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Author(s): Chia-Ying Ling, Fung-Chiat Loo and Titi Rahmawati Hamedon

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Playing-Related Musculoskeletal Disorders Among Classical Piano Students at Tertiary Institutions in Malaysia

Proportion and Associated Risk Factors

Chia-Ying Ling, MSc, Fung-Chiat Loo, PhD, and Titi Rahmawati Hamedon, MD, MPH

Musicians are prone to performance injuries due to the nature of musical practice, and classical pianists are among the groups at high risk for playing-related musculoskeletal disorders (PRMDs). With the growing number of classical pianists in Malaysia, this study aimed to investigate the proportion of PRMDs occurring among classical piano students in tertiary institutions in Malaysia. Associations between gender, practice habits, diet, sports involvement, and PRMD were investigated. A survey was conducted among classical piano students ($n=192$) at tertiary institutions of Kuala Lumpur and Selangor. Results showed that 35.8% ($n=68$) students reported having PRMD. The shoulder was the most commonly affected body site, followed by the arm, finger, and wrist. Pain, fatigue, and stiffness were the most cited symptoms by those who suffered from a PRMD. Chi-square analysis showed a significant relationship between the occurrence of PRMD and practice hours ($p=0.031$), the habit of taking breaks during practice ($p=0.045$), physical cool-down exercises ($p=0.037$), and special diet ($p=0.007$). Multivariate logistic regression analyses confirmed the independent correlation between PRMDs and the lack of taking a break during practice, physical cool-down exercises, and special diet. Because PRMDs are reported at various severity levels, this study should increase awareness of

PRMD among classical piano students and encourage injury prevention in musicians in the future to ensure long-lasting music careers.

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To most of the public, playing a musical instrument is often perceived as a fun and safe job without posing any harm to the body. As with any other occupation, however, there is a possibility for musicians to suffer from injuries due to various reasons related to their music-making.¹ Pianists, like other musical instrumentalists, are one of the groups who have a high incidence of injuries, which are playing-related musculoskeletal disorders (PRMDs). A PRMD is defined as “any pain, weakness, lack of control, numbness, tingling, or other symptoms that interfere with musicians’ ability to play piano at the level they are accustomed to, without taking into account very mild symptoms,” as based on the operational definition of PRMD by Zaza et al.² Generally, all levels of musicians, from beginners and amateur players to professional performers, are susceptible to PRMDs.³ In previous studies, it was found that 30% to 60% of music students had PRMDs.^{2,4–9} Among pianists, including students majoring in piano, the prevalence of PRMD has been reported in the range of 25% to 93%.¹⁰

Piano playing is similar to athletic activities due to its high demands in practice and the requirement to play musical notes accurately.¹⁰ Muscles in the hand, wrist, and fingers can easily work to the extent where pain begins to progress—for example, about 1,800 notes per minute are required to play the sixth Paganini Etude by Franz Liszt.⁹ This massive amount of hand movement is considered analogous to athletic movements. Moreover, it has also been reported that musicians suffer injuries that are similar to overuse injuries seen in athletes.¹¹ Multiple cases of famous pianists who suffered from PRMDs have been documented in the pianist literature, including Robert Schumann, Sergei Rachmaninov, Alexander Scriabin, Leon Fleisher, and Gary Graffman.^{12–14}

In addition, musicians live hectic and stressful lives due to their tight schedule of rehearsals and performances.¹⁵ Lack

Ling Chia Ying, at the time of this study, was a master's student in the Universiti Putra Malaysia; Dr. Loo Fung Chiat is Associate Professor, Department of Music, Faculty of Human Ecology, Universiti Putra Malaysia; and Dr. Titi Rahmawati Hamedon is Senior Medical Lecturer, Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia.

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Address for correspondence: Ling Chia Ying, Dep. of Music, Faculty of Human Ecology, Universiti Putra Malaysia, Serdang 43400, Selangor Darul Ehsan, Malaysia. Tel 03 +603-8946 7126. lcy8501@hotmail.com.

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of sleep, irregular meal times, inadequate rest, and insufficient time to exercise due to this tight schedule all challenge musicians' fitness to cope with a busy lifestyle.^{4,15,16} Also, in order to achieve a virtuoso level of musical performance, musicians devote much time to practicing. As music students, they practice for 6 to 8 hours daily with short periods of break time.¹⁵ The concept of "no pain, no gain" has also been accepted by many music learners and music educators.¹⁷ Along with the requirement for perfectionism, to play demanding music piece without errors requires extended practice time.¹⁴

