/or matters wanted be checked at the screening?  
 If Yes, please check the applicable items.  
 bow leg  knock knee  flat foot  hallux valgus  
 shoulder motion  balance ability  baseball elbow  others \_\_\_\_\_

14. **How does the child go to school?**  
 Please choose one main transportation  
 Owalking  Obicycle  Obus  Ocar  Others \_\_\_\_\_

15. **Comments**  
 \_\_\_\_\_

Figure 2 Tsukuba Childhood Locomotive-Organ Screening Sheet (English version).

### 2019 Questionnaire Personal Result

School: \_\_\_\_\_  
 Class: \_\_\_\_\_ No. \_\_\_\_\_ Name: \_\_\_\_\_

● By the primary screening by the questionnaire sheet T-CLOSS, and the following were extracted

A		B				C			
Scoliosis	Neck tilt	Lumbar bending	Backward bending	elbow	shoulder	One leg Standing	Crouching	O-leg X-leg	Flat feet Hallux valgus

medical history ;  
 pain continues ;  
 last year's examination result ; hospitalization ;  
 sports habits ; commuting method ;

● Necessity of physical examination for specialists  
 YES  NO

Confirmed by a professional examination  We did not find any major problems in this year's examination. However, changes may occur during the growing and developmental age.

**Final Results**  No problem  Third consultation  
 Details ( )

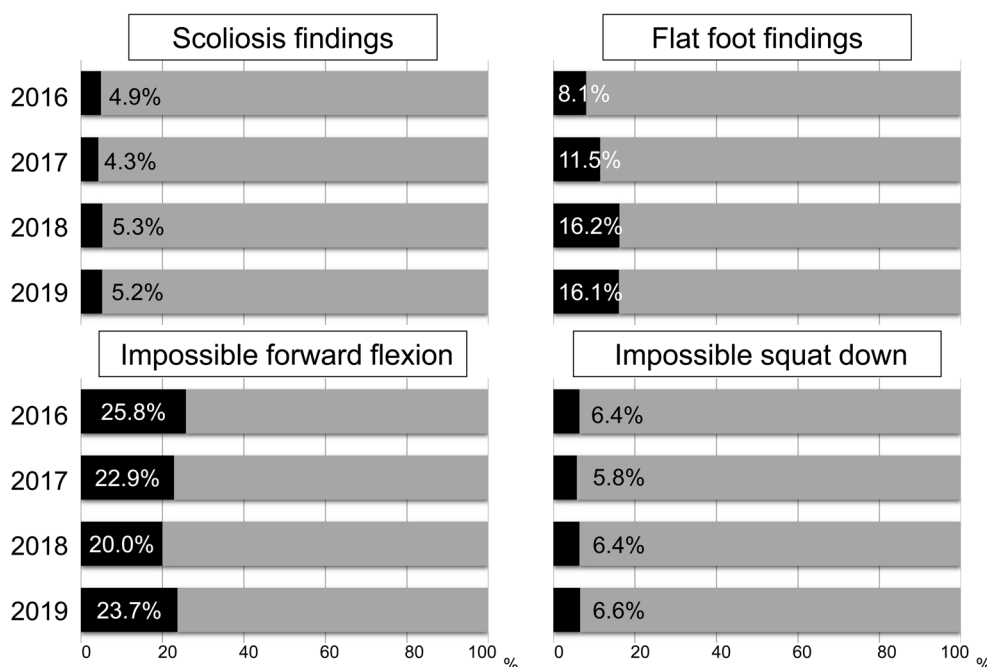
Figure 3 Questionnaire personal result sheet (English version).

**Table 1** Number of students who underwent unified musculoskeletal examinations in each year

Year	2016	2017	2018	2019
Number (students)	19,244	19,675	20,207	20,634
Number of schools in 2019	<ul style="list-style-type: none"> <li>• Elementary schools: 29</li> <li>• Junior high schools: 12</li> <li>• Compulsory education schools: 4 (elementary and junior high schools integrated school)</li> </ul>			

**Table 2** Number of implementations (students)

Year	2016	2017	2018	2019
Boy	9,783	9,985	10,441	10,693
Girl	9,043	9,391	9,702	9,940
1st grade	2,419	2,370	2,450	2,522
2nd	2,332	2,441	2,395	2,456
3rd	2,318	2,391	2,478	2,510
4th	2,224	2,357	2,422	2,506
5th	2,157	2,306	2,353	2,427
6th	2,188	2,192	2,304	2,371
7th	1,900	1,854	1,921	2,015
8th	1,903	1,921	1,910	1,913
9th	1,803	1,843	1,974	1,914



**Figure 4** Findings in the Tsukuba Childhood Locomotive-Organ Screening Sheet questionnaire.

mately 10% of junior high school students (7th to 9th graders) were found to have some musculoskeletal problems and were subjected to a third screening (including consultations) (Figure 5).

