INJURIES IN PIANO PLAYING IN RELATION TO PIANO PLAYING METHODOLOGY, AND POSTURE AMONG THAI PIANISTS

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ABSTRACT
The objective of this survey research is to study whether piano playing methodologies and playing postures are significantly associated with injuries occurred in piano playing. Two hundred and forty self-administered survey questionnaire which was designed by the researcher to investigate the injuries occurred in piano playing, piano playing methodologies and playing postures was distributed to pianists whose age started from 15 years old. There are three piano playing methodologies which were examined in this paper. All examined piano playing methodologies were determined by three possible wrist postures which pianists normally used, traditional piano playing with high wrist position (the wrist position is at the higher level of piano keyboard), traditional piano playing with neutral wrist position (the wrist position is at the same level of piano keyboard), weight piano playing (the wrist position are rotated while playing). There are 4 pairs of playing postures to be studied which are vertical and horizontal finger movement, flat and round finger positions, straight and bent elbow positions, and elevated and non-elevated shoulder positions. The result reported that there is a significant relationship among traditional, weight and neutral of wrist postures and occurrence of injuries in piano playing. The percentages reported that players who use a weight-playing methodology experienced the highest rate of injuries. Players using an elevated shoulder posture had higher percentage of injuries compared to players using non-elevated shoulder posture.

Keywords: Injury, Performer, Pianist, Piano Playing Methodology,

INTRODUCTION

Injuries that occurred in musician or in broader term, playing-related musculoskeletal disorders developed from playing are capable of bringing a miserable experiences and feelings to many pianists. Injuries occurred in piano playing can bring miserable experience and feelings to pianist regardless of level of playing. From the history of piano playing, some experience regarding injuries was recorded such as Robert and Clara Schumann and Sergei Rachmaninov. In twentieth century when piano was highly developed and its quality both in mechanism and sound reached at its peak, many contemporary pianists reported their symptoms and their horrible experience after injuries were developed such as Glenn Gould, and Leon Fleisher (Mark, 1999). In most of cases, injuries can be so severe that they cannot even perform and play some kind of repertoire.

One of the studies about the injuries among musicians especially about the prevalence rate of injuries was conducted by Fishbein and Middlestadt. The study was designed as a survey research. Four thousand and twenty five hundred musician representing forty eight American orchestras were asked particular questions concerning injuries and types of discomforts occurred from their playing. The survey reported from two thousands two hundred and twelve musician that answered such questions, that 20% of musicians got injuries. More specifically, in the study, "Investigating Prevalence playing-related musculoskeletal disorders in relation to piano players' technique and practicing strategies" conducted by Allsop in 2004 reported that ranged from 38.1% to 91% (Allsop,2004).

Since injuries are the feeling of pain in any part of bodies, it also includes the problem and abnormality in controlling the muscle while playing instruments.

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Robert and Clara Schumann are one the first injured pianists who were recorded. The Robert Schumann and Clara Schumann studied with the same teacher, Frederic Wieck, Clara's father and one of the most popular piano teacher in that period. Clara was later suffered from playing too many concerts and repertoires which were not suited to her physical structure. Even worse, Robert Schumann developed a disorder to his right hand when he was only twenty years old and had to end his career as a concert pianist. Even though, Friedrich Wieck was a step ahead of his contemporaries, who overemphasized the value of long hours of practice, focused on healthy playing technique and effective practice, they were still injured. Thus, the injuries are caused by complex and interacting factors.