Various factors can cause the occurrence of PRMDs among pianists. Although not empirically proven, over-practice,¹⁸ faulty piano techniques,^{15,19} physical limitations such as small hand size,^{8,20} insufficient stamina to play demanding piano pieces,¹⁵ and lack of PRMD knowledge among pianists²⁸ have been associated with PRMDs. For music students, a sudden increase of practice time before examinations and performance is one of the causes of PRMDs.²¹ Although piano techniques vary in different genres of music, examples of faulty piano techniques that could put pianists at risk of PRMD include fingers pressing too hard on the keyboard, head deviating from the central position, elevated shoulder, curving of the wrist (which should be in a straight line with the fifth finger), forearm raised until it is not parallel with the floor, elbow too close or too far from the body, and locked wrist.^{15,17} As well, a lack of warm-up and cool-down exercises prior to and after piano playing is also a risk factor for PRMD.¹⁵ The literature also suggests that small-handed pianists are more likely to be injured, for example, when playing octaves and chords; pianists with a smaller hand size have a larger abduction angle between the thumb and little finger that stresses the hand.²⁰

Generally, pianist report PRMDs occurring at the forearm and wrist due to faulty piano-playing position.^{6,20,22,23} Signs and symptoms of PRMD reported include pain, difficulty in moving joints, loss of motor control, numbness, tingling, and swelling.¹⁵ In music schools, there are cases where injured students have ended their studies due to injury.²⁴

Despite the many studies that have been done on musicians' injuries worldwide and the high incidence of PRMDs reported among classical pianists, there have been limited studies looking into the occurrence of PRMD among Malaysian musicians.⁴⁸ In Malaysia, the number of students who study music in tertiary institutions has been increasing since the 1990s, and classical piano is one of the majors that most students choose. The proportion and extent of PRMDs among the students who study music are not known. Since piano is one of the most common musical instruments learned and played in Malaysia, pianists were chosen for this study. In addition, many studies have involved musicians who played multiple types of musical instruments.^{5,7,25,26} Therefore, the occurrence of PRMD affecting specific body sites caused by a single type of instrument remains unclear. The current study was focused on PRMDs and risk factors among classical

pianists. By narrowing down the study scope to one category of musicians, a better understanding of the extent of PRMDs and the associated risk factors specific to pianists could be obtained.

METHODS

Study Design and Participants

In this cross-sectional study, our survey used a questionnaire to collect data from eight tertiary institutions in Kuala Lumpur and Selangor, Malaysia. A total of 192 Malaysian classical piano students who were majoring in classical piano and taking the foundation, diploma, and degree music courses participated in the survey. The foundation and diploma music programs are preparatory programs offered for students pursuing a music degree. Respondents who had physical injuries caused by factors other than piano-playing were excluded from our study. Approval from the Ethical Committee for Research involving Human Subjects of Universiti Putra Malaysia (JKEUPM; #FEM[EX14]P029) was obtained to carry out the research.

Questionnaire Design

A short interview was conducted among some piano major students at Universiti Putra Malaysia to look into their perception and experience of musicians' injury. A questionnaire was designed based on the responses, with modification from those of previous related surveys.^{6,27,28} A pilot test was conducted in another tertiary institution, not included in the current study, which has a similar program to those in the actual study, to learn respondents' understanding and to gather comments for improvement. Amendments were made before a finalized copy of the questionnaire was designed.

The questionnaire consisted of four categories (Appendix 1, online). Prior to the first category, data were collected on the respondents' experience with physical injuries due to music playing or other factors. If the respondent was injured due to a non-music reason, the data were excluded from study. The first section consisted of questions on respondents' demographic characteristics, such as gender, study program, weight, height, and hand size. The second section investigated the respondents' practice habits, such as practice hours, breaks, and warm-up and cool-down exercises. The third section included questions on the respondents' experience of PRMD, which included only respondents who had experienced any signs and symptom in the preceding 6 months (as indicated in the questionnaire in Appendix 1). The severity of PRMD was further categorized on a scale from 0 to 7 (as shown in Table 1).^{21,29} Level 0 to 2 were considered as very mild discomfort, and thus, only those who had rated severity at level 3 or above were considered as having PRMD. The last section examined respondents' dietary habits,

TABLE 1. Level of Severity of Signs and Symptoms of Pain Among Pianists*

Level	Signs and Symptoms	No. of Respondents (n=192)	Percentage
0	No pain during and after playing piano.	75	39.1%
1	Feeling tired during and after playing piano, but no pain or other symptoms.	13	6.8%
2	Pain occurs while playing piano, or for a short period of time (<2 days) after playing piano. The individual is able to play normally.	36	18.8%
3	Pain occurs while playing piano and persists for a longer period (>2 days) after class. However, playing piano is not yet restricted.	19	9.9%
4	Pain progresses. The individual has to change playing techniques and reduce playing time. Pain resolves after the alteration.	29	15.1%
5	Pain occurs once the individual starts to play piano. Changing technique and shortening playing time do not relieve pain. Some daily activities are affected.	13	6.8%
6	Pain persists even when the individual does not play piano. Many daily activities are affected. The individual has to stop playing piano completely until recovery.	7	3.6%
7	Pain persists. No recovery. The individual is not able to play piano anymore.	0	0%

* Respondents who rated pain at level 0–2 were not considered as having a PRMD. Modified from Fry²¹ and Robinson and Zander.²⁹

involvement in sports, and specific exercises done for the purpose of enhancing piano-playing.

