

Prevalence and Causal Factors of Playing-Related Musculoskeletal Disorders of the Upper Extremity and Trunk among Japanese Pianists and Piano Students

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Abstract—The purpose of this study was to investigate the prevalence of playing-related musculoskeletal disorders (PRMDs) among Japanese female classical pianists of different age groups. The causal factors for PRMDs also were examined. A group of 203 senior pianists, including piano teachers and students with piano majors at high schools and colleges, were surveyed using questionnaires. Results showed that 77% of these pianists suffered from PRMDs in at least one of their body portions. This value was larger than those reported in Western countries. Forty-four percent of these were serious enough to warrant medical treatment, which was a lower rate than reported in Western countries. The difference in these numbers may reflect the current state of understanding of PRMDs among Japanese pianists and their educators. The prevalence of PRMDs was found to be age-dependent. In the student groups, the finger/hand had the highest rate of PRMDs, followed by the forearm and shoulder. The senior group, on the other hand, had the highest PRMD incidence at the neck/trunk, followed by the forearm and hand/finger. Care may need to be exercised for these differences. The results also indicated that prolonged daily practice (>4 hours), playing chords forcefully, eagerness about practice, and nervous traits were found to contribute to the development of PRMDs in these pianists. Hand size was, on the other hand, not a significant risk factor of PRMDs. *Med Probl Perform Art* 2006;21:112–117.

Although complaints of nerve and musculoskeletal pain related to playing musical instruments have been reported for many decades, the search for cures for these problems seems to be a relatively recent issue. Pianists are one group who often suffer from these problems. Previous researchers have reported that more than 60% of keyboard players, and mostly pianists, had experienced playing-related physical problems.¹⁻³ Symptoms of such problems range from a local tingling sensation or muscle tightness to prolonged

and unbearable pain due to damage to the nerves, muscles, tendons, and skeletal structures.^{1,4,5} Zaza and Farewell⁶ termed these problems “playing-related musculoskeletal disorders” (PRMDs). Some of the commonly reported severe cases are carpal tunnel syndrome, focal dystonia (or musician’s cramp), and tendinitis, which in most cases develops in the forearms and hands.^{7,9}

Although there are a number of surveys on injuries and discomfort among pianists in Western countries, to our knowledge no systematic study has been conducted in Asian countries, where the population of pianists, especially female players, is quite high. Statistics indicate that Asian people, such as Japanese, Korean, and Chinese, have smaller body dimension and less muscular strength than people in Western countries. Grieco et al.,¹ who examined musculoskeletal disorders among young Italian piano students, reported that anthropometric characteristics and muscular structure were factors causing the disorders. De Smet et al.¹⁰ similarly reported that pianists with small hands were prone to suffer from overuse injuries in the upper extremities. Pak and Chesky² also reported that gender (females > males) and age (younger > elder) were risk factors of PRMDs in keyboard players.

In the present survey using a self-report questionnaire, we attempted to elucidate playing-related physical problems among Japanese female pianists at various ages. An attempt was also made to investigate some of the causal factors related to the problems.

METHODS

Respondents

Two hundred-sixty questionnaires were delivered to female students who belong to the classical-piano major course in two high schools and five music colleges, piano teachers in these institutions, and 25 professionally active female classical pianists. From these, a total of 203 responses were returned from 63 high school students, 83 college students, and 57 senior pianists (37 piano teachers and 20 professionals). Their returned ratios were 71%, 78%, and 88%,

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TABLE 1: Incidence of Self-reported PRMDs by Age Group

Group	No.	Hand/Finger	Wrist	Forearm	Elbow	Shoulder	Neck/Trunk
High school	63	29	20	21	4	27	15
College	83	45	32	43	8	40	40
Senior	57	28	16	30	10	27	31
Total	203	102	68	94	22	94	86

respectively, and the mean returned rate was 78% for all respondents.

