ABSTRACT

Objectives: To clarify the frequency of musculoskeletal problems in public elementary and junior high school children, and to determine the advantages and problems of musculoskeletal examinations.

Study design: School-based cross-sectional study nested in a cohort.

Methods: We examined 41,376 public elementary and junior high school children (aged 6–15 years) in Miyazaki, Japan, from 2008 to 2014. Participation was voluntary. Participants received an in-school primary musculoskeletal examination (clinical examination with check items and a questionnaire) and a secondary examination at an orthopaedic outpatient clinic as indicated. Estimated prevalence rates for musculoskeletal problems were calculated from the results of both examinations.

Results: The total estimated prevalence of musculoskeletal problems was 8.6%. Prevalence by school grade ranged from 3.2% to 13.7%. Estimated prevalence rates increased as grade increased, and were higher in junior high than in elementary school students. The secondary examination identified musculoskeletal problems on the back (65.4%), knee (8.1%), ankle or feet (7.3%) and elbow (5.4%). Of those referred for a secondary examination, 44.4% had not reported musculoskeletal complaints on the initial questionnaire. Overall, 69.8% of problems diagnosed in the secondary

examination were previously undiagnosed.

Conclusions: School-based musculoskeletal examination enables early detection of abnormal growth and disorders of the locomotive organs, and is expected to support children's musculoskeletal growth and development. We recommend musculoskeletal examinations as part of school check-ups in Japan. Our findings suggest musculoskeletal examinations should be conducted for students in higher elementary school grades and for all junior high school students. Evaluation should include both direct clinical examination and questionnaires.

Keywords: School children; Musculoskeletal problems; Musculoskeletal examination; Estimated prevalence rates.

Introduction

In Japan, problems in preventive medicine include declining birth rates and an aging society. The World Health Organization's 2016 World Health Statistics ranked Japan first in the world, with the life expectancy of Japanese people as 83.7 years and the healthy life expectancy as 74.9 years.[1] The most important contributor associated with reduced healthy life expectancy in Japan was musculoskeletal disorders (25%).[2]

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) reported a decrease in the physical strength and athletic abilities of children in Japan over the past 30 years,[3] attributed to failure of healthy growth of the locomotive organs. Increasing rates of obesity and lifestyle-related diseases associated with lack of exercise have been highlighted in children. Moreover, sports-related injuries of the extremities and spinal injuries associated with excessive exercise have increased in Japan. These very different problems affecting the locomotive organs may lead to metabolic syndrome or locomotive syndrome in older age.[4–9]

Physical check-ups for children in Japan (including internal medicine, dental health, eyesight/eye disease, audiometry, urinalysis for kidney disease, parasite burdens, electrocardiograms, tuberculosis, spine/thorax problems, skin disease and otorhinolaryngologic disease) have been implemented by law since the 1951 School

Health and Safety Act.

School medical check-ups are usually carried out in schools, and have demonstrated efficacy in the early detection and prevention of diseases. In 1994, the former Ministry of Education, Science, Sports and Culture of Japan (now the MEXT) stipulated in a notice that “abnormalities of the bones or joints, and conditions of the extremities, must be given special attention during examination of the spine and thorax”. However, although examinations for scoliosis have been part of school medical check-ups for a long time, very few schools examine the extremities in Japan.[10] In addition, there has been no medical check system for extremities.

The Bone and Joint Decade Japan, part of an international collaboration to address musculoskeletal conditions as a public health issue, worked to establish school medical examinations of the locomotive organs. The project started in 2005 in four areas (Hokkaido, Kyoto, Tokushima, and Shimane). Ten areas are currently participating in the project. As part of this project, the Miyazaki Prefecture group, organised by orthopaedic surgeons in our institution, began performing musculoskeletal examinations in 2007 to screen for musculoskeletal problems in elementary and junior high school children.

Previous studies have reported on sports medical check-ups or sport-related injuries in

child and adolescent athletes.[11–14] However, most check-ups concerned sport-specific injuries (e.g., tennis,[15] soccer,[16,17] basketball,[18] long-distance running[19] and ice skating[20]) or body part-specific injuries (e.g., anterior cruciate ligament injuries,[21,22] knee injuries,[23] throwing-related injuries[24,25] and low back pain[26]). Studies have investigated musculoskeletal pain[27–32] and the relationship between musculoskeletal pain and hypermobility[33–35] in school children, but few reports describe the results of musculoskeletal problems in school-based screening.[36–38] The results of musculoskeletal examinations in three other project areas in Japan (Shimane,[39] Niigata[40] and Kyoto[41]) have been reported (in Japanese).

This study aimed to clarify the frequency of musculoskeletal problems in public elementary and junior high school children, and determine the advantages and problems of musculoskeletal examinations as part of school medical check-ups.

Methods

We (Miyazaki Prefecture group) used data for 2008–2014. Although we have conducted musculoskeletal examinations in schools since 2007, the examination system changed during the first year. In 2007, primary in-school musculoskeletal examinations were conducted by school doctors (internists or paediatricians). Since 2008, examinations

have been conducted by orthopaedic surgeons. The clinical examination protocol and medical questionnaire were modified based on issues identified during the first year. Therefore, data for 2007 were excluded from the present study.