In our questionnaire, the occurrence of PRMD was defined as “any pain, weakness, lack of control, numbness, tingling, or other symptoms that interfere with musicians’ ability to play piano at the level they are accustomed to, without taking into account very mild symptoms,” as based on the operational definition of PRMD by Zaza et al.² Mild, short-lived, and transient symptoms that were not inhibiting music playing were excluded, as those might not be actual PRMD.^{2,18,27}

Participation in the survey was totally voluntary. Informed consent was obtained before the survey was conducted, and anonymity of the respondents was also ensured.

Data Analysis

All data were analyzed using SPSS statistical software (ver. 21, IBM-SPSS, Armonk, NY, USA). Descriptive statistics and chi-squared tests were performed to analyze the data. Significant relationship between independent variables and the occurrence of PRMD was assessed by chi-squared test. Subsequently, logistic regression analysis was performed to verify the independent association of variables. Both chi-squared and logistic regression analyses were conducted at the significance level of $p < 0.05$.

RESULTS

Out of 311 students, a total of 192 students from eight institutions took part in the survey, for a response rate of 61.7%. Females ($n=163$, 84.9%) predominated in the study group and there were only 29 (15.1%) male respondents, which reflects the female majority in students undertaking music programs in general in Malaysia. The mean age of the students was 20.5 yrs.

Table 1 reports the level of injury or PRMD of the respondents. Some respondents experienced multiple signs and symptoms and in more than one body site (Table 2). The data collected showed that respondents had graded a

combination of pain levels at different body parts afflicted by PRMDs. However, the current study reported only the highest injury level rated by every respondent. A total of 68 respondents (35.4%) were found to experience a PRMD (defined as level 3 and above).

The shoulder was the most commonly affected site (52.9%), followed by the arm (50.0%) and back (48.5%). Pain, fatigue, and stiffness were the three symptoms that were most reported.

Association of PRMD and Risk Factors

Chi-squared analysis was done to assess the relationship between the occurrence of PRMD and independent variables. All the demographic characteristics of respondents had no significant relationship when tested by chi-squared analysis, as shown in Table 3.

Daily piano practice time ranged from 30 min to 7 hours. Practice hours, habit of taking a break during piano practice, and the use of physical cool-down exercises were found, on chi-squared testing, to have a significant relationship with the occurrence of PRMD, as shown in Table 4.

Table 5 shows the respondents’ consumption of dietary supplement, sports participation, and use of specific exercises done to enhance piano-playing. The list of nutritional products, sports, and exercises are shown in Appendix 2 (online). Taking specific dietary supplements was found to have a significant relationship with the occurrence of PRMD. Engaging in sports or specific exercises did not have a significant relationship with PRMDs.

Multivariate logistic regression analysis was done to confirm the independent correlations found on chi-squared analysis. It showed that the lack of taking a break in the middle of practice, the lack of physical cool-down exercises, and lack of special dietary intake were associated with the occurrence of PRMD (Table 6). While chi-squared analysis also showed a significant relationship between PRMD and practice time, the results of logistic regression did not confirm that increasing practice hours contributed to PRMDs.

TABLE 2. Symptoms of Injury at Various Body Sites Among Respondents with PRMD

	Finger	Wrist	Arm	Neck	Shoulder	Back	Leg	Foot
No. of Respondents (%)*	19 (27.9%)	25 (36.8%)	34 (50.0%)	22 (32.4%)	36 (52.9%)	33 (48.5%)	1 (1.5%)	0 (0.0%)
Pain	17	19	29	14	25	24	1	0
Fatigue	12	13	24	18	22	26	0	0
Stiffness	26	22	22	11	19	10	1	0
Numbness	7	8	2	3	4	2	0	0
Swelling	1	0	2	0	1	0	0	0
Spasm	1	3	3	3	8	5	0	0
Pins and needles sensation	5	1	1	0	2	5	0	0

* The number of respondents who reported PRMD at different body sites (includes only those whose injury level was in the range of 3–7).