All respondents were Japanese, whose ages ranged from 15 to 60 years old. Their mean body height was 158.3 cm (SD 4.6 cm; range, 145 to 172 cm). No difference in body height was found among the three groups. Ninety-eight percent of the pianists were self-assessed right-hand dominant. Their starting age of piano lessons ranged between 1 and 11 yrs old, with the mean age of 4.5 yrs (SD 1.6 yrs), and years of experience in playing piano ranged between 9 and 50, with a mean of 18.7 yrs (SD 9.0 yrs). Fifty-five percent of them reported that they had absolute pitch. A vast majority (94%) of the respondents reported using grand pianos for their daily practice.

Questionnaire

The questionnaire consisted of 40 questions classified into three main sections based on their contents. The first section asked mostly about personal matters and practice conditions: sex, age, occupation, body height, hand dominance, the starting age of taking piano lessons, total number of years playing piano, possession of absolute pitch, difficulty of covering octave keys, subjective judgment of upper extremity strength in daily life, type of piano used for common practice, frequency of weekly practice, average duration of each practice, average interpractice rest period, habit of using excessive force in pressing key, likes or dislikes of piano practice, self-judged personal character, and stage fright.

The second section was concerned with the history of PRMDs associated with practicing and playing the piano. The PRMDs in the present questionnaire were defined as “pain, weakness, numbness, tingling, or other symptoms that interfered with the ability to play the piano at an ordinary level for more than a few days.”⁶ The respondents were asked to not reply about physical problems caused by events other than playing the piano. Separate schematic drawings of the fingers, hands, arms, elbows, shoulders, neck, and trunk were provided, and the respondents were asked to circle the specific spot at which the problem(s) occurred within the past 5 years. They were allowed to circle multiple sites if necessary.

Additional information related to the PRMDs also was asked. These included if the subject underwent medical treatment, type(s) of medical clinic, name(s) of disorder diagnosed, period to cure each problem, and measures that the respondents took after the incidence of the problems.

The third section asked about the daily experience of perceived muscular tension while playing fundamental piano

techniques that included arpeggio with *legato*, a chord forcefully (*fortissimo: ff*), and passage rapidly (*presto*). The *legato* technique is to play smooth, continuous notes with a variable amount of overlap between the time at which one key is released and the time at which the next key is depressed.

Statistical Analysis

A Chi-square test was performed to test any frequency distribution difference of responses between or among the groups of interest for comparison. Statistical significance was accepted at $p < 0.05$.

RESULTS

PRMDs Experienced

Body Portion Difference

Out of 203 respondents, 157 (77%) reported that they sustained PRMDs in some portion(s) of their body. Table 1 shows the number of PRMD incidences classified by body area. The finger/hand had the highest rate of PRMD, followed by the forearm, shoulder, and neck/trunk.

The number of PRMDs experienced in the past 5 years for each body portion is summarized in Figure 1. The results show that the distribution is dichotomized to “occasionally (<3 times)” and “frequently (>7 times)” for most of the body portions, but most evidently in the forearm and elbow. A higher proportion of the “frequent” PRMD incidence was reported in the proximal body portions, especially the neck/trunk and shoulder, whereas a higher proportion of “occasionally” incidence was reported in the distal portions.

Of the 102 cases of PRMDs in the hands/fingers, 89 (87%) specified finger problems. Of these 89 cases, the most common finger indicated was the little finger (57%) as well as the thumb (57%), followed by the ring (37%) and middle (36%). The index finger was reported to experience the least problems (21%).

As for the right-left side difference, more than 60% of the respondents reported that the disorders were experienced on both sides (62% for the hand/finger, 61% for the forearm, and 63% for the shoulder). Less than 20% of the respondents indicated that the problem was limited to one side of the body. The problems in the right side involved the hand/finger (18%), forearm (12%), and shoulder (9%), and those in the left side involved the hand/finger (10%), forearm (5%), and shoulder (3%).