LITERATURE REVIEW

Piano playing methodologies invented from the past until the peak of piano pedagogy in 20th century can be presented into two ways based on the way of using fingers in piano playing and coordination from the remaining parts of the body. Firstly, piano players can use only fingers in their piano playing without supporting from remaining parts of the body such as arms. This way of playing was invented even before the piano was invented by Bartolomeo Cristofori. Due to the lightness of early keyboard instruments' touching such as harpsicord, clavichord, coordination from the remaining parts of the body was not necessary for keyboard players comparing to the heavier touch of present concert grand piano. However, when piano has been gradually developed for 2 centuries, most of players have still played piano with traditional playing method which is probably suitable for early keyboard instruments even though the touch of the piano is much heavier than early keyboard instruments. This kind of piano playing technique was systematically developed and popularized by Bach, Clementi and Czerny. Due to the fact that, when players hold their wrist higher than the piano keyboard, the fingers would normally be active. For players who believe in this playing method, sometimes they will keep their wrists high. However, if not, they will keep their wrist at neutral position which means wrist position is at the same level of the keyboard. Secondly, pianists can play the piano with coordination of the other parts of the body. The movement of fingers would be supported from the weight of the rest of body parts especially arms and torso. The wrist position is not static. The wrists always move and rotate so that the natural weight of the body can support the fingers. Deppe was one of the first pianists who focused on the coordination of all parts which was later developed by Matthay, Breithaupt, Fielden, Ortmann and Wihiteside. Moreover, theories of piano playing developed in the twentieth century were concerned with study of muscles, joints, tendons., application of laws of leverage to support playing

Piano Playing Postures

Playing postures were normally considered every parts of the body including fingers. They should be in balance according to the anatomical body structure. There are eight postures which were used by Allsop (2007). All body positions and postures can be summarized as the following table.

Table 1 Piano Playing Postures

Body Position	Postures
Finger Positions	*Flat*
	Rounded
Elbow Position	*Straight*
	Bent
Shoulder Position	*Elevated*
	Non-elevated

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Finger Movement	*Vertical*	
	Horizontal	

PURPOSE OF THE STUDY

The main purpose of this paper is to examine if piano playing methodologies employed by pianists and playing postures are related with the occurrence of injuries in piano playing. Two research questions were 1) Do different piano playing methodologies affect injuries in piano playing? And 2) Do different playing postures affect injuries in piano playing? The framework of this research and hypotheses can be drawn as below.

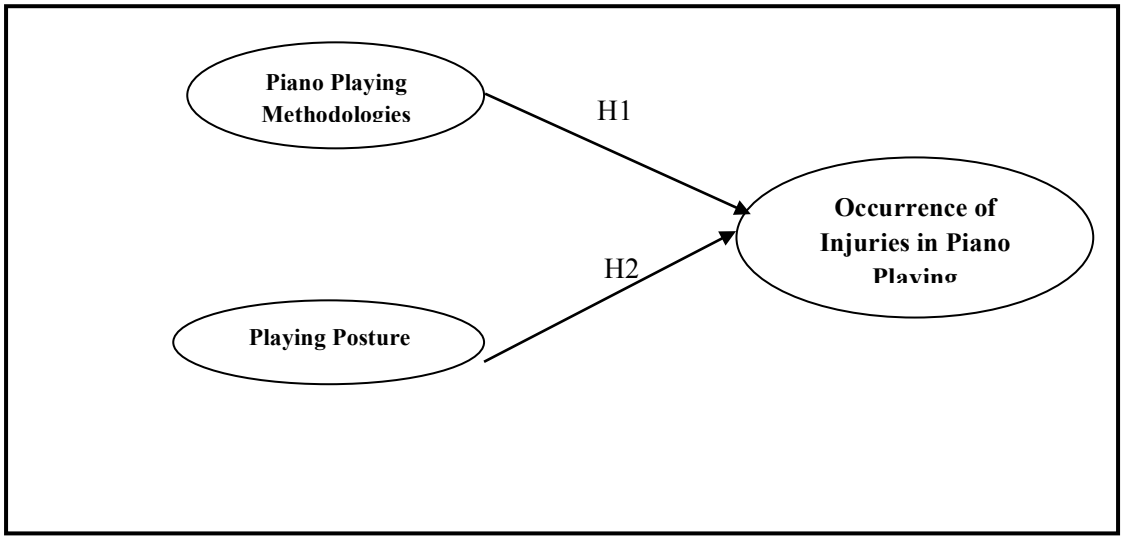

Figure 1 Theoretical Framework

Piano playing methodologies were measure in according to three wrist postures which pianists can possibly use. The first is traditional piano playing with high wrist position. Piano players who play piano using this method, most of the time, their wrists are always at the higher level of piano keyboard. The second is traditional piano playing with neutral wrist position. Piano players who play piano using this method, their wrists are mostly at the same level of piano keyboard. The third is weight piano playing. Piano players who play piano using this method, their wrists are mostly rotated while playing.