DISCUSSION

In the current study, the proportion of music students who had PRMD was 35.4%, lower than the rates reported in prior studies. Except for the Shield and Dockrell study⁶ that reported a 25.8% rate of PRMD, other studies of PRMD among classical piano students have reported rates of 62.0%,³⁰ 42.0%,³¹ and 38.4%.³² One of the possible reasons for the variation in the percentage of PRMDs is the definition of PRMD applied in various studies. In the current study, the severity of pain was briefly described in the questionnaire, to avoid the respondents' perceiving injury and problems differently which may affect the rate of PRMD reported. Mild, short-lived, and transient symptoms were excluded, as those might not be actual PRMD. Thus, the level of PRMD reported among classical piano students was lower than that of previous studies. In the above-mentioned studies, PRMD was determined by any "discomfort" caused by piano playing. The occurrence of PRMD obtained from these data included mild symptoms.

However, discomfort or mild symptoms occurring at an early stage were not inhibiting music playing, and sometimes the symptoms were transient.^{18,27,33} Thus, a mild symptom is too general to be considered as a PRMD. Bruno et al.³² and Allsop and Ackland²⁸ provided a more specific definition of PRMD in which a PRMD was considered to occur if there were any symptoms that interfered with piano playing within a given time frame. However, mild and transient symptoms were still regarded as PRMD in these two studies.

In our study, the shoulder was the body part most commonly affected by PRMD, which differed from the findings of Shields and Dockrell,⁶ Parry,¹⁵ and Allsop and Ackland.²⁸ The second most injured area was the arm, followed by the back. Normally pianists experienced PRMD around the hand region, especially the wrist, due to long periods of playing postures that bring discomfort to the body.²⁸ When the hands play along the piano keys, the wrist will be hurt if it is not maintained in a neutral position to the piano keys.²⁸ In the current study, observation

TABLE 3. Association of PRMD with Demographic Characteristics and Other Features, by Chi-Squared Analysis

	% of Respondents (n)*	Row Percentage of Respondents (n)*		χ^2	Sig- χ^2 †
		PRMD	No PRMD		
Gender				0.531	0.466
Male	15.1 (29)	41.4 (12)	58.6 (17)		
Female	84.9 (163)	34.4 (56)	65.6 (107)		
Program					
Foundation	2.6 (5)	—	—	—	—
Diploma	46.4 (89)	—	—	—	—
Degree	51.0 (98)	—	—	—	—
BMI				0.00	0.991
<24.9 (underweight, normal)	91.2 (175)	35.4 (62)	64.6 (113)		
>25 (overweight, obesity)	8.8 (17)	35.3 (6)	64.7 (11)		
Hand size (left)				2.789	0.095
> 20 cm	45.8 (88)	54.5 (48)	45.5 (40)		
≤ 20 cm	54.2 (104)	66.3 (69)	33.7 (35)		
Hand size (right)				0.884	0.347
> 20 cm	38.5 (74)	56.8 (42)	43.2 (32)		
≤ 20 cm	61.5 (118)	63.6 (75)	36.4 (43)		

* Numbers in parentheses are total number of respondents in each category. Row percentage is the number of respondents of a particular category divided by the total number of respondents in the particular row, converted to a percentage. BMI, body mass index.

† Difference of non-dependent variables and PRMD is considered statistically significance at $p < 0.05$.

TABLE 4. Association Between PRMD and Practice Habits, by Chi-Squared Analysis

	% of Respondents (n)*	Row Percentage of Respondents (n)*		χ^2	Sig- χ^2 †
		PRMD	No PRMD		
Practice time				4.642	0.031†
<3 hrs	53.1 (102)	28.4 (29)	71.6 (73)		
≥3 hrs	46.9 (90)	43.3 (39)	56.7 (51)		
Taking break				4.008	0.045†
Yes	91.7 (176)	37.5 (66)	62.5 (110)		
No	8.3 (16)	12.5 (2)	87.5 (14)		
Physical warm-up				3.43	0.064
Yes	46.9 (90)	42.2 (38)	57.8 (52)		
No	53.1 (102)	29.4 (30)	70.6 (72)		
Physical cool-down				4.363	0.037†
Yes	22.4 (43)	48.8 (21)	51.2 (22)		
No	77.6 (149)	31.5 (47)	68.5 (102)		
Musical warm-up				0.867	0.352
Yes	74.0 (142)	37.3 (53)	62.7 (89)		
No	26.0 (50)	30.0 (15)	70.0 (35)		
Musical cool-down				1.105	0.293
Yes	8.9 (17)	47.1 (8)	52.9 (9)		
No	91.1 (175)	34.3 (60)	65.7 (115)		

*Numbers in parentheses are total number of respondents in each category. Physical warm-up and cool-down exercises were hand and finger stretching, shoulder stretching, and deep breathing. Musical warm-up and cool-down activities included practicing Hanon, scales, arpeggios, easy repertoire, and Dohnányi.