During the first 3 years, students in Miyazaki City (where our institution is located) voluntarily participated in the study. Three municipalities participated from 2011 and an additional municipality participated in 2014. We explained the purpose and methods of our study to the Prefectural Board of Education of Miyazaki, and a principal of the Educational Committee of Miyazaki City to obtain permission to conduct the study. Then, we explained the study to public school nurses and principals in Miyazaki City and the additional municipalities. After participating schools were identified, we held a briefing session for school doctors and nurses, and provided a DVD about how the musculoskeletal examination would be reviewed. Participating schools were voluntary participants.

Workshops involving multiple examinations were conducted with the examiners (senior orthopaedic surgeons) to provide training to reduce the time taken for examinations and ensure assessments were performed in a uniform and consistent way. Sessions (approximately 2 hours) were conducted at the beginning and end of each year by the same trainer. Inter-rater reliability for workshop participants was not performed due to

time restrictions for in-school examinations.

Participants

We used data for 41,376 children (20,219 girls, 21,157 boys) who received in-school musculoskeletal examinations in Miyazaki, Japan, from 2008 to 2014. Of these, 21,429 were in elementary school (Grades 1–6) and 19,947 were in junior high school (Grades 7–9) (Tables 1, 2). Musculoskeletal examinations were performed at 407 schools over the 7-year period. The number of participating schools and students increased each year (Table 1). Some schools participated in multiple years; however, most selected the same grades each time (e.g., we examined 6th grade students every year for one school). All students in two small-scale schools (322 students in total, 0.8%) participated in examinations annually for whole years and in eight small-scale schools (930 students in total, 2.2%) participated for several years over the 7-year period. Schools identified which grades were selected.

Students at the participating schools (mostly across several grades) and their parents were provided with a written explanation of the study. Participation was voluntary, and informed consent was obtained before participation. Over the 7-year period, 1070 students (2.5%) were excluded from analysis due to absenteeism from school or declining to participate.

Participating students received a primary musculoskeletal examination carried out at school and a secondary examination at an orthopaedic clinic as indicated.

Primary examination

The primary examination comprised a clinical examination and a questionnaire. We reviewed both the examination and questionnaire results for all participants. The clinical examination included seven check items: 1) gait; 2) spinal deformity (Adams forward-bending test[42]); 3) shoulder motion (flexion, abduction-external rotation); 4) upper extremity deformity; 5) elbow motion (flexion, extension); 6) squatting; and 7) lower extremity deformity. As there were time restrictions for the examinations not to interfere with students' school schedules, we trained to examine systematically through seven check items to reduce the time taken for examinations.

We administered a 4-item self-report questionnaire, completed with assistance from the students' families, to measure physical activity patterns and musculoskeletal conditions. The questionnaire and check items were modified from the draft proposal of the School Health Committee of The Bone and Joint Decade Japan.[43] To simplify evaluation and statistical processing, the answer sheet could be read by an optical character reader. The answer sheet included space for examiners to check off clinical examination results. Questionnaire items included: 1) sports club affiliations and amount of time spent in

sports activities; 2) musculoskeletal problems at present; 3) musculoskeletal problems in the past; and 4) free comment section (omitted from 2013 due to the increasing number of participants). Participants were given a numbered list of response options for each question and asked to record the appropriate number on the answer sheet.

Senior orthopaedic surgeons evaluated the primary clinical examinations and questionnaires, and classified participants into five categories: 1) under treatment; 2) requiring consultation; 3) requiring special attention; 4) no significant findings; and 5) indeterminate result or others with statistical errors or extra musculoskeletal problems. Abnormal findings included: a fractured leg in a cast; scoliosis wearing a brace (assessed as under treatment); limping; undiagnosed deformity of the spine; undetected limited range of motion in elbows or shoulders; untreated deformity of upper extremities; incomplete squatting with pain; continuous low back pain (assessed as requiring consultation); and incomplete squatting due to tightness or imbalance in the lower extremities, obesity, asymptomatic bowleg or knock-knee (assessed as requiring special attention). Students classified as under treatment or requiring consultation were informed they required a secondary examination at a medical institution (Fig. 1).

Secondary examination

Secondary examinations were performed at an orthopaedic clinic, which students visited

out of school hours. These students were classified into four categories by the examining orthopaedic surgeons: 1) requiring treatment; 2) observation (routine visit to hospital); 3) observation (with remarkable changes); and 4) no significant findings. We received the secondary examination results and categorised any evaluations other than the four categories listed above and incomplete evaluations as “other” or “indeterminate results” (Fig. 1). Estimated prevalence rates were calculated from the results of the primary and secondary examinations using the formula: (Number of students requiring secondary examination/Total number of participants) × (Number of students in secondary examination categorised as “requiring treatment” and “observation”/Number of secondary examination participants) × 100.

In cases where a student had multiple results, the most serious classification was used in the analysis.

Statistical analysis

Chi-square tests were used for the analysis of students with abnormal findings in the secondary examination. Statistical analysis was performed with the statistical software package Ystat 2004 (Igaku Tosho Shuppan Co., Ltd., Tokyo, Japan). Significance was set at $P < 0.01$.