Piano playing postures were measure into 4 pairs, finger movements, finger positions, elbow positions and shoulder positions. Finger movements consist of vertical and horizontal finger .Finger positions consist of flat and round finger positions. Elbow positions consist of straight and bent positions. Shoulder positions consist of elevated and non-elevated shoulder positions.

Table 2 Summary of Variables

Variables	Level of Measurement	To be analyzed as
Occurrence of Injuries	Nominal	Players with injuries and Player without injuries

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Piano Playing Methodologies	Nominal	Traditional, Weight, Neutral
Finger Movements	Nominal	vertical, horizontal
Finger Position	Nominal	flat, round
Elbow position	Nominal	straight, bent
Shoulder position	Nominal	elevated, non-elevated

As this study aims to find the relationship between piano playing methodologies and the occurrence of injuries in piano playing, the first hypothesis of this study was addressed as:

H1: Piano playing methodologies have significant effect on the occurrence of injuries

The importance the postures of the players sitting in front of the piano cannot be ignored in the study regarding such matter. Thus, the second hypothesis can be stated as:

H2: Playing postures, (fingers movement, finger position, elbow, shoulder) have significant effect on the occurrence of injuries

METHOD

Sample Size

The formula used for calculating sample size is referred to the literature review regarding the prevalence rate of injuries among musician. The formula invented by Kish (1965) was used for such purpose.

$$\frac{Z^2_{\propto/2}\, P(1-P)}{d^2}$$

Table 3. Sample Size Calculation

	1	**2**	**3**	**4**	**5**
Confidence Level	95	95	95	95	95
Rate or Proportion	0.1	0.15	0.2	0.25	0.3
Allowable Error	0.05	0.05	0.05	0.05	0.05
Sample size	139	196	246	289	323
Relative error	50%	33.3%	25%	20%	16.7%

The Official Publication of International Conference of Symphony and Opera Musicians displayed that 20% of musicians can possibly develop injuries (Fishbein and Middlestadt, 1988). In accordance with Kish's formula, at the rate or proportion at 20%, and at confident level at 95%, relative error at 25% and absolute precision require at 5%, the minimun sample size for this research is 246. The questionniare was distributed to 246 pianists whose age started from 15 years old. The participants were Thai and living in Bangkok.

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They were asked specific questions about piano playing methodologies, piano playing postures and the occurrence of injuries. However, there are 222 pianists who respond back.

Instrument

The main research instrument in this study was a questionnaire. Question items were firstly developed in English. It was then translated into Thai and back-translated by two independent bilinguals using the method suggested by Douglas and Craig (1983).

Participants will be asked specific questions about piano playing methodologies and playing postures that they are normally using. The pictures of hand and wrist positions and movements will be given with brief explanation. Regarding injuries, they will be asked to answer if they have ever experienced injuries since they started their piano lesson, which parts of body they got injuries, and the degree of intensity of eight symptoms listed, pain, spasm, pins and needles, numbness, fatigue, swelling, stiffness, and ache. The degree of intensity will be measured according to five-point Likert scale (1=none, 2=mild, 3=moderate, 4=severe, 5= very severe)

DATA ANALYSIS

All collected data was analyzed with Statistical Package for the Social Sciences (SPSS) version 21 and with descriptive statistics (mean, standard deviation, maximum, and minimum), frequency counts with SPSS, Pearson Chi-square tests. Descriptive information concerning piano playing methodologies, playing postures, used by our participants, play would be firstly presented. Then, the degree of discomforts would be calculated and statistically tested in order to display overall situation about injuries occurred in piano playing. Secondly, Pearson Chi-square tests would be used to test H1 and H2; do different piano playing methodologies and postures and movement affect the occurrence of injuries?