†Difference is considered statistically significance at $p < 0.05$.

of piano playing was not a part of the survey method, but it may be possible that a faulty playing posture such as an elevated shoulder could cause discomfort in the shoulder.

Among the respondents who reported PRMD, pain, fatigue, and stiffness were the most common symptoms. In other studies, pain was also the commonest symptom reported by pianists.^{6,28,31} In the current study, most respondents with no PRMD but who rated their discomfort at level 1 or 2 also reported pain, fatigue, and stiffness at a mild level. Based on this result, pain, fatigue, and stiffness could be the early symptoms of PRMD. As the pain progresses, it then can affect playing, and other symptoms might start to surface once the PRMD becomes more serious.^{34,35} Dommerholt³⁶ also reported cases of a bassoonist and an organist who experienced mild pain before the

symptoms turned into a PRMD a few months later.³⁶ On the contrary, sometimes no pain or other symptoms occurred but playing was affected, as in the case of Gary Graffman.¹³ Hence, pianists should pay attention to any degree of pain, fatigue, stiffness and any awkward condition in hands that affects playing because the symptoms might be the first signs of a developing PRMD. There still may be time to prevent a PRMD from developing into a more severe stage if good rest and review of piano practice habits are done to relieve the symptoms.

Statistical analysis did not show that gender had a significant association with the occurrence of PRMDs among classical piano students, which is in contrast to previous studies.^{28,37,38} This may due to the gender imbalance in this study, because female respondents were predominant in

TABLE 5. Association Between PRMD and Dietary Habits, Sports Practice, and Specific Exercises, by Chi-Squared Analysis

	% of Respondents (n)*	Row Percentage of Respondents (n)*		χ^2	Sig- χ^2 †
		PRMD	No PRMD		
Taking dietary supplement				7.287	0.007†
Yes	16.7 (32)	56.3 (18)	43.7 (14)		
No	83.3 (160)	31.2 (50)	68.8 (110)		
Engagement in sports				0.499	0.480
Yes	42.2 (81)	38.3 (31)	61.7 (50)		
No	57.8 (111)	33.3 (37)	66.7 (74)		
Specific exercise				0.856	0.355
Yes	17.2 (33)	42.4 (14)	57.6 (19)		
No	82.8 (159)	34.0 (54)	66.0 (105)		

*Numbers in parentheses are total number of respondents in each category.

†Difference is considered statistically significance at $p < 0.05$.

TABLE 6. Correlation Between PRMD and Risk Factors, by Logistic Regression

Variables	Odds Ratio	95% CI	p-Value
>3 hrs of practice	0.500	0.267 – 0.939	0.031
Lack of taking a break during practice	4.478	0.943 – 21.263	0.059
Lack of physical cool-down exercises	2.043	0.988 – 4.223	0.054
Lack of special dietary intake	2.559	1.141 – 5.739	0.023

number. This is because females comprise the majority of students undertaking music programs in general, and this phenomenon has lasted since the 90s when music tertiary programs started in Malaysia. In addition, chi-squared analysis did not show any significant relationship between hand size and PRMDs. This result differs from the findings of other pianist injury studies, which stated that small hand size contributed to PRMDs among pianists.³²

Slightly over half of the respondents (53.1%) in this study practiced piano for 2 to 3 hours per day, and statistical analysis showed a significant relationship between PRMD and practice time. However, results of logistic regression did not confirm that increasing practice hours contributed to PRMDs. Thus, in future study, further analysis of practice habits, including the consistency of daily practice hours and repertoire practiced, is needed to show if increasing hours of practice constitute a risk factor for PRMD. This is because while longer piano practice hours may not lead to PRMD due to less demanding repertoire, intensive practice of demanding piano pieces in a short time might contribute.

Both the habit of taking a break and physical cool-down exercises were found to be significantly associated with the occurrence of PRMD in current study. The literature also has pointed out that taking breaks is important for PRMD prevention among pianists.²⁸ The chance for pianists to get a PRMD decreases when pianists take more short breaks during piano playing.²⁸ Similar to the preventive roles played by warm-up and cool-down exercises, taking a break in the middle of practice helps in protecting muscles from becoming easily injured. Fry³⁹ and Dawson³ have suggested that musicians take a 5-minute break after 25 minutes of music playing. During a short break, the muscles are allowed to rest and to restore energy for the pianist to resume practice.