Results

The primary and secondary examination results and estimated prevalence rates are shown in Tables 1 and 2. In total, 21.0% of students had abnormal findings in the primary clinical examination, ranging by school grade from 5.1% (2nd grade) to 37.1% (9th grade); 9.3% reported musculoskeletal problems on the questionnaire, ranging by school grade from 1.0% (1st grade) to 17.0% (9th grade). A secondary examination was recommended for 14.7% of students (range: 7.2% in Grade 3 to 21.9% in Grade 9). Of the 6100 students referred for a secondary examination, 2708 (44.4%) had not reported present or past musculoskeletal problems on the questionnaire. The clinical examination in the primary evaluation took 21.5 seconds (range 12–92 seconds) per student when we reviewed students in 7th grade (n = 112).

The consultation rate for secondary examinations (percentage of students who actually underwent a secondary examination) was 43.4%, ranging by examination year from 28.5–54.6%, and by school grade from 23.5% (9th grade) to 87.5% (1st grade). The secondary examination identified 1864 musculoskeletal problems in 2645 students. Of these, 1302 problems (69.8%) were previously undiagnosed, 1219 (65.4%) were on the back, 151 (8.1%) the knee, 137 (7.3%) the ankle/feet, and 100 (5.4%) the elbow. Figure 2 presents a breakdown of the body regions of the musculoskeletal problems identified in the secondary examination. The main diagnoses were: scoliosis (n = 1173, 62.9%),

Osgood-Schlatter disease (n = 70, 3.8%), humeral medial epicondylitis (n = 48, 2.6%), postural scoliosis (n = 36, 1.9%), lower limb deformities (bowleg or knock-knee) (n = 27, 1.4%), pes planus (n = 23, 1.2%), lumbago (n = 22, 1.2%), and spondylolysis (n = 18, 1.0%). The secondary examinations identified 35 musculoskeletal problems due to other diseases or congenital disorders difficult to classify by body region, including cerebral palsy (n = 8), congenital paralysis of extremities (n = 5), brain disease (n = 2), Down syndrome (n = 2), juvenile rheumatoid arthritis (n = 1) and dermatomyositis (n = 1). In addition, 878 (47.1%) of 1864 musculoskeletal problems found in the secondary examination were students who reported no musculoskeletal complaints on the questionnaire (Fig. 3): scoliosis (84.3%), postural scoliosis (2.2%), humeral medial epicondylitis (1.1%), lower limb deformities (bowleg or knock-knee) (1.8%), Osgood-Schlatter disease (0.7%), limited range of motion of ankle (1.0%) and pes planus (0.6%).

Students with spinal deformity detected in the primary examination were significantly more likely to complete the secondary examination ($P < 0.0001$). Secondary examination data showed that problems on the back were significantly more prevalent in those who lived in local areas ($P = 0.0004$). However, problems on the knee and lower extremities (hip, thigh and lower leg) were significantly more prevalent in those

who lived in Miyazaki City ($P = 0.001$; $P = 0.005$). There were no significant differences in prevalence rates by school size. Students with low back and knee problems were significantly more likely to seek follow-up assessment, and were more often categorised as requiring treatment/observation (routine visit to hospital) than those with back problems ($P = 0.006$; $P = 0.001$).

The overall estimated prevalence of musculoskeletal problems was 8.6%, ranging from 3.2–13.7% by school grade (Tables 1, 2).

Discussion

In summary, the total estimated prevalence rate of musculoskeletal problems was 8.6%; 44.4% of students referred for a secondary examination had not reported musculoskeletal complaints on the questionnaire, and 69.8% of problems found in the secondary examination were previously undiagnosed. Students with spinal deformity detected in the primary examination were more likely to complete the secondary examination than those with other findings. The secondary examination showed significant differences in body regions of problems by school location, and in those who sought follow-up assessment.

Early detection of orthopaedic and rheumatic diseases may prevent musculoskeletal

disorders later in life, reduce musculoskeletal disease and improve the healthy life expectancy in Japan. However, there is currently no physical check-up for musculoskeletal problems. In Japan, school medical check-ups play an important role in children's health. Our secondary examinations detected a large number of previously undiagnosed musculoskeletal problems. In addition, estimated prevalence rates increased as school grade increased, highlighting the importance of in-school musculoskeletal examinations for the early detection and treatment of musculoskeletal diseases. The prevalence of musculoskeletal problems reported in three other project areas in Japan were: Shimane (n = 38,235) elementary school 3.2–8.0%, junior high 7.0–14.7% and high school 17.9–26.3%;[39] Niigata (n = 1,418) elementary school 2.07% and junior high school 3.01%;[40] and Kyoto (n = 3,558) elementary school 3.0% and junior high school 7.1%.[41] These studies also found the prevalence of musculoskeletal problems increased as age increased, supporting the inclusion of musculoskeletal examinations in school health check-ups.

In many countries, even in Japan, school medical check-ups for musculoskeletal problems focus on scoliosis.[44–54] However, our secondary examinations found extra spinal problems represented approximately 30% of identified problems, suggesting school-based screening should cover a range of musculoskeletal problems.