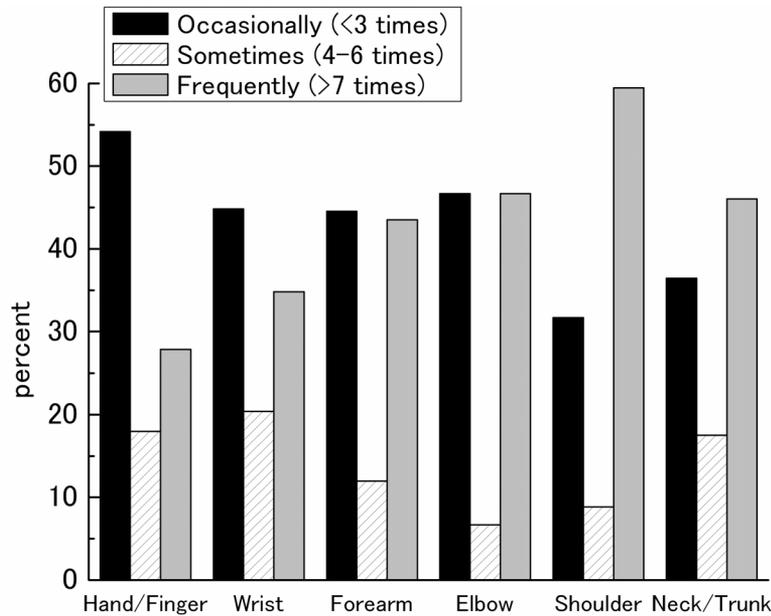


FIGURE 1. Rate of PRMD occurrences for each body area within the past 5 years.

Age Difference

Of 157 individuals who reported PRMDs, 46 (26%) were high school students, 64 (41%) were college students, and 47 (30%) were senior players. A Chi-square test revealed that these group differences were insignificant for the occurrence of PRMDs. As can be seen in Table 1, the high school and college group had the highest incidence of disorders in the hand/finger (46% and 54%, respectively). This was followed by the shoulder (43%), forearm (33%), and wrist (32%) for the high school group and by the forearm (52%), trunk/neck (48%), and shoulder (48%) for the college group. A rank order of body portions with a higher rate of the incidence in the senior pianists was somewhat different from these. The senior group reported that they sustained problems in the trunk/neck most often (54%), followed by the forearm (53%) and hand/finger (49%). Significant group differences were found for the forearm (senior and college > high school), elbow (senior > high school), and neck/trunk (senior and college > high school) (Table 1).

Remedies

To lessen the PRMDs in our respondents, rest seemed to be the predominant measure taken across all body portions (Table 2). This was followed by changing the playing technique (e.g., intentional muscular relaxation during playing, the use of a less painful form, and/or reconsideration of the current practice habits). Sixty-nine (44%) out of the 157 individuals who reported PRMDs sought professional medical (mostly orthopedic) treatment. Of these, 30% indicated that they also consulted with acupuncturists.

Pain at the shoulder was treated mostly by self-massage. Of the 64 individuals who went to the orthopedic clinic, 36%

were diagnosed with tendinitis of the hand/finger, 20% had tendinitis of the wrist and forearm, 14% had arthritis of the fingers, 11% had lumbago, 9% had neuroses of the finger/hand, shoulder, and neck/trunk, and 5% had carpal tunnel syndrome at the wrist. These diagnoses were not confirmed by their medical records, and thus they may have made some errors in the exact names of their reported injuries.

Causal Factors of the PRMDs

Hand Span and Muscle Strength

When asked about the hand span and how hard it is to cover octave keys, 8% of the 203 respondents reported great difficulty, 11% had some difficulty, 53% reported little difficulty, and 28% had no difficulty. As for self-estimated muscle strength of the upper extremity, 54% reported that they recognized its weakness, and 40% reported that they did not feel weakness. Chi-square tests revealed no significant effect of hand span and muscle strength on PRMD prevalence at any body portion.

Excessive Muscular Tension

Thirty-three percent of the 203 respondents reported excessive muscle tension in some portion of their body during exercising arpeggio with a *legato* touch, while 57% reported no excessive tension. When playing arpeggio at a fastest tempo (*presto*), 33% of the respondents reported that they commonly felt excessive muscle tension in some portion of their body, while 58% reported no muscle tension. Chi-square tests revealed no effect of these differences on PRMD prevalence.