FINDINGS

DESCRIPTIVE DATA

Table 4 Piano Playing Methodologies

Piano Playing Methodologies	Percentage
Traditional Playing (High wrist)	20.1
Weight Playing	8.2
Traditional Playing (Neutral)	71.7

From the data that has been collected, it showed that majority of our participants play piano using traditional playing method with neutral wrist (71.7%), followed by traditional playing with high wrist (20.1%) and weight playing (8.2%).

Table 5 Playing Postures

Playing Postures	Percentage
Finger Positions	
Flat	14.7

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Rounded	85.3
Elbow Position	
Straight	13.2
Bent	86.8
Shoulder Position	
Elevated	22.6
Non-elevated	77.4
Finger Movement	
Vertical	84.6
Horizontal	15.4

Regarding playing posture, there are four pairs of playing postures displayed in this section, the majority of our participants plays piano using rounded finger position (85.3%), bent elbow position (86.8%), non-elevated shoulder position (77.4%) and move fingers vertically (84.6%)

Testing Of Hypotheses

H1: Piano playing methodologies have significant effect on the occurrence of injuries

According to table 7 and table 8, the Pearson Chi-Square test reported a significant relationship among traditional, weight and neutral of wrist postures and occurrence of injuries in piano playing [Chi (3, N=219) = 7.70, $p < 0.05$] as shown in Table 8. The table 7 showed that pianists who played the piano using weight playing technique have the highest percentage of developing injuries (83.3%) followed by pianists playing piano with natural wrist position technique (73.1%) and the least percentage of developing injuries went to pianists using traditional playing technique (56.8%)

Table 7 Crosstabulation: Piano Playing Methodologies and Occurrence of Injuries

			Occurrence of Injuries		Total
			Yes	No	
Piano Playing Methodologies	Traditional (High Wrist)	% within	56.8%	43.2%	100.0%
	Weight Playing	% within	83.3%	16.7%	100.0%
	Tradition (Neutral Wrist)	% within	76.4%	23.6%	100.0%
	Total		73.1%	26.9%	100.0%

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Table 8 Chi-Square Tests: Piano Playing Methodologies and Occurrence of Injuries

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.770(a)	2	.021
Likelihood Ratio	7.357	2	.025
Linear-by-Linear Association	5.487	1	.019
N of Valid Cases	219		

1 cells (16.7%) have expected count less than 5. The minimum expected count is 4.85.

H2: Playing postures, (fingers movement, finger position, elbow, shoulder) have significant effect on the occurrence of injuries

From the table 9 and table 10 shown below, the Pearson Chi-Square [Chi (2, N=217) = 9.223, p <0.05] test did show that players using an elevated shoulder posture had higher percentage of injuries compared to players using non-elevated shoulder posture. Pianists who played piano with elevated shoulder got injury for 89.8%. Pianists who played piano with non-elevated shoulder got injury for 67.9%.

Table 9 Cross Tabulation: Shoulder Postures and the Occurrence of Injuries

			Occurrence of Injuries		Total
			Yes	No	
Shoulder Posture	Elevated	Count	44	5	49
		% within	89.8%	10.2%	100.0%
	Non-Elevated	Count	114	54	168
		% within	67.9%	32.1%	100.0%
	Total	Count	158	59	217
		%within	72.8%	27.2%	100.0%

Table 10 Chi-Square Tests: Shoulder Postures and Occurrence of Injuries

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	9.223(b)	1	.002		
Continuity Correction(a)	8.148	1	.004		
Likelihood Ratio	10.662	1	.001		
Fisher's Exact Test				.002	.001

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Linear-by-Linear Association	9.181	1	.002
N of Valid Cases	217		

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 13.32.

