

BIOMECHANICAL ANALYSIS OF HAND WEBSpace IN RELATION WITH DIMENSIONS OF PIANO AMONG AMATEUR PIANIST

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ABSTRACT

BACKGROUND: Piano playing is similar athletic activity because it has high demands in practice and requirements to play musical notes accurately. Recent studies provide evidence that hand size is a crucial risk factor for pain and subsequent injury among pianist.

AIM & OBJECTIVE: The aim of my study is to do biomechanical analysis of hand web space in relation with dimension of piano among amateur pianist.

METHODOLOGY: It is an observational study in which 20 amateur piano players were recruited according to inclusion and exclusion criteria. Two different dimensions of piano, a grand piano with 230 mm and upright piano with 190 mm of octave length were fitted. The participants were made to play the musical repertoire and scales consequently in two pianos. Visual analogue scale was used to measure the pain and speed of the performance was evaluated using timer. The hand position was recorded in digital camera and analyzed using kinovea software 0.9.5.

OUTCOME MEASURE: VAS score, Postural analysis, Stop watch

RESULTS & CONCLUSION: This study concludes that there is a correlation between hand web space and dimension of piano. This study also concludes that women have higher intensity of pain in both grand piano and upright piano in comparison with men. The possible prevention of future occurrence of playing related musculoskeletal disorder is to seek a suitable modified piano for small handed pianist to minimize the intensity of pain and to increase their level of performance.

KEYWORDS: ERGONOMICS, AMATEUR PIANO PLAYERS, HAND WEB SPACE, PIANO DIMENSIONS,

INTRODUCTION

Music is the most indispensable piece of any entertainment that enacts as a tool in transmitting negative into positive energy. Playing an instrument allows you to express many emotions in a very personal and pleasing way. The Piano plays a lead role in an orchestral session. The evolution of Piano was developed in the year 14th century. The first evolution was clavichord manufactured in the year 14th century. The second evolution was harpsichord invented in the year 16th century. In the year 18th century the first generation of piano known as the forte pinao was invented by Bartolomeo Cristofori. In the 20th century the upright and grand piano was coined and distributed in the market.

The mechanism of piano generates sound when the key is depressed by plucking or striking a string through a key action mechanism. The high octave strikes three strings at a time, the middle octave notes strike two strings and the bass octave notes strike one string at a time. The material, thickness, and tension of a string determine the pitch of the note. The strings towards the right side of the piano are shorter and thinner to produce high-pitch notes on parallel towards the left are stronger and thicker to produce low pitch sounds. The touch of each key varies from 52g for present-day acoustic piano. The player has to exert a collective force of near between 48.4 to 57.4 kilograms per minute or between 168.9 to 201.4 kilograms which significantly causes stress in the musculoskeletal system of the body, especially in hands and arms¹.

Musicians are wizards who spread the fragrance of joy by absorbing the woes in the form of playing-related musculoskeletal disorders. To most of the public playing an instrument is a fun and safe job without perceiving posing any harm to the body² but still, musicians are also exposed to musculoskeletal disorders when a given motion is highly repetitive combined with the prolonged use of body segments and without a proper understanding of the anatomical limits and motion range of the human body. Muscles in the hand, wrist, and fingers can easily work to an extent where pain begins to progress.

In a 1992 survey Ong stated that 53.7% of student population, general hand flexibility did not correlate with the tendency to develop playing-related musculoskeletal disorder⁴. On contrary, there is evidence that illustrates that impact of hand size will affect the motions while playing piano¹. Lee et al., 1990 stated that the size of the hand itself influenced the touch control of playing⁵. The

heavier weight of touch key control, longer strings, and greater mechanical properties of present-day acoustic pianos need a much greater force, physical strength, and ability to complete the playing task¹.

Nowadays students learning piano in the tertiary institution has been increasing² and the tutors have focused on the end results, subsequently they may struggle blindly on acquiring techniques to the point of injury. Piano playing is similar to athletic activity¹. Researchers have affirmed that joint mobility and finger spans are significant factors that impact piano performance. The prevalence of PRMD among pianists including students majoring in piano has been reported in the range of 25% to 93%¹.

Pain is the foremost symptom-related musculoskeletal disorder, at the appearance of pain, the pianist must begin thoughtfully analyzing the situation from every aspect such as piano dimension, hand size, posture, lifestyle, muscle imbalance or weakness, daily activities course of techniques, and practice habits.