It is common to incorporate cool-down exercise in sports activities to prevent muscle injury.⁴⁰ The nature of piano playing is analogous to sports activities and requires pianists to perform cool-down exercises also to prevent muscle cramping and stiffness.⁴¹ Previous research also supports the effectiveness of exercises such as resistance, core stability, and aerobic exercises in minimizing PRMD among musicians.^{42,43,44} While general strengthening fitness may not be sufficient to prevent PRMD, specific exercises designed to strengthen the supportive muscles of body parts that are prone to PRMD can give more benefit to musicians.⁴⁵

In addition, statistical analysis showed that the lack of consuming nutritional products was significantly associ-

ated with PRMD occurrence, i.e., pianists who took diet suppl had a lower risk of PRMD. So far, there have been no similar finding documented in previous PRMD studies among classical pianists. It is a common belief among many people that taking supplements can boost the body's health. Nevertheless, musicians still need to be physically fit to sustain a music-making life since playing piano is same as doing athletic activities. The daily nutrition of musicians should be carefully planned to cope with a hectic performance life, including intake of low to medium glycemic carbohydrates to ensure sufficient energy during performance and high glycemic index foods after performances to help repair muscle fiber breakdown.⁴⁶

Poor physical fitness has been cited as one of the risk factors for PRMD among musicians.⁴⁷ In order to perform the hectic task of piano playing, pianists are encouraged to gain muscle strength and overall physical conditioning. In our study, 42.2% of the respondents participated sports. Also, 29.1% reported practicing specific exercises to enhance their piano playing, in which Alexander technique and yoga were the most reported (Appendix 2, online). A number of them practiced tai chi, Pilates, and exercises to build up stamina. These techniques can help train breathing and relaxation and to overcome performance anxiety during performance.¹⁵ Alexander technique is useful for training the musicians to stand, sit, move, and breathe in a comfortable posture and position and may lower the risk of getting a PRMD.⁴¹ However, neither engagement in sports or specific exercises was found to have a significant relationship with the occurrence of PRMD.

Limitations

A limitation of this study is its cross-sectional design. Also, generalisation of the study results to the whole population of classical piano students at tertiary institutions in Malaysia is not possible because of the limited geographical area where the survey was conducted. The findings apply to classical piano students in Kuala Lumpur and Selangor, where most higher institutions that offer music programs are found. The presence of PRMDs was based on the self-reported discomfort rated by respondents without evaluation by medical practitioners.

In addition to piano practice, other daily activities such as computer usage might contribute to the occurrence of PRMDs in students in this study. Like other undergraduates, music students similarly must use computers for assignments, research work, and probably also social websites. These activities may cause injury if overdone or may aggra-

vate the existing symptoms of PRMD caused by piano practice. Injury due to computer usage, or other hobbies or work history, was not examined in detail in the current study.

As single type of musician was the focus in the study, our findings help in understanding PRMD specific to classical pianists. While the occurrence and progression of PRMD might be different between young and old classical pianists, in this study the factor of aging was excluded because the age bracket of the respondents was narrowed to teenagers.

Conclusions

Although the proportion of respondents who incurred a serious PRMD in this study is not high, the issue of PRMDs should not be neglected. The extent of PRMDs reported should be taken as an alarming rate of injury, and it is hoped that this study will raise the awareness of PRMDs among musicians. Based on the statistical analysis of the study, classical piano students could be advised to pay attention to piano practice time, the habit of taking rests during practice, using physical cool-down exercises after piano practice, and using special dietary intake to prevent PRMD. In future studies of PRMDs, expansion of the sample size and investigation of the contribution of practice time among classical piano students would provide a better statistical analysis and understanding of PRMD. To improve the wellbeing of classical piano students, PRMD education should be conducted in tertiary institutions. This would help students to enjoy music-making without being injured as well as help their future music careers last for many years.

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APPENDIX 1. Questionnaire: Playing-Related Musculoskeletal Disorders Among Classical Piano Students at Tertiary Institutions in Malaysia

SECTION A. Background of Respondents

1. Gender: ☐ Male
☐ Female
2. Age (in 2013): _____
3. Race: ☐ Malay
☐ Chinese
☐ Indian
☐ Other. Please specify _____
4. Current program of study attended:
☐ Diploma
☐ Degree
☐ Master
5. Current academic year:
☐ 1st year
☐ 2nd year
☐ 3rd year
☐ 4th year
6. Weight (in kg) _____
7. Height (in meters) : _____
8. Hand size: Left hand _____ cm
Right hand _____ cm
(Please measure on the graph paper provided.)
9. Handedness: ☐ Right handed
☐ Left handed
☐ Both left and right handed

SECTION B. Piano Practice Habits

1. Approximately how many **hours** per day do you usually practice playing piano?
☐ 1 ☐ 2 ☐ 3 ☐ 4
☐ 5 ☐ 6 ☐ 7 ☐ 8
 More than 8 hrs. Please specify _____
 Other. Please specify the time spent _____
2. Do you do **physical warm-up** exercises **before** practice?
☐ Yes. Please state the total time spent (in **minutes**) _____
☐ No
3. Do you do **physical cool-down** exercises **after** practice?
☐ Yes. Please state the total time spent (in **minutes**) _____
☐ No
4. Do you do **musical warm-up** exercises **before** practice?
☐ Yes. Please state the total time spent (in **minutes**) _____
☐ No
5. Do you do **musical cool-down** exercises **after** practice?
☐ Yes. Please state the total time spent (in **minutes**) _____
☐ No
6. Do you usually take a break during practice?
☐ Yes. Please go to **question 7**.
☐ No
7. What is your duration of practice time before you take a break?
 _____ minutes.
8. Usually how long of a break will you take after practice?
 _____ minutes.