For elbow position, the Pearson Chi-Square [Chi (2, N=212) =0.451, p =.321] from table 11 and 12 test did not report a significant association between the occurrence of injuries and the straight and the bent elbow postures.

Table 11 Cross Tabulation: Elbow Positions and the Occurrence of Injuries

			Occurrence of Injuries		**Total**
			Yes	**No**	
Elbow Position	Straight	Count	19	9	28
		% within	67.9%	32.1%	100.0%
	Bent	Count	136	48	184
		% within	73.9%	26.1%	100.0%
	Total	Count	155	57	212
		%within	73.1%	26.9%	100.0%

Table 12 Chi-Square Tests: Elbow and Occurrence of Injuries

	Value	**df**	**Asymp. Sig. (2-sided)**	**Exact Sig. (2-sided)**	**Exact Sig. (1-sided)**
Pearson Chi-Square	.453(b)	1	.501		
Continuity Correction(a)	.198	1	.657		
Likelihood Ratio	.439	1	.507		
Fisher's Exact Test				.499	.321
Linear-by-Linear Association	.451	1	.502		
N of Valid Cases	212				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.53.

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Regarding fingers movements, the Pearson Chi-Square [Chi (2, N=214) =1.427, p =.164] test did show that there is no significant association between the occurrence of injuries and players playing with vertical and the horizontal movement of fingers.

Table 13 Cross Tabulation: Finger Movement and the Occurrence of Injuries

			Occurrence of Injuries		Total
			Yes	No	
Finger Movement	Vertical	Count	130	51	181
		% within	71.8%	28.2%	100.0%
	Horizontal	Count	27	6	33
		% within	73.9%	26.1%	100.0%
	Total	Count	157	57	214
		%within	73.4%	26.6%	100.0%

Table 14 Chi-Square Tests: Finger Movement and Occurrence of Injuries

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.427(b)	1	.232		
Continuity Correction(a)	.961	1	.327		
Likelihood Ratio	1.525	1	.217		
Fisher's Exact Test				.288	.164
Linear-by-Linear Association	1.420	1	.233		
N of Valid Cases	214				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.79.

About fingers positions, from the table 15 and table 16, the Pearson Chi-Square [Chi (2, N=211) =.415, p =.328] test did show that there is no significant relationship between the occurrence of injuries between players playing with flat and rounded finger position.

Table 15 Chi-Square Tests: Finger Positions and Occurrence of Injuries

		Occurrence of Injuries	Total

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			Yes	No	
Finger Position	Flat	Count	21	10	31
		% within	67.7%	32.3%	100.0%
	Round	Count	132	48	180
		% within	73.9%	26.7%	100.0%
	Total	Count	153	58	211
		%within	72.5%	27.5%	100.0%

Table 16 Chi-Square Tests: Finger Positions and Occurrence of Injuries

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.415(b)	1	.520		
Continuity Correction(a)	.182	1	.670		
Likelihood Ratio	.404	1	.525		
Fisher's Exact Test				.519	.328
Linear-by-Linear Association	.413	1	.521		
N of Valid Cases	211				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.52.

CONCLUSION

Injuries in piano playing researched in this study are a range of abnormal conditions occurred in the muscles, tendons and other soft tissues. In this study, only playing methodologies and practice strategies were investigated. Piano playing methodologies explored in this study were based on wrist postures and movements Three kinds of piano playing methodologies were presented in the survey questionnaire the traditional-playing wrist-posture, the weight-playing wrist-posture, the neutral wrist- posture. Piano playing methodologies were also studied together with other playing postures of the other parts of body. Playing postures comprised of finger movements, finger positions, elbow position and shoulder positions.