Details of the consultation recommendations for 2019 are shown in Figure 6, including 29.8% for scoliosis, 19.8% for flat foot, 12.2% for back pain, and 7.8% for knee pain and Osgood's disease (Figure 6). Of the 524 students who received a third screening recommendation in 2019, the actual consultation rate was 40.8% (n=248). The consultation rate decreased as the students advanced to higher grades (Figure 7). In the lower grades (elementary), the consultation rate was 50–60%, but the consultation rate declined to 25–40% by the seventh grade in junior high school. The consultation rates in 2017 and 2018 were 47.7% and 46.9%, respectively.

During consultation, responses to the letter of introduction were collected from the medical institution for feedback. Based on the information, the proportion of students with disease status requiring treatment was 12.2%, requiring regular outpatient visits was 34.5%, with slight findings but did not require outpatient visits was 34.5%, and without abnormalities was 16.4% (Figure 8).

The proportion of students requiring treatment and outpatient visits was 46.7% (n=248), which accounted for 1.2% of all elementary and junior high school students in the city. The rates of the identified conditions were as follows: 30.6% for scoliosis, 19.8% for flat feet, 6.0% for hallux valgus, 6.0% for Osgood's disease, and 4.8% for lumbar spondylolysis (Figure 9).

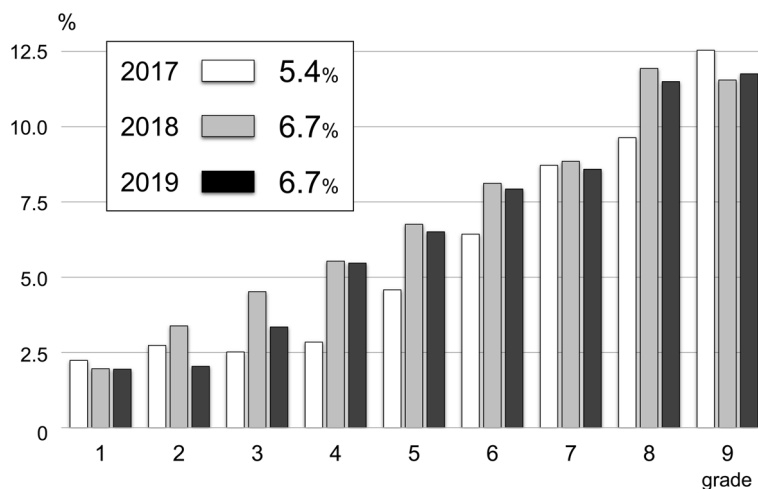


Figure 5 Consultation recommendation rate.

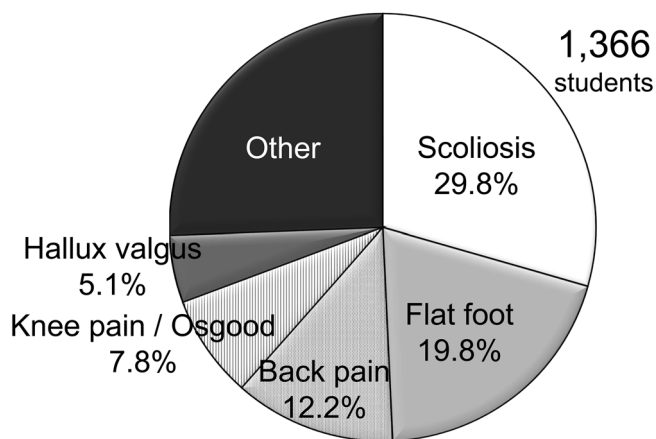


Figure 6 Consultation recommendation rates in 2019.