SECTION C. Experience of Playing-Related Musculoskeletal Disorders

1. During the **last 6 months**, have you experienced any **discomfort which affects your piano playing**? The discomfort could be in any form as described in **Table C1** (below), or any other symptoms that affect your piano playing.

- ☐ Yes. Please go to **question 2**.
☐ No. Please go to **section D**.

Table C1: Description of Types of Symptoms

Types of discomfort	Description
Pain	A feeling of physical suffering caused by injury or illness.
Fatigue	Extreme tiredness.
Stiffness	Not moving or bending easily, feeling inflexible.
Numbness	Lack of sensation.
Pins & needles	Tingling sensation, like being poked by the sharp point of an object.
Swelling	A part of your body which has become larger and rounder due to illness or injury.
Spasm	Sudden, uncontrollable and often painful tightening of muscle.

2. Please describe the **discomfort** in the body parts that you have experienced.

You can choose more than 1 option from the terms provided in **Table 1**. You can also write your own answer if the terms provided do not fit your answer.

<input type="checkbox"/> Finger	<input type="checkbox"/> Wrist	<input type="checkbox"/> Arm	<input type="checkbox"/> Neck	<input type="checkbox"/> Shoulder	<input type="checkbox"/> Back
<input type="checkbox"/> Pain	<input type="checkbox"/> Pain	<input type="checkbox"/> Pain	<input type="checkbox"/> Pain	<input type="checkbox"/> Pain	<input type="checkbox"/> Pain
<input type="checkbox"/> Fatigue	<input type="checkbox"/> Fatigue	<input type="checkbox"/> Fatigue	<input type="checkbox"/> Fatigue	<input type="checkbox"/> Fatigue	<input type="checkbox"/> Fatigue
<input type="checkbox"/> Stiffness	<input type="checkbox"/> Stiffness	<input type="checkbox"/> Stiffness	<input type="checkbox"/> Stiffness	<input type="checkbox"/> Stiffness	<input type="checkbox"/> Stiffness
<input type="checkbox"/> Numbness	<input type="checkbox"/> Numbness	<input type="checkbox"/> Numbness	<input type="checkbox"/> Numbness	<input type="checkbox"/> Numbness	<input type="checkbox"/> Numbness
<input type="checkbox"/> Swelling	<input type="checkbox"/> Swelling	<input type="checkbox"/> Swelling	<input type="checkbox"/> Swelling	<input type="checkbox"/> Swelling	<input type="checkbox"/> Swelling
<input type="checkbox"/> Spasm	<input type="checkbox"/> Spasm	<input type="checkbox"/> Spasm	<input type="checkbox"/> Spasm	<input type="checkbox"/> Spasm	<input type="checkbox"/> Spasm
<input type="checkbox"/> Pins & needles sensation	<input type="checkbox"/> Pins & needles sensation	<input type="checkbox"/> Pins & needles sensation	<input type="checkbox"/> Pins & needles sensation	<input type="checkbox"/> Pins & needles sensation	<input type="checkbox"/> Pins & needles sensation
<input type="checkbox"/> Other	<input type="checkbox"/> Other	<input type="checkbox"/> Other	<input type="checkbox"/> Other	<input type="checkbox"/> Other	<input type="checkbox"/> Other

☐ **Other parts of the body.** Please specify _____

- ☐ Pain ☐ Fatigue ☐ Stiffness ☐ Numbness
☐ Swelling ☐ Spasm ☐ Pins & needles sensation
☐ Other. Please specify _____

3. Referring to your answer **to the above question**, what is the level of **discomfort**? Please refer to the **pain grading level** guidance provided in **Table C2**.