Having used questionnaire as a tool and data collection method, the quantitative research method had been designed to answer research questions, which are 1) Do different piano playing methodologies affect injuries in piano playing? And 2) Do different playing postures affect injuries in piano playing? To answer H1) Piano playing methodologies have significant effect on the occurrence of injuries, H2) Playing postures, (fingers movement, finger position, elbow, shoulder) have significant effect on the occurrence of injuries

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According to research questions 1) To what extent do different piano playing methodologies affect injuries in piano playing? The result from the chi-square analysis of collected data from 222 respondents showed that three piano playing methodologies have significant effect on the occurrence of injuries. Pianists who used weight playing as their playing method revealed the highest percentage of injuries, the small number of players who reportedly used this system warrants further investigation. Among the remaining three commonly used wrist- postures, the weight-playing and traditional-playing wrist postures reported the lowest percentage of injuries, while players adopting the neutral wrist posture reported a significantly greater percentage of injuries.

2) To what extent do different playing postures affect injuries in piano playing? The result from the chi-square analysis displayed that shoulder postures have significant effect on the occurrence of injuries. Pianists whose shoulder are mostly elevated are more likely to develop injuries which accounted for 89.8%.Compared with the non-elevated shoulder posture, piano players holding a sustained elevated shoulder posture reported a significantly higher percentage of injuries. The result supports Hagberg and colleagues (2005) findings that the highest injuries occurred from instrumental practice were neck and shoulder pain.

Using an elevated shoulder posture when playing can greatly increase tension in the muscles in the upper part of the body. Professor Dr. Saranatra Waikakul said that using the elevated shoulder posture for a long period of practice-time would reduce the functional capacity of the fingers (personal communication, August 1, 2016) Pianists were often unaware of their shoulder posture at the time of practicing or performing.

SUGGESTION

From the results, in order to prevent injuries in piano playing, pianists need to be aware of every part of bodies involved in piano playing. Also, they need to carefully plan and be careful how they practice. Because, one of the major reasons which bring about injuries in piano playing is excessive repetitive movement, in order to master the piece for the performance, pianists have to practice a lot; therefore, pianists cannot avoid repetitive movements.

The first is the chosen repertoire must be appropriate for pianists' capabilities. Like in the case of Clara Schumann, the repertoire she played was not suited to her hand size, was totally what she had learnt for long period of time. The octave-trilled passage in Brahms' Piano Concerto No.1 was not common in her time. Apart from those factors, piano playing methodology concentrated almost only on the movement of the fingers, ignoring the remaining parts of the body in piano playing. Some sources reported that it was the fashion of that time to playing with fingers alone, with stiff wrist. Relaxation in piano playing was not taken into major consideration in piano pedagogy as much as present time. Due to the fact that tension is one of the factors that is capable of placing pianists at risk for developing injury, abnormality and injury was found in Clara's hands. If a composition is not suited to students' hand size, not only it is difficult to achieve, but also it is very risky that students get injury. The music chosen must be appropriate to students' hands and body structure. Although the goal of piano education is to let students experience different styles of music as much as possible.

Assigning several pieces with different level of technical difficulty and styles is also recommended. Pianists can also musically learn a lot from playing technically easier pieces. Meanwhile, highly technical demanded pieces have normally taken longer time to achieve.

Also, pianists ought to prepare themselves well enough for their own practice. To be ready, an overall structure of the piece, character of the pieces, analyzing technical pattern and difficulty within the piece and also additional exercises might be needed in order to play the piece with utmost ease and relaxation.

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Fingering is one of the important factors that can help pianists to play the piece without unnecessary problems. Good fingering can make the piece easier to play and practice. In contrast, bad fingering or fingering that is not suited to their hands can increase unnecessary difficulty to the piece which might be difficult enough. Inexperienced pianists are more likely to play whatever fingers touch the keyboard, playing the fingering which was recommended by the editors or composers without trying whether such fingering is appropriate for them. Even though the fundamental principle of good fingering lying on individual hand size and shape, the most important concept is to keep the hand at normal position and as small as possible. Keeping hand with stretching position occasionally brings about tension and lastly leads to injury.