Time restrictions, cost-effectiveness, and human resource limitations indicate examination participants should be selected. Selection may be based on questionnaire results, school grade, or affiliation with sports clubs. Selection by sports club affiliation makes it a sports medical check-up, not a school-based examination, so selection should be independent of sports club affiliation. We found that approximately 40% of students with abnormal primary clinical examination findings, and approximately 50% of those with musculoskeletal problems in the secondary examination indicated no present or past musculoskeletal complaints on the questionnaire. This suggests that selection based only on questionnaire results might increase the risk of false-negative results. Therefore, evaluation should include both direct clinical examinations and questionnaires. Nussinovitch et al. suggested scoliosis screening should be conducted at age 10–12 years.[36] We found that more junior high school students required secondary examinations than elementary school students, and estimated prevalence rates increased as school grade increased. This result suggests musculoskeletal examinations should be conducted for higher-grade elementary school students and junior high school students. A comparison of our results with those of three other project areas in Japan showed our results were similar to Shimane. The prevalence rates for junior high school students were higher than those for elementary school students in all project areas, supporting

our screening recommendation. The prevalence rates in Niigata and Kyoto were lower than our study. However, Niigata results did not include students who were under treatment at the time of examination, and the primary examinations in Kyoto were conducted by school doctors (internists or paediatricians), which might have reduced the prevalence.

Nussinovitch et al. reported undiagnosed musculoskeletal abnormalities in 14.8% of Israeli high school students (n = 2380); of these 70% were Adams forward bending test abnormalities, and 11% were scoliosis.[36] Adegbehingbe et al. identified musculoskeletal disorders (questionnaire and physical examination) in 3.0% of Nigerian secondary school students aged 9–22 (n = 4441): 69.9% lower limb deformity, 20.3% upper limb deformity, 6.8% limb length discrepancy, 4.4% scoliosis and 3.9% pes planus.[38] These results differed from our findings, possibly because the pattern of musculoskeletal problems differs in different countries.

Inappropriate orthopaedic screening techniques resulted in a fourfold increase in the referral costs for scoliosis screening.[53,54] In our study, there were no significant findings for 955 (36.1%) of the 2645 students referred for a secondary examination, even though screening was conducted by trained orthopaedic surgeons. To reduce inappropriate referrals for cost-effective screening, specific criteria for school musculoskeletal

examinations should be established and appropriate school grades selected.

This study has several limitations. Firstly, all students in 10 small-scale schools (1252 students in total, 3.0%) participated in examinations annually for several or whole years over the 7-year period. However, Uchio et al. reported that 0.1% of students had two consecutive musculoskeletal abnormalities over a 3-year period.[39] Secondly, as participation was voluntary, participating schools may have had a higher interest and awareness in identifying and responding to musculoskeletal problems, and thus have a different incidence of these problems than schools that volunteered later or did not participate. This might have distorted cumulative results. Thirdly, inter-rater reliability was not performed for the examiners, which might need to be considered to ensure future examinations are conducted in a uniform and consistent way. Fourthly, participants were diagnosed and classified without international criteria; however, all examiners were senior orthopaedic surgeons with Japanese Board of Orthopaedic Surgery qualifications. Fifthly, we omitted the free-text information from the questionnaire later in the study period due to difficulty in responding to the comments as the number of participants increased; however, this did not influence the actual results of the primary examinations. Finally, the consultation rates for secondary examinations increased gradually each year, with approximately 50% of referred

students not completing a secondary examination, which might have influenced the prevalence rates. Consultation rates tended to decrease as school grade increased. Eimori et al. reported consultation rates for tertiary examinations at medical institutions were 66.7% in elementary and 44.3% in junior high school students in Niigata.[40] Uchio et al. noted a lack of awareness about musculoskeletal problems in physical education teachers, sports coaches and students' families.[39] This indicates it is necessary to provide information about the importance of locomotive organs for later life to teachers and school nurses as well as students and their families. Annual musculoskeletal examinations may help students and their families recognise the importance of locomotive organs, and increase secondary examination consultation rates. Musculoskeletal disorders due to excessive exercise during childhood, as well as aging and increased load on the locomotive organs, may lead to problems such as osteoarthrosis, spondylosis deformans or locomotive syndrome later in life. In addition, poor motor performance (e.g., poor balance or muscle strength) caused by lack of exercise during childhood may result in insufficient exercise in adulthood, potentially leading to further decreases in physical strength and motor performance, eventually resulting in locomotive syndrome. Although it seems dichotomous, both lack of exercise and excessive exercise prevent healthy growth and development of the locomotive

organs in children. School-based musculoskeletal examinations enable early detection of abnormal growth and dysfunction of the locomotive organs, and identify children who need interventions to support musculoskeletal growth and development. Prevention of musculoskeletal disorders during childhood is expected to help prevent development of locomotive and metabolic syndromes later in life. Our study highlighted the importance of in-school musculoskeletal examinations. The role of musculoskeletal examinations should be understood by school officials, students, parents and government officials as well as by medical personnel.

Footnote

A small-scale school was defined as elementary schools with 6–11 classes or junior high schools with 3–11 classes; an appropriate-scale school as 12–18 classes and a large-scale school as 19–30 classes. In Japan, there is a maximum of 35–40 students per class.