<input type="checkbox"/> Finger	<input type="checkbox"/> Wrist	<input type="checkbox"/> Arm	<input type="checkbox"/> Neck	<input type="checkbox"/> Shoulder	<input type="checkbox"/> Back
<input type="checkbox"/> Level 0	<input type="checkbox"/> Level 0	<input type="checkbox"/> Level 0	<input type="checkbox"/> Level 0	<input type="checkbox"/> Level 0	<input type="checkbox"/> Level 0
<input type="checkbox"/> Level 1	<input type="checkbox"/> Level 1	<input type="checkbox"/> Level 1	<input type="checkbox"/> Level 1	<input type="checkbox"/> Level 1	<input type="checkbox"/> Level 1
<input type="checkbox"/> Level 2	<input type="checkbox"/> Level 2	<input type="checkbox"/> Level 2	<input type="checkbox"/> Level 2	<input type="checkbox"/> Level 2	<input type="checkbox"/> Level 2
<input type="checkbox"/> Level 3	<input type="checkbox"/> Level 3	<input type="checkbox"/> Level 3	<input type="checkbox"/> Level 3	<input type="checkbox"/> Level 3	<input type="checkbox"/> Level 3
<input type="checkbox"/> Level 4	<input type="checkbox"/> Level 4	<input type="checkbox"/> Level 4	<input type="checkbox"/> Level 4	<input type="checkbox"/> Level 4	<input type="checkbox"/> Level 4
<input type="checkbox"/> Level 5	<input type="checkbox"/> Level 5	<input type="checkbox"/> Level 5	<input type="checkbox"/> Level 5	<input type="checkbox"/> Level 5	<input type="checkbox"/> Level 5
<input type="checkbox"/> Level 6	<input type="checkbox"/> Level 6	<input type="checkbox"/> Level 6	<input type="checkbox"/> Level 6	<input type="checkbox"/> Level 6	<input type="checkbox"/> Level 6
<input type="checkbox"/> Level 7	<input type="checkbox"/> Level 7	<input type="checkbox"/> Level 7	<input type="checkbox"/> Level 7	<input type="checkbox"/> Level 7	<input type="checkbox"/> Level 7

☐ **Other parts of body.** Please specify _____

- ☐ Level 0 ☐ Level 1 ☐ Level 2 ☐ Level 3 ☐ Level 4
☐ Level 5 ☐ Level 6 ☐ Level 7

Table C2: Level of Pain in Pianists

Level	Signs and symptoms
0	No pain during and after playing piano.
1	Feeling tired during and after playing piano, but no pain or other symptoms.
2	Pain occurs while playing piano, or for a short period of time (<2 days) after playing piano. The individual is able to play normally.
3	Pain occurs while playing piano and persists for a longer period (>2 days) after class. However, playing piano is not yet restricted.
4	Pain progresses. The individual has to change playing techniques and reduce playing time. Pain resolves after the alteration.
5	Pain occurs once the individual starts to play piano. Changing technique and shortening playing time do not relieve pain. Some daily activities are affected.
6	Pain persists even when the individual does not play piano. Many daily activities are affected. The individual has to stop playing piano completely until recovery.
7	Pain persists. No recovery. The individual is not able to play piano anymore.

SECTION D. Dietary Habit, Hobbies, and Lifestyle

1. Do you have any special dietary intake or take supplements to help you to stay fit physically and mentally?
☐ Yes. Please specify _____
☐ No
2. What is/are the sports that you normally engage in?
☐ I play _____
☐ No, I do not engage in sports.
8. Do you do any specific exercises to enhance piano playing?
 (You can choose more than 1 option)
☐ Yes. For example, _____
☐ a. Alexander technique
☐ b. Pilates
☐ c. Tai chi
☐ d. Yoga
☐ e. Other. Please specify _____
☐ f. No

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APPENDIX 2. Dietary Supplements, Sports, and Exercises Used by Respondents

Dietary Supplement	No. of Students (n=32)	Sports	No. of Students (n=81)	Exercises*	No. of Students (n=33)
Vitamins, daily vitamins	3	Swimming	27	Alexander technique	12
Vitamin B complex	4	Walking	1	Pilates	3
Vitamin C	11	Hockey	1	Tai chi	3
Multivitamins	1	Snooker	1	Yoga	13
Spirulina	5	Bowling	2	Normal warm-up exercises	1
Primrose/EPO	3	Badminton	34	Stretching fingers, finger exercises	2
Calcium	3	Netball	1	Badminton	1
Fish oil	2	Dance	1	Sports for stamina	2
Juice	1	Jogging/running	15	Aerobic exercises	1
Oliferin	1	Gym	6		
Food supplement pills	1	Tennis	1		
Maximol drink	1	Cycling	2		
N'care supplements	1	Basketball	3		
Protein powder	2	Soccer/football	2		
Enzyme	1	Volleyball	2		
Probiotics	1	Squash	2		
E.Excel	2	Frisbee	1		
Reduce cold drinks and spicy food	1	Hiking	2		
USANA	1	Climbing	1		
Minerals	1	Any form of exercise	1		
Honey	1	Yoga	2		
Ginseng	1	Marathon	1		
Chlorella	1	Climb the stairs	1		
		Ping pong	1		
		Martial arts	1		

*Exercises done by respondents to enhance piano playing.