When playing chords forcefully (*ff: fortissimo*), 32% of the respondents reported excessive muscle tension, and 60%

TABLE 2: Remedies for Reducing the Symptoms of PRMDs*

	Hand/Finger (n = 102)	Wrist (n = 68)	Forearm (n = 94)	Elbow (n = 22)	Shoulder (n = 94)	Neck/Trunk (n = 86)
Complete rest	68.8	68.7	77.3	60.0	41.2	54.3
Changing performance technique or practice habits	63.5	47.8	53.4	60.0	43.5	45.7
Self-massage	36.5	37.3	47.7	25.0	70.6	48.1
Icing or warming	41.7	41.8	38.6	55.0	24.7	14.8
Medical treatment	40.6	28.4	15.9	25.0	34.1	21.0
Nothing	21.9	11.9	17.0	15.0	11.8	17.3
Acupuncture	10.4	10.4	11.4	20.0	15.3	14.8
Others	13.5	6.0	0.0	0.0	5.9	4.9

*Numbers are the percentage of the total responses for each body region. Boldfaced numbers indicate >50%.

reported no muscle tension. Unlike the results of the *legato* or *presto* play, the pianists who were experiencing excessive muscle tension when playing chords had a higher rate of PRMDs at the hand/finger ($p = 0.01$), wrist ($p = 0.001$), forearm ($p = 0.004$), and elbow ($p = 0.025$). Similarly, the respondents who reported that they were warned often by their teacher about having excessive key compression force during playing had a higher rate of PRMD incidence at the finger/hand ($p = 0.041$) and forearm ($p = 0.015$).

Practice and Rest

As for the number of weekly practice days, 56% of the respondents answered that they practice 7 days. Those who answered 6, 5, 4 and <4 days were 16%, 12%, 8%, and 6% of the respondents, respectively. No difference was found in the distribution of weekly practice days between those with and without PRMDs for any body area.

The mean practice durations per day were 163 min (SD 99; range, 35 to 570). Age group data indicated that the college students practiced for longer duration (mean, 184 min) than the high school students (147 min) and senior players (146 min). The respondents were divided into five groups based on their practice duration (<60, 61–120, 121–180, 181–240, and >240-min groups), and the effect of practice duration on PRMDs was studied. A significant duration effect was found for the higher PRMD rate in the hand/finger ($p = 0.034$) for the >240-min group and the neck/trunk ($p = 0.017$) for the 181–240-min and >240-min groups.

During the practice periods, 66% of the players replied that they take regular rests. The mean rest periods reported were 13.7 min (SD 12.6) for the high school group, 14.0 min (SD 12.9) for the college group, and 20.4 min (SD 38.6) for the senior group. Though the senior group tended to have a longer rest period, the difference between groups was not significant. The PRMD incidence did not differ between those who take rests regularly and others.

Mental Factors

Concerning the “likes” and “dislikes” of respondents toward piano practice, the number of respondents who

stated that they “like very much,” “kind of like,” “neither like nor dislike,” “kind of dislike,” and “dislike” practice were 11%, 34%, 31%, 14%, and 5%, respectively. A significant effect of this distribution on the incidence of PRMDs was found at the shoulder ($p = 0.025$) and neck/trunk ($p = 0.021$). Thus, more eager pianists are prone to have problems in these body portions.

Regarding self-judged personal characteristics in daily life, 11% of respondents described themselves as “very relaxed and calm,” 33% as a “little relaxed,” 23% as “neither relaxed nor nervous,” 24% as a “little nervous,” and 5% as “very nervous.” There was a significantly higher rate of PRMDs at the neck/trunk for those who considered themselves nervous ($p = 0.047$).

The subjects were asked if they become nervous when playing the piano in front of other people, to serve as a measure of stage fright. The responses were as follows: 50% replied “experience always,” 38% “relatively often,” 6% “sometimes,” 3% “very few time,” and 2% “never.” As with the personal characteristics, a Chi-square test revealed a higher incidence of PRMDs at the neck/trunk for those who responded “experience always” and “relatively often” ($p = 0.035$).