Miyazaki Prefecture (approximately 1 million inhabitants) extends north and south and has 26 municipalities, including semi-urban, mountainous and coastal areas. Miyazaki City (population approximately 500,000), is the prefectural capital of Miyazaki; it is predominantly semi-urban with coastal and mountainous areas, and has small-,

appropriate- and large-scale schools.

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Figure Captions

Fig. 1

Flowchart of the musculoskeletal examination system.

Fig. 2

Body regions associated with musculoskeletal findings in secondary examination participants (n = 2645).

Fig. 3

Body regions associated with musculoskeletal findings in secondary examination participants with no present or past musculoskeletal problems on the questionnaire (n = 846).

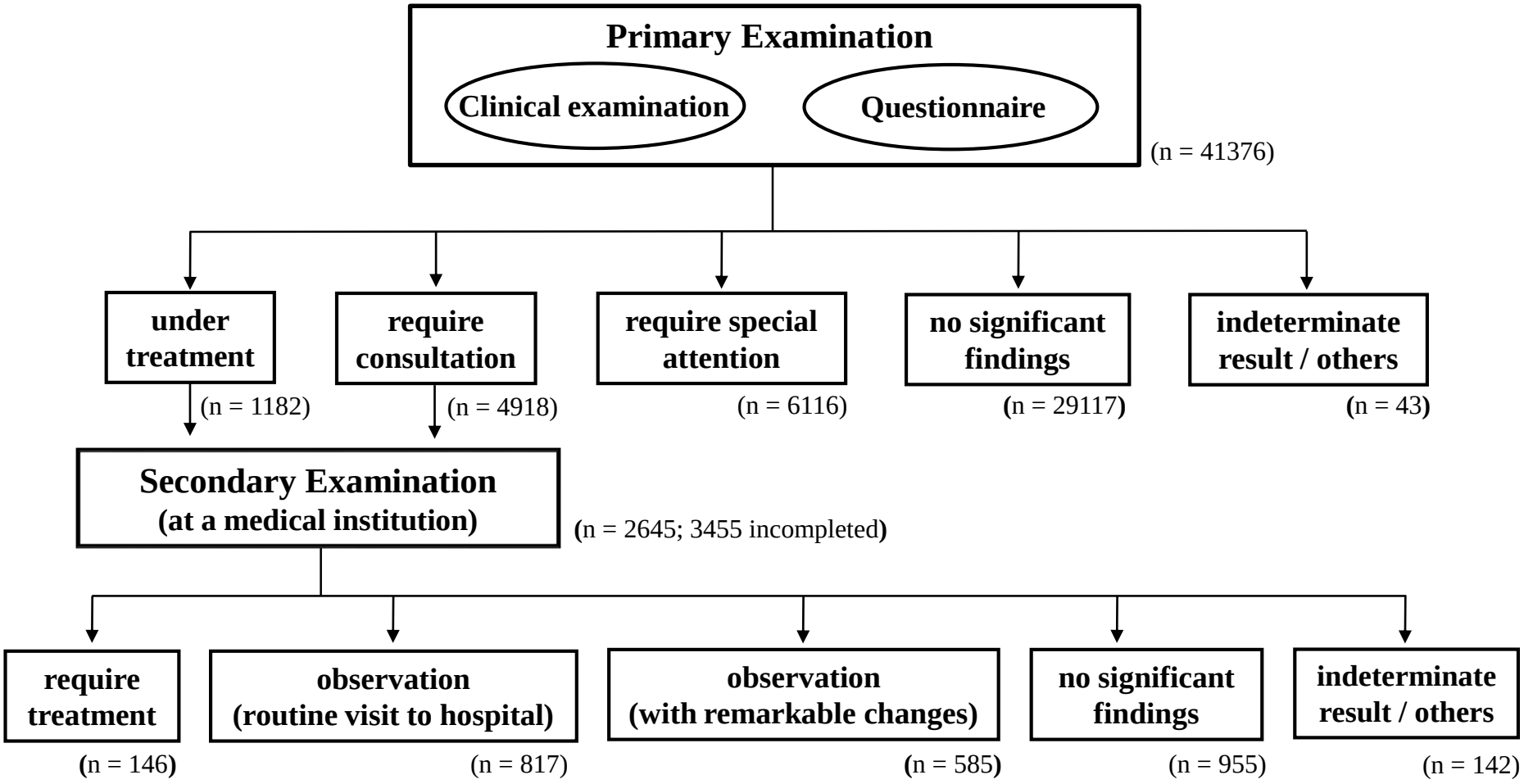
Primary Examination
Clinical examination
Questionnaire
(n = 41376)
under treatment
require consultation
require special attention
no significant findings
indeterminate result / others
(n = 1182)
(n = 4918)
(n = 6116)
(n = 29117)
(n = 43)
Secondary Examination
(at a medical institution)
(n = 2645; 3455 incompleted)
require treatment
observation (routine visit to hospital)
observation (with remarkable changes)
no significant findings
indeterminate result / others
(n = 146)
(n = 817)
(n = 585)
(n = 955)
(n = 142)