Evaluating the seriousness of an injuries at early onset is important in ensuring proper care and treatment and also in minimizing the chances of prolonged or permanent damage. Multiple cases of a famous pianist who suffered from the playing-related musculoskeletal disorder have been documented in the pianist literature, including Robert Schumann, Sergei Rachmaninov, Alexander Scriabin, Leon Fleshier, and Gary Graffman².

Learning music is most prevailing in contemporary genesis, on parallel the evolution of learning music also significantly boosted up the musculoskeletal disorder among amateur musician which bounce back its impact in a later stages. Besides there are many evidence which illustrates the prevalence rate of musculoskeletal disorder in to relation with nature of musical performance and practice with distinct of instruments. The origin factor of pain is still clouded behind, which can significantly benefit the educators in exploring connection between playing related musculoskeletal disorder and instruments. The biomechanical analysis approach to facilitate the perspective of educators in providing appropriate size of piano in relation with hand dimension of the students which will significantly reduce the occurrence of playing related musculoskeletal disorder and enhance the performance of the player towards the achieving goal.

METHODOLOGY

It is an observational study in which 20 amateur piano players under 15-20 years of age, both gender, piano players with minimum 8 years of playing experience and players who have attended up to fifth grade exam were recruited for the study. Players who learn other instrument along with piano, players with any recent injury and players who learn sports were excluded out of the study.

Two different dimensions of piano, a grand piano with 230 mm of octave length and upright piano with 190 mm of octave length were fitted in different rooms. All set-ups, tuning, and modification of the piano were conducted by a full-time piano technician.

The players were explained in detail about the need and procedure of the study, and then an informed consent form was obtained from the piano players. The participants were given a copy of musical repertoire to be used during study. The assigned repertoire consisted of two session, the first session included of playing a musical piece "A walk At Stumble Head" published by Gareth Batch. The second session consisted of playing C major scale of two octaves both ascending and descending.

On the scheduled day tutors were appointed to monitor the participants while playing. The participants were interviewed about their demographic data and hand span of the participant was measured using a wooden ruler. Then the participant was made to play their musical repertoire and piano scales in two consecutive pianos.

Once after completion of the musical repertoire participants intensity of pain was measured using Visual Analogue Scale and the speed of performance was analyzed using timer while playing scales. To make the study more evident the hand posture was also recorded using digital camera which was then analyzed using Kinovea software version 0.9.5. The collected data was statically analyzed using SPSS software.

RESULT

TABLE I
INTENSITY OF PAIN IN 230 CM PIANO DIMENSION AND 190 CM PIANO DIMENSION

	Group	N	Mean	Std. Deviation	t - Value	P - Value
VAS	Black 230	20	2.25	.716	4.346	0.000*
	Brown 190	20	1.35	.587		

	Brown 190	20	48.15	4.614		
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BAR DIAGRAM I
INTENSITY OF PAIN IN 230 CM PIANO DIMENSION AND 190 CM PIANO DIMENSION

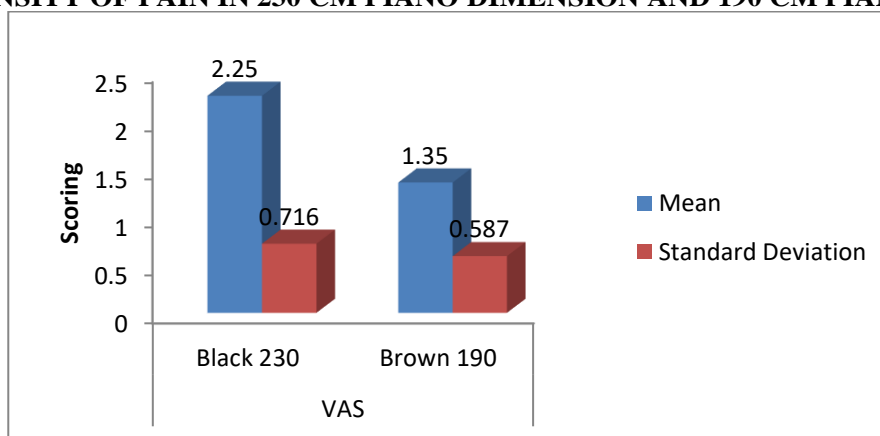


TABLE II
PLAYING SPEED IN 230 CM DIMENSION PIANO AND 190 CM DIMENSION of PIANO

	Group	N	Mean	Std. Deviation	t - Value	P - Value
Speed of Scales	Black 230	20	8.1355	1.20271	0.959	0.344
	Brown 190	20	7.7535	1.31379		
	Brown 190	20	48.15	4.614		