## Discussion

In 2016, Japan started conducting musculoskeletal examinations using region-specific methods, as the implementation was left to each municipality. The main feature of our screening was that we used a uniform questionnaire that was distributed throughout the city, and orthopedic surgeons performed the secondary examination in all schools. In this study, we reported the results of a 4-year exercise examination in elementary and junior high school students in a single city. The consultation advisory rate was 6.7% in 2019, while the actual consultation rate in medical institutions was as low as 40.8%.

Although it has been possible for 4 years since its inception, a nationwide uniform screening system is very rarely

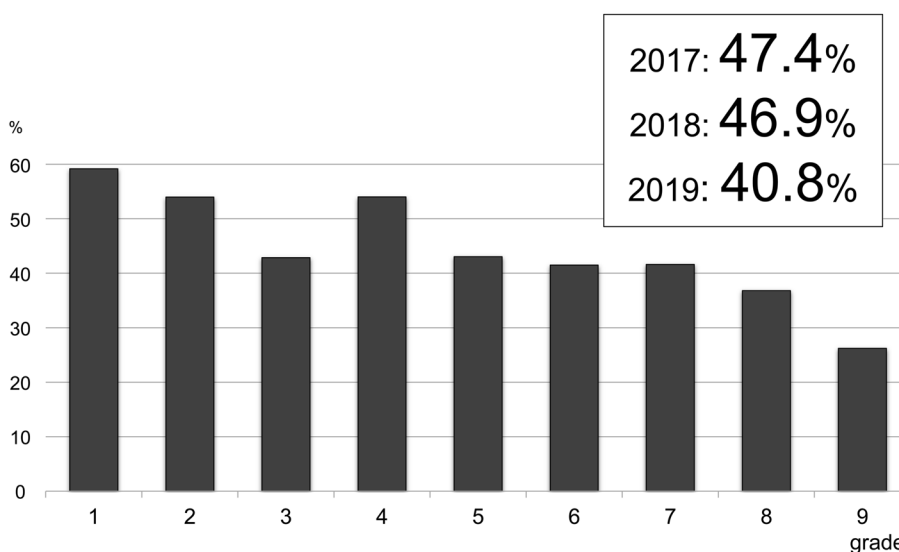
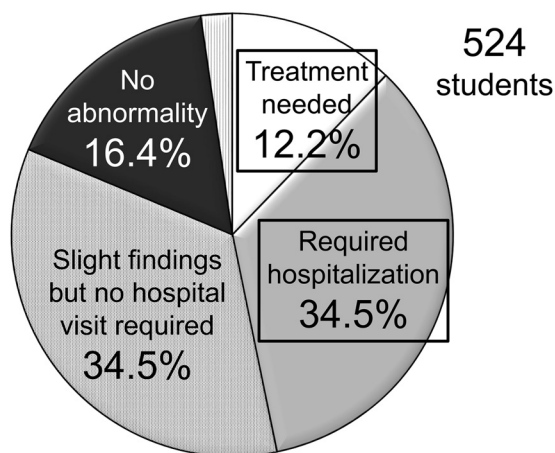


Figure 7 Consultation rate after the third screening in 2019.





**Figure 8** Medical institution consultation results in 2019.

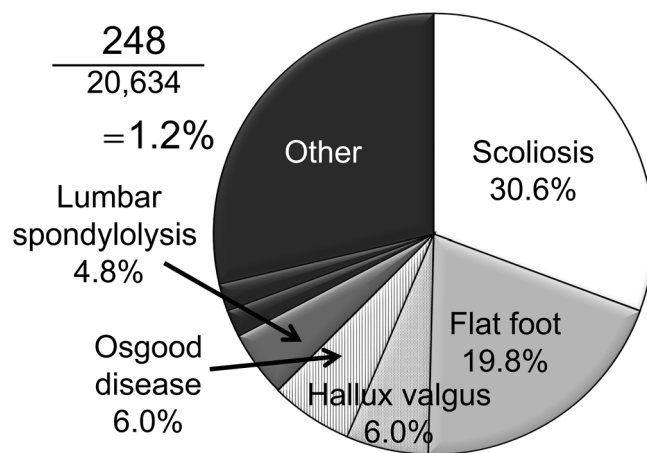
implemented. It was an advanced effort to prevent students from developing musculoskeletal impairment. This approach has been implemented continuously, and students, parents, school doctors, nurses, and teachers have gradually gained a better understanding of the musculoskeletal examinations.