DISCUSSION

Our survey revealed several interesting features about playing-related disorders and problems in Japanese female classical pianists. PRMDs were experienced by 77% of these pianists, and of these, 44% sought medical treatment including acupuncture. As for the Western countries, Revak,⁴ who surveyed 71 male and female piano undergraduate and graduate students in the United States, found an incidence of only 42% of PRMDs, with a higher rate of problems in women. They also reported that 57% of these individuals sought medical treatment. Pak and Chesky² found that 63% of 184 classical pianists in the United States had some musculoskeletal problems in the hand, finger, and wrist, and 50% of those with such problems had severe pain. They also reported that female keyboard players, which included all types of musicians who played keyboard instruments, had about a 16% higher rate of these problems than male players. Grieco et al.¹ surveyed 117 Italian piano students and found

that 62% experienced PRMD, of whom 60% had serious problems. De Smet et al.¹⁰ likewise reported that overuse injuries were sustained in 53% of 33 female pianists and 36% of 33 male pianists in Belgium.

The current finding of PRMD incidence was >10% higher than that reported in Western countries, whereas the rate of serious problems reported seemed to be lower than those of Western countries. The greater incidence of PRMDs in Japanese pianists may be attributed to the fact that only women, who are known to have a higher rate of playing-related problems, were surveyed in this study. However, none of the previous researchers in the Western countries provided the ratio of women examined. The smaller rate of medically treated pianists with health problems in Japan seems to be related to the lack of recognition of musicians' medicine by the players themselves or their educators, along with the lack of medical doctors and therapists specializing in music medicine as well as their professional organization in Asian countries. Indeed, the number of individuals who responded that they perform self-treatment, including massage, the use of ice or hot packs, or use of commercially available anti-inflammatory medications, was much greater than that reported in Western countries.¹

The higher rate of PRMDs in Japanese pianists also may be due to repertoires that recent, serious young players may play. The fact is that an increasing number of young Asian pianists are receiving awards at the international competitions in these days. This should result in a tendency for young players to practice and play technically demanding pieces and études.

In the present study, we found that PRMDs were most prevalent at the finger/hand, followed by the forearm/shoulder, neck/trunk, and wrist in a descending order, among young performers. This prevalence was slightly different for the senior players. They had the highest PRMD incidence at the trunk/neck, followed by forearm and hand/finger. Without considering such an age difference, Revak⁴ and Hochberg et al.¹¹ reported that the hand/finger had the highest ratio of PRMD, which was followed by the forearm, wrist, and upper arm/shoulder. De Smet et al.¹⁰ reported that the wrist had the highest prevalence of overuse injuries, followed by the forearm, elbow, and fingers. These three groups of researchers did not include trunk and neck for their surveys. Grieco et al.,¹ who included the trunk in their survey of overuse injuries, reported that the trunk and neck was the site with most frequent serious prolonged problems among young pianists. This was followed by the wrist, forearm, and shoulder. They, on the other hand, did not survey senior players. The findings of the present study were therefore in some ways similar to the findings of previous studies in Western nations, yet some results were different, due possibly to the consideration of age-related change. It may also be different because only females were surveyed in this study.

Causal Factors of PRMDs

We found that age influenced the prevalence of PRMDs for the forearm, elbow, and neck/trunk in the present survey.

In all of these areas, the rate increased with age. This increase seems to be reasonable, because musculoskeletal problems are well known to be more common with increasing age. Pak and Chesky,² however, reported that age was inversely related to the prevalence of PRMDs at the hand, finger, and wrist. According to their results, the 10- to 20-year-old group had a PRMD incidence of 73%, which decreased to 63% for the 21- to 30-year-old group, and 58% for the 31- to 40-year-old group. When we computed the number of incidences for the corresponding regions of the body, we found rates of 58%, 65%, and 59% for the high school, college, and senior groups, respectively. Therefore, the discrepancy most likely was due to the data from the younger groups. The reason for this discrepancy is unknown. The discrepancy may have resulted because more serious young respondents and/or those who were more interested in PRMDs could have been recruited in the Pak and Chesky survey than in ours, because their survey was done through the Internet and included respondents from all over the United States.² We also speculate that PRMDs are less recognized in younger Japanese pianists, and thus they tend to overlook the problems. Thus, a tendency to report or judge PRMDs may differ among different age groups in different cultures, and this factor may need to be carefully considered when performing similar surveys in the future.