BAR DIAGRAM II
PLAYING SPEED IN 230 CM DIMENSION PIANO AND 190 CM DIMENSION PIANO

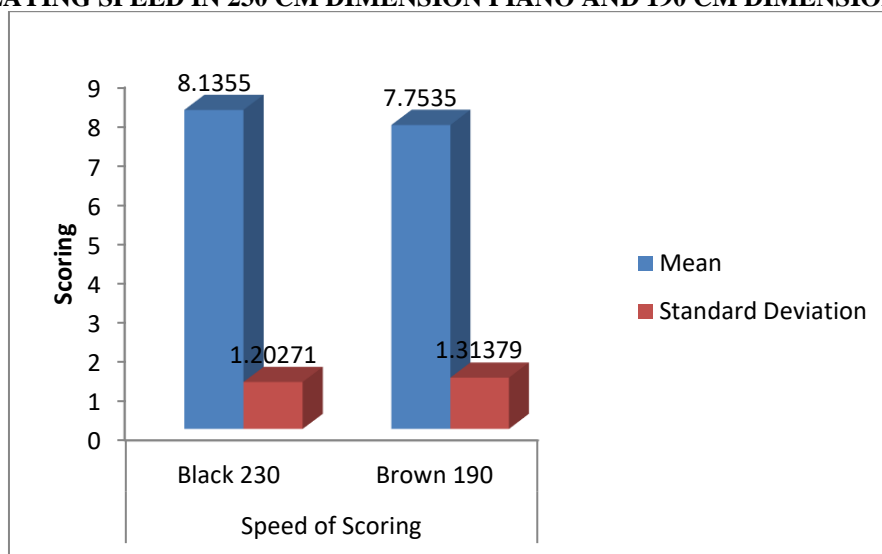


TABLE III
INTENSITY OF PAIN IN DIFFERENT DIMENSION OF PIANO IN RELATION WITH GENDER

Gender		N	Mean	Std. Deviation	t - Value	P - Value
VAS Black 230	MALE	10	2.20	.919	-0.305	0.764 NS
	FEMALE	10	2.30	.483		
VAS Brown 190	MALE	10	1.30	.675	-0.372	0 714
	FEMALE	10	1.40	.516		

BAR DIAGRAM III
INTENSITY OF PAIN IN DIFFERENT DIMENSION OF PIANO IN RELATION WITH GENDER

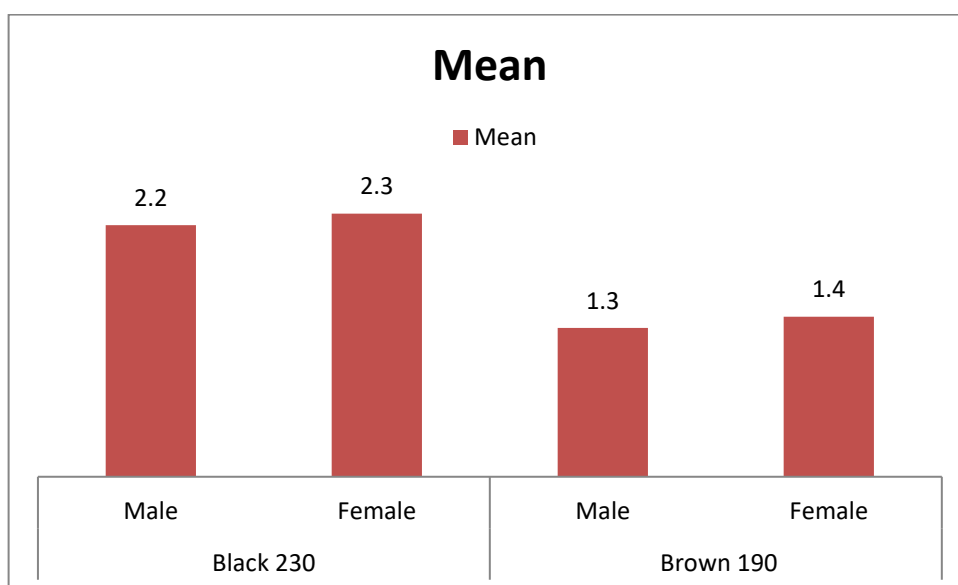
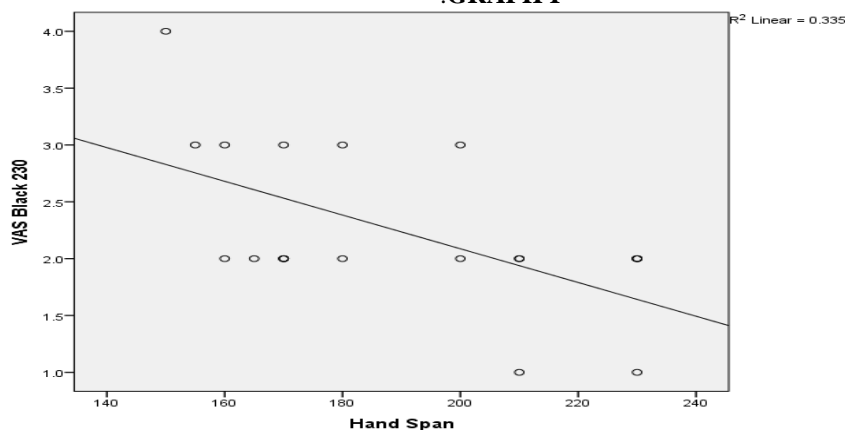