RECOMMENDATION FOR FUTURE RESEARCH

This research is just the starting point in this area especially in Thailand. There are some recommendations for future research as follows:

Injuries in piano playing should be more specifically investigated into types of injuries at locations of body parts not just the occurrence of injuries. The research can be quantitatively conducted by using survey research method.

Research about injuries in piano playing should be qualitatively conducted. Using survey techniques that require information and respondents' perception has some limitations. One possible limitation of the study was that the information extracted from the self-administered questionnaire might contain an error between the players' perception of playing-techniques and postures and those that they actually applied when practicing. The majority of respondents expressed that they did not pay much attention to the kind of techniques and postures they actually used when playing, because they lacked the knowledge of different playing-techniques, and they had never been given a choice. Also, the technique which pianists used depends on the music they play. Normally, the players might not use the same technique for all kinds of music. Qualitative researches can be conducted by in-depth interview of pianists who have experienced injuries in their playing.

Future researches focus on some factors so more specific information concerning the effect of such factors having on injuries in piano playing can be gathered and analyzed such as repertoire, types of piano technique, piano practicing strategies. The effect of the other factors must be excluded by using more advanced statistical methods. Questionnaire survey is still recommended as it can identify the sample draws conclusions from large sample with many or makes inferences about the population, describing the characteristics of a large population as a whole

REFERENCES

Allsop, L. L. (2007). Investigating the prevalence of playing-related musculoskeletal disorders in relation to piano players' playing-techniques and practicing strategies. (Unpublished master's thesis). University of Western Australia, Crawley, Australia.
Altenmuller, Bogousslavsky, J., Boller, F., & Hennerici, M.(2005). Neurological disorders in famous artists. Basel, NY: Karger.
Altenmuller, E. (2006). Music, motor control and the brain. Oxford: Oxford University Press.
Bach, C. P., & Mitchell, W. J. (1949). Essay on the true art of playing keyboard instruments. New York, NY: W.W. Norton & Company.
Berenson, G., & Kropff, K. (2002). A symposium for pianists and teachers: Strategies to develop the mind and body for optimal performance. Dayton, OH: Heritage Music Press.
Blackie, H., Stone, R., & Tiernn, A. (1999). An investigation of injury prevention among university piano students. Medical Problems of Performing Artists, 14(3), 141-149.
Boardman, R. C. (1954). A history of theories of teaching piano technique (Unpublished Doctoral

Submit Date: 14.02.2017, Acceptance Date: 07.03.2017, DOI NO: 10.7456/1070ASE/024