Fig. 1

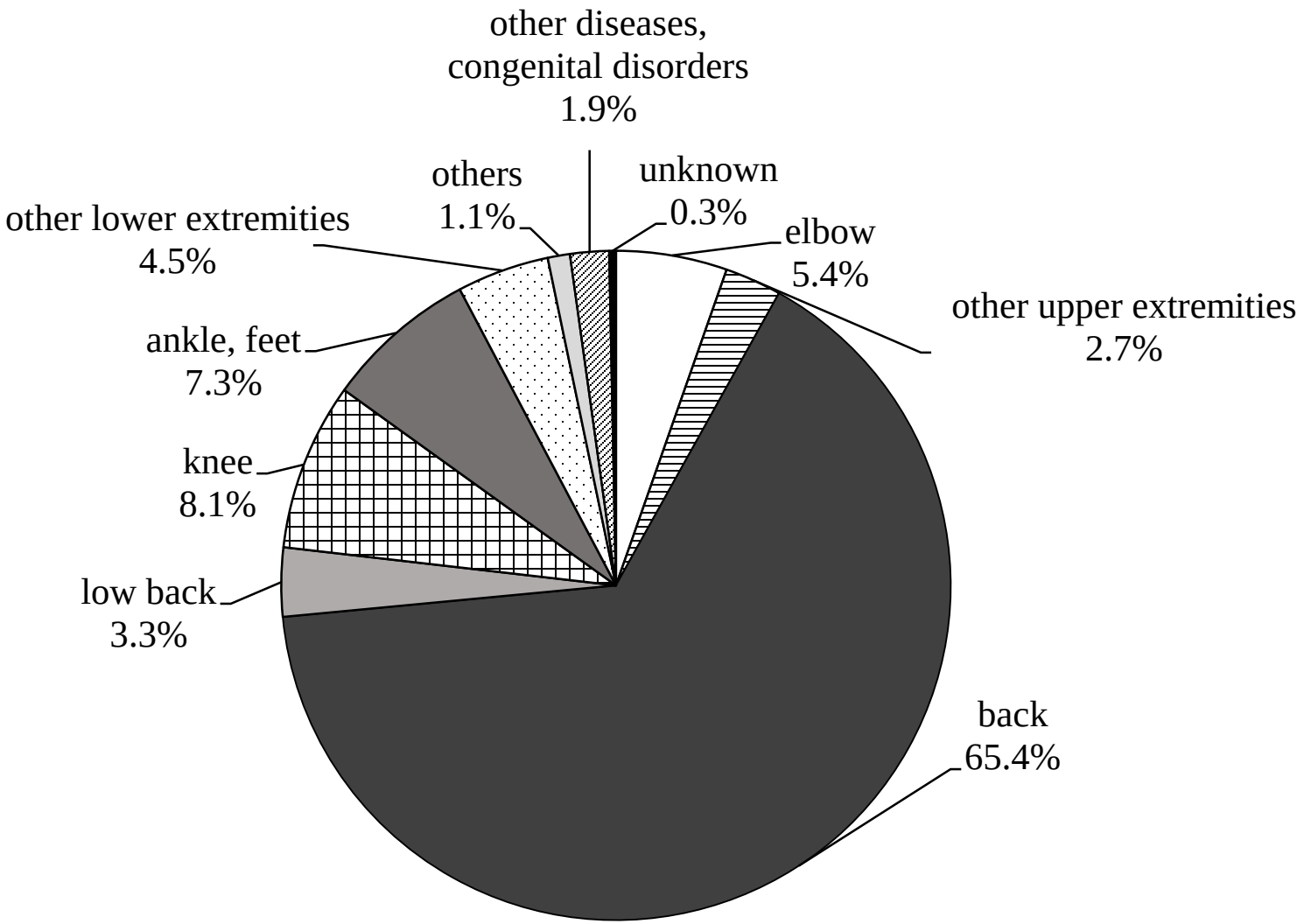
other diseases,
congenital disorders
1.9%
others
1.1%
unknown
0.3%
other lower extremities
4.5%
elbow
5.4%
other upper extremities
2.7%
ankle, feet
7.3%
knee
8.1%
low back
3.3%
back
65.4%