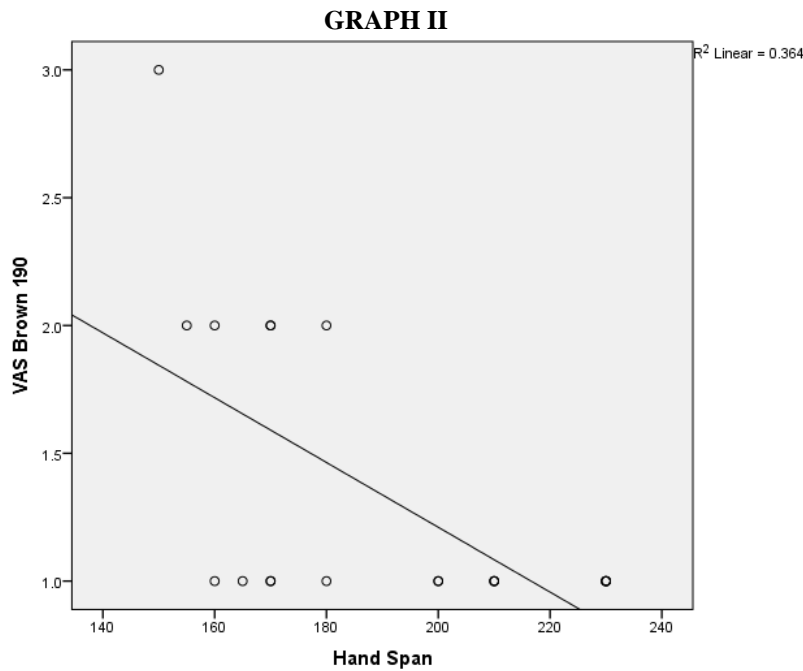
TABLE IV
CORRELATION OF HAND WEB SPAN IN WITH DIAMETER OF PIANO

		VAS Black 230	VAS Brown 190	Speed of scales Black 230	Speed of scales Brown 190
Hand Span	Pearson Correlation	-.579**	-.603**	-.081	.046
	Sig. (2-tailed)	.008	.005	.735	.846
	N	20	20	20	20