dissertation). New York University, New York, NY.
Brandfonbrener, A. G. (2003). Musculoskeletal problems of instrumental musicians. Hand Clinics, 19(2), 231-239.
Bree, M., & Baker, T. (1902). The groundwork of the Leschetizky method. New York, NY: G. Schirmer.
Brower, H., & Johnson, J. (2003). Piano mastery: Talks with Paderewski, Hofmann, Bauer, Godowsky, Grainger, Rachmaninoff, and others: the Harriette Brower interviews 1915-1926. Mineola, NY: Dover Publications.
Bruser, M. (1999). The art of practicing: A guide to making music from the heart. New York, NY: Bell Tower.
Caldron P. H, Calabrese L. H., Clough J. D., Lederman R. J., Williams G., Leatherman J. (1986). A Survey of musculoskeletal problems encountered in high- level musicians. Medical Problems of Performing Artists. 1(4), 136-139.
Chung, I. S. (1992). Wrist motion analysis in pianists. Medical Problems of Performing Artists, 7, 1-5
Cooke, J. F. (1999). Great pianists on piano playing: Godowsky, Hofmann, Lhevinne, Paderewski, and 24 other legendary performers. Mineola, NY: Dover Publications.
Crombie, D. (1995). Piano: Evolution, design and performance. London, UK: Bafalon.
Douglas, S., & Craig, C. (1983). International marketing research. Englewood Cliffs, NJ: Prentice-Hall.
Eigeldinger, J. (1986). Chopin: Pianist and teacher as seen by his pupils (3rd ed.). Cambridge, UK: Cambridge University Press.
Fielden, T. (1961). The science of pianoforte technique. New York, NY: St. Martin Press.
Middlestadt S. E. & Fishbein M. (1988). Health and occupational correlates of perceived occupational stress in symphony orchestra musicians. Journal of Occupational Medicine, 30(9), 687-692.
Fraser, A. (2003). The craft of piano playing: a new approach to piano technique. Lanham, MD: Scarecrow Press.
Gerig, R. R. (2007). Famous pianists & their technique. Bloomington, IN: Indiana University Press.
Grieco, A. (1989). Muscular effort and musculo-skeletal disorders in piano students: Electromyographic, clinical and preventive aspects, Ergonomics, 32, 697-716
Guptill, C., Zaza, C. & Paul, S. (2000). Anoccupational study of physical playing- related injuries in college music students, Medical Problems of Performing Artists, 15(2), 86-90
Hagberg, M., Thiringer, G. & Brangstrom, L. (2005). Incidence of tinnitus, impaired hearing and musculoskeletal disorders among students enrolled in academic music education – a retrospective cohort study. Int Arch Occup Environ Health, 78, 575-583.
Hofmann, J. (1976). Piano playing, with piano questions answered. New York, NY: Dover Publications.
Hoppmann R. A (1998). Musculoskeletal problems in instrumental musicians. Textbook of Performing Arts Medicine. 2, 71-110.
Poniatowska, I. (2003). Chopin and his work in the context of culture. Kraków, Poland: Musica Iagellonica.
Kish, L. (1965). Survey sampling. New York, NY: John Wiley & Sons.
Leimer, K., & Gieseking, W. (1972). Piano technique: Consisting of the two complete books the shortest way to pianistic perfection and rhythmic, dynamics, pedal and other problems of piano playing. New York, NY: Dover Publications.
Lhevinne, J. (1972). Basic principles in pianoforte playing. New York, NY: Dover Publications.
Lockwood A. H (1989). Medical problems of musicians. The New England Journal of Medicine. 320(4), 221-227
Manchester, R. (1988). Medical aspects of music development. Psychomusicology. A Journal of Research in Music Cognition, 7(2), 147-152.
Mark, T., & Gary, R. (2004). What every pianist needs to know about the body: With supplementary material for organists. Chicago, IL: GIA Publications.
Nagai L & Eng J (1992). Overuse injuries incurred by musicians. Physiotherapy Canada. 44(1): 23-30
Robertson, K. D., & Griepenkerl, F. C. (1991). Arm-weight and weight-transference technique: Its systematic use as a technical and artistic vehicle in piano playing. (Unpublished master's thesis). Boston

Submit Date: 14.02.2017, Acceptance Date: 07.03.2017, DOI NO: 10.7456/1070ASE/024

University, MA, USA.
Sakai, N. (1992). Hand pain related to keyboard techniques in pianists, Medical Problems of Performing Artists, 7(2), 63-65
Sandor, G. (1981). On piano playing: motion, sound, and expression. New York, NY: Schirmer Books.
Spangler, H. (1950). History of pianoforte methods. (Unpublished Doctoral Dissertation). University of North Dakota, Grand Fork, ND.
Storm, S. A. (2006). Performing arts medicine. Philadelphia, PA: Saunders.
Szklener, A. (2004). Chopin in performance: History, theory, practice. Warsaw, Poland: Narodowy Instytut Fryderyka Chopina.
Whiteside, A. (1983). Indispensables of piano playing. New York, NY: C. Scribner's Sons.
Zaza, C., Charles, C., & Muszynski, A. (1998). The meaning of playing-related musculoskeletal disorders to classical musicians. Social Science & Medicine, 47(12), 2013-2023.

Submit Date: 14.02.2017, Acceptance Date: 07.03.2017, DOI NO: 10.7456/1070ASE/024