Fig. 2

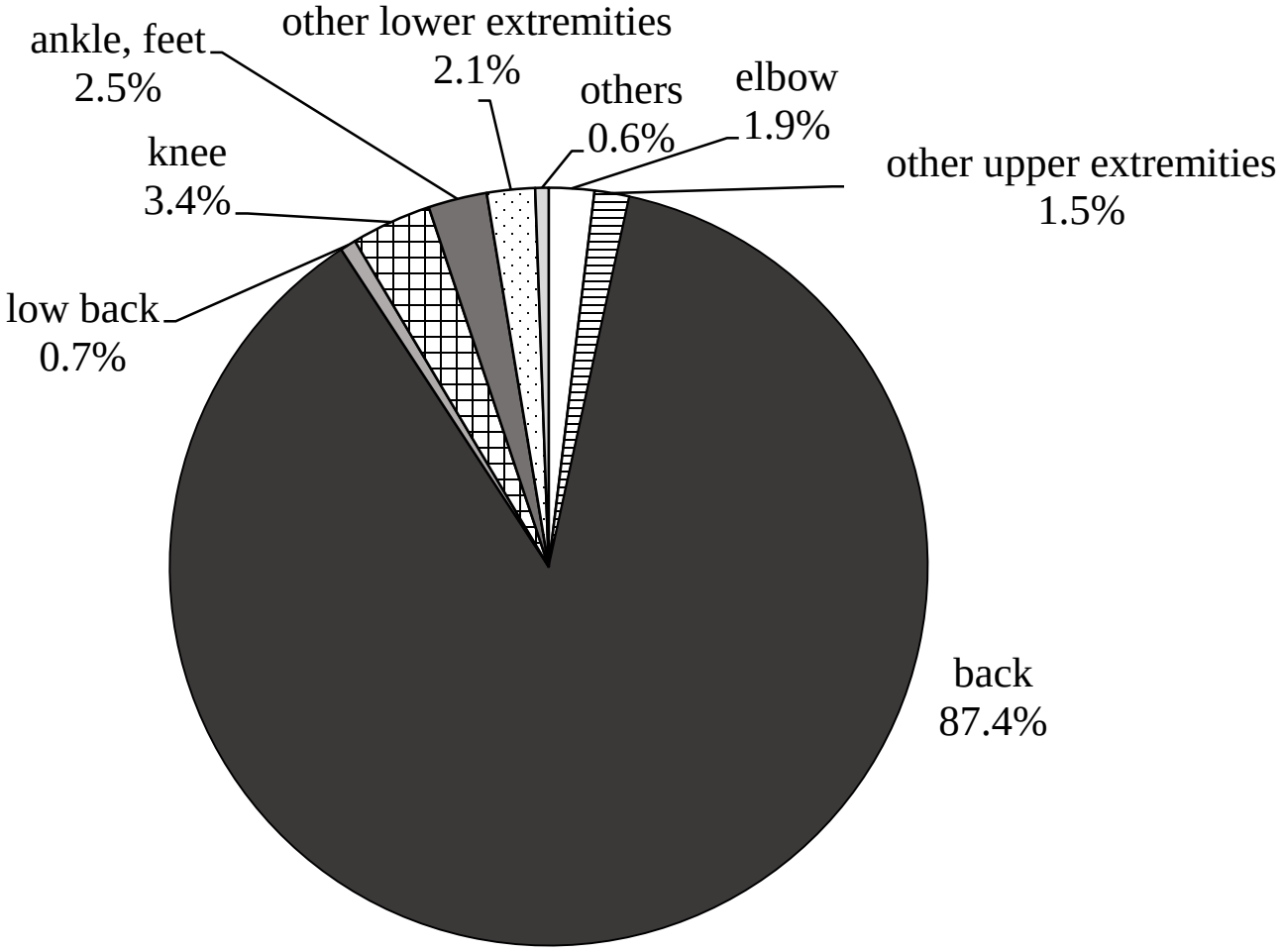
ankle, feet
2.5%
other lower extremities
2.1%
others
0.6%
elbow
1.9%
other upper extremities
1.5%
knee
3.4%
low back
0.7%
back
87.4%

Fig. 3

Table 1. Results of the primary and secondary musculoskeletal examinations for elementary and junior high school students

	Year							Total
	2008	2009	2010	2011	2012	2013	2014	
Primary examination								
Number of schools	16	26	35	67	87	86	90	407
Elementary school	12	13	19	38	53	54	59	248
Junior high school	4	13	16	29	34	32	31	159
Number of participants	2131	3624	4129	6335	8568	8161	8428	41376
Elementary school students	1193	1392	1824	2971	4415	4770	4864	21429
Junior high school students	938	2232	2305	3364	4153	3391	3564	19947
Clinical examination with abnormal findings, n (%)	103 (4.8)	303 (8.4)	600 (14.5)	1418 (22.4)	1966 (22.9)	2358 (28.9)	1950 (23.1)	8698 (21.0)
Questionnaire with present musculoskeletal problems, n (%)	197 (9.2)	366 (10.1)	396 (9.6)	570 (9.0)	806 (9.4)	748 (9.2)	784 (9.3)	3867 (9.3)
Results, n (%)								
Under treatment	96 (4.5)	187 (5.2)	136 (3.3)	186 (2.9)	260 (3.0)	156 (1.9)	161 (1.9)	1182 (2.9)
Require consultation	168 (7.9)	395 (10.9)	567 (13.7)	759 (12.0)	792 (9.2)	1136 (13.9)	1101 (13.1)	4918 (11.9)
Require special attention	93 (4.4)	256 (7.1)	363 (8.8)	1007 (15.9)	1655 (19.3)	1512 (18.5)	1230 (14.6)	6116 (14.8)
No significant findings	1755 (82.4)	2777 (76.6)	3058 (74.1)	4380 (69.1)	5857 (68.4)	5356 (65.6)	5934 (70.4)	29117 (70.4)
Indeterminate result or Others	19 (0.9)	9 (0.2)	5 (0.1)	3 (0.05)	4 (0.05)	1 (0.01)	2 (0.02)	43 (0.01)
Secondary examination								
Require secondary examination, n	264	582	703	945	1052	1292	1262	6100
Underwent secondary examination, n (%)	81 (30.7)	166 (28.5)	279 (39.7)	349 (36.9)	400 (38.0)	705 (54.6)	665 (52.7)	2645 (43.4)
Number of consultations, body regions	97	183	324	400	444	789	729	2966
None of consultation history, body regions (%)	51 (52.6)	138 (75.4)	224 (69.1)	281(70.3)	316 (71.2)	608 (77.1)	566 (77.6)	2184 (73.6)
Results, n (%)								
Require treatment	11 (13.6)	15 (9.0)	18 (6.5)	21 (6.0)	32 (8.0)	30 (4.3)	19 (2.9)	146 (5.5)
Observation (routine visit)	22 (27.2)	47 (28.3)	59 (21.1)	116 (33.2)	134 (33.5)	239 (33.9)	200 (30.1)	817 (30.9)
Observation (remarkable changes)	22 (27.2)	36 (21.7)	75 (26.9)	74 (21.2)	107 (26.8)	112 (15.9)	159 (23.9)	585 (22.1)
No significant findings	23 (28.4)	64 (38.6)	100 (35.8)	118 (33.8)	119 (29.8)	281 (39.9)	250 (37.6)	955 (36.1)
Indeterminate result or Others	3 (3.7)	4 (2.4)	27 (9.7)	20 (5.7)	8 (2.0)	43 (6.1)	37 (5.6)	142 (5.4)
Estimated prevalence rates, %	8.4	9.5	9.3	9.0	8.4	8.5	8.5	8.6