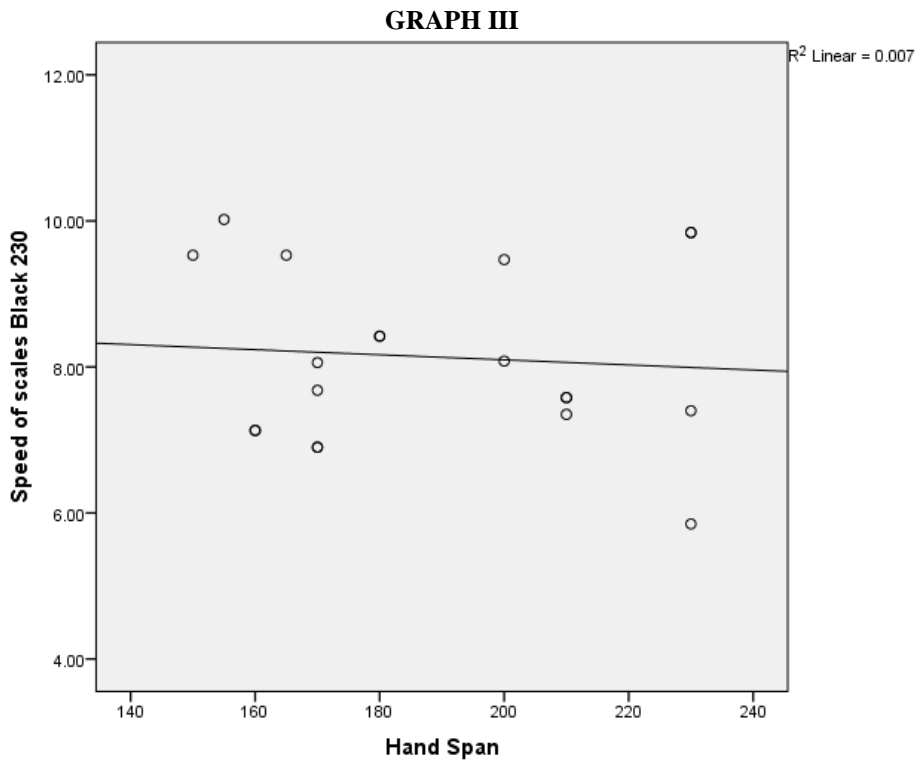
.GRAPH I



Pearsons correlation between participants hand span and visual analogue scale states moderate negative correlation in grand piano

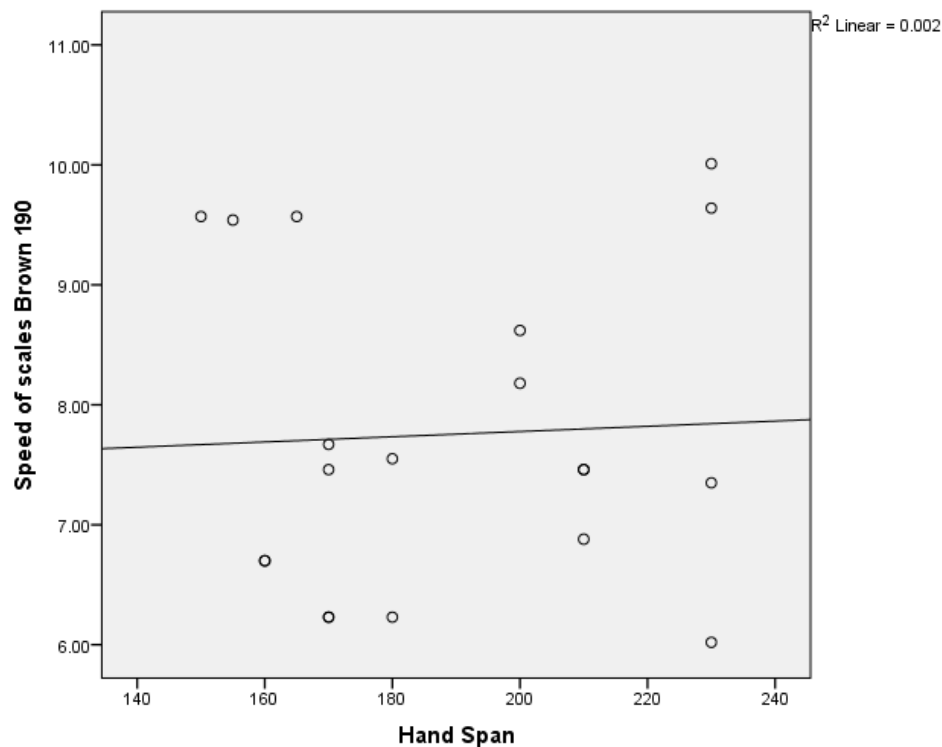


Pearsons correlation between participants hand span and visual analogue scale states moderate negative correlation in upright piano



Pearsons correlation between participants hand span and speed of playing states very low negative correlation in grand piano

GRAPH IV



Pearsons correlation between participants hand span and speed of playing states positive correlation in upright piano

DISCUSSION

The harmony of grand and upright piano is not electrically modified; it is naturally made by the mechanism of striking and plucking strings based upon the pitch of the notes being depressed. The dynamics of sound are also based on the pressure exerted on the keys by the player.