The proportion of students who were recommended for consultation was 5.4–6.7% in the past 3 years, indicating that disease suspicion likely increases with advancing grade. Approximately 10% of junior high school students have findings that suggest some kind of disability, indicating that their conditions cannot be overlooked. These rates appeared to be nearly equivalent to those previously reported<sup>5</sup>.

According to the disease type, scoliosis and flatfeet were the most prevalent, and the screening effectiveness was shown because some of the cases required surgery and functional improvements were attained by rehabilitation intervention<sup>6–9</sup>.

However, the consultation rate was not high, accounting for only 40.8% of the recommendations in 2019. In addition, the consultation rate tended to decrease with increasing age, and junior high school students were less active during consultation. This is also the time when junior high school students not only enter the growth and development period, along with increase in club activities but also undergo an increase in the incidence of musculoskeletal disease. This period was thought to be the best time to actively intervene for musculoskeletal diseases and educate students about musculoskeletal impairment.

What was highlighted by this examination was the fact that many of the findings called “musculoskeletal dysfunction” were found during screening. Careful attention is needed, as “lumbar flexion impossible” accounted for 20–25%, and “squatting impossible” was found in approximately 6% of students. Although not all of these findings can lead to lo-



**Figure 9** Consultation rates for the identified medical conditions in 2019.

comotor disease, the body may be stiff, causing inadequate performance of locomotor functions during childhood, and attention must be paid to injuries. In this way, considering that students get older over time, we cannot deny that there are concerns about musculoskeletal activity. In the future, treatment for these musculoskeletal dysfunctions and function improvement programs should be conducted in hospitals and schools.

Although the role of musculoskeletal screening is sufficient, some problems were identified. First, the accuracy of extraction is not always sufficient because self-reported examinations are based on a questionnaire<sup>10</sup>. Compared with the results of an examination in which an orthopedic surgeon examined all items, there was a slight discrepancy in the results of this screening, which was performed based on only the extracted items. Because the questionnaire is assessed by a person without medical knowledge, accurate judgment may not always be possible. The content must be simpler and more fulfilling, and information and education on the individual and family receiving the information must be considered. This education was predicted to lead to enlightenment activities that focus on the musculoskeletal system.

Second, medical institutions have a low consultation rate, approximately 40% in 2019. These examinations include minor changes and findings that may not be a major physical problem. Even if few findings may suggest consultation to a medical institution in case of a suspicious situation, many parents do not understand the importance of such findings and disregard them. With regard to findings associated with minor musculoskeletal issues after consultation in a medical institution, individuals often do not receive a new consultation even if the findings change. As elementary and junior high school students gradually grow over time, they should be reminded of possible major musculoskeletal

changes. The consultation rate decreases as a result of continual medical examination over several years. There is a possibility that the family's sense of crisis may have diminished for minor issues that have been continuously pointed out; hence, it appears necessary to raise awareness.

Finally, the amount of time and effort of orthopedic surgeons in performing the screening should be considered. Many school doctors are non-orthopedic surgeons, and they find it difficult to perform musculoskeletal examinations that include specialized fields. Although we, as orthopedic surgeons, conduct most interventions, screening 20,000 students is not an easy task. There are many things to be improved, such as the content, methods, manpower, and educational activities. Particularly, as limitations of this study, there were differences in the answers on the mark sheet because of the large number of students and schools participating in the survey. While some families enthusiastically described the condition of their children, some families did not actively participate in the intervention; thus, the reliability of screening of the answers for a medical examination centered on mark sheets varies. Second, different doctors performed the examinations. Although the evaluation is based on the same standard as far as possible, it was difficult to determine whether the evaluations were performed in the same manner because there may be subjective evaluations and limited examination times. Thus, a more objective and easy evaluation method is desired in the future.

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## Conclusion

In the implementation of the nationwide screening, the most important aspect is the cooperation of schools and local governments. In this regard, the region was very cooperative, and we were able to pursue this project with greater collaboration. In the future, we hope to conduct more sophisticated musculoskeletal examinations by using these results to focus on early detection and treatment and improvements in musculoskeletal function in elementary and junior high school students.

Currently, many features of the nationwide musculoskeletal screening method need improvement because of drawbacks such as the authenticity of the mark sheet, uniformity of examination evaluation, and manpower. Further enrichment of the questionnaire contents, examination methods, and enlightenment activities are required. Nevertheless, our results suggest that musculoskeletal examinations are an effective tool to screen primary and junior high school students for musculoskeletal disorders and dysfunction.

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