Hand span, estimated as the ease of an octave key touch in the present study, did not influence PRMD prevalence of the hand/finger or wrist in the current female pianists. This was unexpected considering the previous report by Farias et al.¹² and De Smet et al.,¹⁰ who reported that pianists with a small hand size had a higher rate of overuse injuries. Farias et al.¹² also warned about interpreting hand span effects when genders were mixed. Females who are known to have a predominance of PRMDs also tend to have a smaller hand size.^{6,13} Our data indicated that hand size itself was not a major or direct causal factor influencing the occurrence of PRMDs within the Japanese female pianists.

Revak⁴ reported that playing the piano with tension in the hands and arms might contribute to the development of discomfort. The present findings indicate that excessive muscle tension when practicing chords with *fortissimo* contributes to PRMD development at the hand/finger, wrist, forearm, and elbow. Interestingly, playing arpeggio with a *legato* touch as well as at *presto*, which may create more static tension at the hand and forearm musculature than playing chords, did not influence the prevalence of PRMDs. Therefore, repetitive application of dynamic force seems to be more stressful to the musculoskeletal structures of the hand/finger and arm than application of tonic force in female pianists. This question needs to be examined in a future study.

Daily practice duration exceeding 4 hrs was found to increase the incidence of PRMDs at the hand/finger and neck/trunk in our pianists. The number of days per week and interpractice rest duration, on the other hand, did not affect the PRMD rate. Our finding that excessive practice periods caused physical problems seems to be reasonable. However, the relationship between the period of practice and playing-

related problems seems to be controversial. For example, Brandfonbrener¹⁴ and Manchester and Park¹⁵ reported that hours of practicing musical instruments was significantly related to the frequency of reported musculoskeletal injuries. Pak and Chesky² and De Smet et al.,¹⁰ on the other hand, found no relationship between the practice period and musculoskeletal problems in pianists. The reason for this discrepancy is uncertain. It may be because we analyzed the data by body portion of only female pianists whereas Pak and Chesky² and De Smet et al.¹⁰ analyzed the combined data for the whole upper limb of both genders. These researchers also did not survey problems at the trunk and neck.

Eagerness about practice and nervous personal characteristics were related to the incidence of PRMDs, especially at the proximal body portions. These mental variables may be related to practice duration; eager and nervous pianists most likely practice more before a recital or test. Nervous individuals also are known to have higher muscle tension at the neck and shoulders.^{16,17} The mental factors therefore may be indirect causes of PRMD incidence. Further study should be conducted to examine the effect of mental or personal traits on PRMD incidence in musicians.

One also may expect to find a tendency to report injuries and seek medical care among those with varying degrees of anxiety. However, we found no clear relationship between nervous traits or eagerness and the number of pianists who suffered from injuries that required medical care at any body portions. A study using more complete tests of mental and/or personal traits should be conducted to re-examine the effect of anxiety on PRMDs or more serious injuries in pianists.

Questions about the causal factors in the present study were limited to events directly related to piano playing. However, there was a possibility that other daily activities, such as heavy computer use, sport activities, or housekeeping, might have cumulatively and thus indirectly contributed to the present PRMDs. This possibility in relation to occupation or age-related differences may need to be examined in a future study.

CONCLUSIONS

With the limitations of the present study based on a self-report questionnaire, the following conclusions appear to be justified: The prevalence of PRMDs in female Japanese pianists is a serious problem that needs more medical attention. Moreover, proper knowledge of injury prevention for

pianists must be taught. Age-dependent care for PRMD prevention is also needed due to the differences in injuries at different ages. Hand size is not a direct causal factor of PRMDs within a population of female pianists. On the other hand, repetitive application of dynamic key-striking force and prolonged daily practice can be direct risk factors for PRMDs in this population. Emotional traits such as eagerness and nervousness also can contribute indirectly to the prevalence of PRMDs.

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