Musicians are also prone to injuries due to the nature of musical practice and pianists are among the groups at high risk for playing related musculoskeletal disorder¹. Injuries occurring in piano playing can cause miserable experiences. In time immemorial learning instrument in India was bounded because of lack of interest and financial defalcation. On other hand in current era extracurricular activities has being adjoined as a part of educational curriculum, so the number of students learning piano in tertiary institution has been increasing, but due to fewer tertiary institution and educators the students are not properly focused and also pianos in institutions are being consequently changed based on the availability of piano at the scheduled time for students which indirectly affects the performance. This is also one such factor that significantly cause playing related musculoskeletal disorder among amateur piano players. There are many prevalence studies that illustrate the percentage of pain among pianists in wrist and hands. Previously two studies were conducted in the year (2019- 2022) topic entitled as prevalence of musculoskeletal disorder in wrist and fingers among amateur pianist which illustrated there is a high intensity of pain in weight playing methodology and also specific pain in fourth and fifth finger while playing⁸. Another topic entitled as "Effect of finger and hand exercise among amateur pianist which illustrated that there is significant decrease of pain in fingers and wrist after four weeks of charted exercise protocol for fingers and wrist among amateur pianist⁹.

Though the above stated studies define peculiar about pain in wrist and fingers among amateur pianist the originating factor for pain is still clouded behind. The cornerstone idea of this research was to do biomechanical analysis on hand web space in relation with dimension of piano. The study was conducted in Kingsway music tertiary institution at vellore, Tamil Nadu, India, 20 participants were included according to the inclusion and exclusion criteria, the participants were clearly informed about the need and procedure of the study.

Two different dimensions of piano, a grand piano with 230 mm of octave length and upright piano with 190 mm of octave length were fitted in different rooms. The participants hand web space was measured and they were given a musical repertoire along with scales to assess the intensity of pain and speed of playing in two consecutive pianos. Once after completion of playing the pain was assessed using visual analogue scales and speed was evaluated using timer. To make the study more evident the playing posture was also captured using digital camera and analyzed with kinovea software version 0.9.5 to measure the deviation of angle on wrist and finger in both the pianos.

The statistical analysis defines that according to table I the participants intensity of pain while playing in grand piano with octave dimension 230 mm is 2.25 of mean value which is significantly higher than upright piano with octave dimension 190mm which is 1.30 of mean value. According to table II the participants playing speed was significantly faster in upright piano with octave 190mm dimension of mean value 7.7535 than grand piano octave dimension of 230 mm with mean value 8.1355. According to table III women have significantly higher intensity of pain with mean value of 2.30 in grand piano and mean value of 1.40 upright piano in comparing with men. According to table IV Pearson correlation was used to

correlate between participants hand span with visual analogue scale which states moderate negative correlation in both grand piano and upright piano. A correlation was also made between participants hand span with speed of playing which states very low negative correlation in grand piano and positive correlation in upright piano.

The statically analysis defines that hand web space has a direct and indirect correlation with the dimension of piano. In the time of playing a piece, the fingers are stretched to play the notes accurately, by the reason of inappropriate dimensions of piano, the fingers are stretched at an intense level which significantly causes overstretch of muscles, ligaments and tendons. The repetitive motion can cause a strain, which in a later stage impacts the performance and ends the carrier. The concept behind the origination of pain is being defined, but still in depth biomechanical analysis has to be conducted to distinguish the specific region and muscles pushed down to injury during performance. Musicians, especially music students, often continue playing their instrument despite experiencing symptoms of pain. However, despite of historical importance such statistics it is clear that the problem of playing related musculoskeletal among musician is far from being solved, solution used to treat musculoskeletal complaints can include the appropriate use of piano in accordance to age and hand web space.

CONCLUSION

This study concludes that there is a correlation between hand web space and dimension of piano. This study also concludes that women have higher intensity of pain in both grand piano and upright piano in comparison with men. Designing a modified piano for small handed pianist can reduce the impact of pain and enhance their level of performance which will also significantly cause interception of playing related musculoskeletal disorder.

CONFLICT OF INTEREST- NIL

SOURCE OF FUNDING-SELF FUNDING

ETHICAL CLEARANCE- INSTITUTIONAL ETHICAL COMMITTEE

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