Table 2. Results of primary and secondary musculoskeletal examinations for elementary and junior high school students by school grade

	School grade								
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Age, yrs	6–7	7–8	8–9	9–10	10–11	11–12	12–13	13–14	14–15
Primary examination									
Number of participants	96	311	97	10462	2253	8210	12412	7069	466
girls	38	154	32	5147	1078	4016	6082	3451	221
boys	58	157	65	5315	1175	4194	6330	3618	245
Clinical examination with abnormal findings, n (%)	14 (14.6)	16 (5.1)	13 (13.4)	1761 (16.8)	462 (20.5)	1704 (20.8)	2685 (21.6)	1870 (26.5)	173 (37.1)
Questionnaire with present musculoskeletal problems, n (%)	1 (1.0)	9 (2.9)	4 (4.1)	455 (4.3)	151 (6.7)	772 (9.4)	1271 (10.2)	1125 (15.9)	79 (17.0)
Results, n (%)									
Under treatment	0 (0)	5 (1.6)	1 (1.0)	130 (1.2)	26 (1.2)	266 (3.2)	416 (3.4)	311 (4.4)	27 (5.8)
Require consultation	8 (8.3)	18 (5.8)	6 (6.2)	1062 (10.2)	276 (12.3)	903 (11.0)	1562 (12.6)	1008 (14.3)	75 (16.1)
Require special attention	5 (5.2)	8 (2.6)	11 (11.3)	1026 (9.8)	316 (14.0)	1268 (15.4)	1860 (15.0)	1503 (21.3)	119 (25.5)
No significant findings	80 (83.3)	276 (88.7)	79 (81.4)	8235 (78.7)	1634 (72.5)	5759 (70.1)	8565 (69.0)	4244 (60.0)	245 (52.6)
Indeterminate result or Others	3 (3.1)	4 (1.3)	0 (0)	9 (0.09)	1 (0.04)	14 (0.2)	9 (0.07)	3 (0.04)	0 (0)
Secondary examination									
Require secondary examination, n	8	23	7	1192	302	1169	1978	1319	102
Underwent secondary examination, n (%)	7 (87.5)	14 (60.9)	4 (57.1)	670 (56.2)	156 (51.7)	488 (41.7)	850 (43.0)	432 (32.8)	24 (23.5)
Number of consultations, body regions	7	18	6	719	180	542	963	504	27
None of consultation history, body regions (%)	7 (100)	10 (55.6)	3 (50.0)	565 (78.6)	134 (74.4)	417 (76.9)	680 (70.6)	352 (69.8)	16 (59.3)
Results, n (%)									
Require treatment	0 (0)	1 (7.1)	2 (50.0)	20 (29.9)	8 (5.1)	32 (6.6)	46 (5.4)	37 (8.6)	0 (0)
Observation (routine visit)	4 (57.1)	3 (21.4)	0 (0)	197 (29.4)	50 (32.1)	170 (34.8)	259 (30.5)	124 (28.7)	10 (41.7)
Observation (remarkable changes)	0 (0)	2 (14.3)	0 (0)	148 (22.1)	38 (24.4)	83 (17.0)	209 (24.6)	100 (23.1)	5 (20.8)
No significant findings	3 (42.9)	7 (50.0)	2 (50.0)	261 (39.0)	56 (35.9)	176 (36.1)	285 (33.5)	157 (36.3)	8 (33.3)
Indeterminate result or Others	0	1 (7.1)	0	44 (6.6)	4 (2.6)	27 (5.5)	51 (6.0)	14 (3.2)	1 (4.2)
Estimated prevalence rates, %	4.8	3.2	3.6	6.2	8.2	8.3	9.6	11.3	13.7