EFFECTS OF THE REPERTOIRE ON THE MUSCULOSKELETAL SYSTEM OF BOTH HIGH-SCHOOL AND EXPERT PIANISTS

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ABSTRACT

This research analyzes the relation between piano repertoire and symptoms of "playing-related musculoskeletal disorder" (PRMD) in high school pianists compared to concert pianists (experts) using online questionnaires. The compared results between the repertoire studied and PRMD was confirmed in 21.42% of the expert pianists and in 48% of the high-school pianists. 36% of the high-school pianists manifesting the symptoms identify a specific repertoire practiced (Classical or Romantic) as a causative factor. 21.42% of the expert pianists detect a relation between repertoire and PRMD symptoms, of which 14.28% point to the Romantic repertoire, 7.14% to a specific musical work, and 7.14% to passages played loud and fast. Due to the possible negative impact of a specific repertoire on young pianists as well as on those who play mainly a very specific repertoire, both professors and pianists may take into consideration, as a prophylactic strategy, a varied pianistic repertoire diversified in terms of styles and technique, and an individualized approach to the piano technique based on the anatomic and physiological particularities of each pianist.

Key-words

piano repertoire, piano technique, symptoms, musculoskeletal, beginner vs. expert pianist

INTRODUCTION

Joints, arms and vulnerable muscles are affected by repeated performance on a musical instrument. The most frequent causes for PRMD in classical music performers include: repetitive motion (Sheibani-Rad et al., 2013), extended practice time as well as fatigue due to altered posture (Blackie et al., 1999). In piano performance, repetitive motor tasks are not style-specific, bringing into question if there is any stylistic period more prone to cause PRMD than others and what could help prevention?

Argument for comparing different-age pianists

King & Prior report major differences to exist between the motor abilities of a beginner artists and those acquired in the final stages of personal development in music, a process based on a well-organized approach: "In a real sense, an expert performer's familiarity with a musical instrument is qualitatively different compared with a novice in terms of the knowledge that defines and drives the motor interaction with the instrument" (King & Prior, 2016).

The abilities as well as the motor-related pathologies manifested in artists performing classical music appear to differ from those manifested in artists performing

other music genres as shown in a 2014 study where the PRMD prevalence in classical music school students was significantly higher (66.6%) compared to students practicing other music genres (22.2%). The explanation for this difference was allegedly the fact that classical music requires a "more demanding and sustained" posture (Árnason et al., 2014).

Regardless of age, Sheibani-Rad & Wolfe see classical musicians as a group vulnerable to musculoskeletal pathologies, especially women performing artists in their 30's and 40's (Sheibani-Rad et al., 2013). Time is a risk factor for musicians, as the elite performing artists practice for about 8 hours per day. Even when adequate techniques are employed routinely, long-time practicing on a musical instrument can lead to overstrain syndromes (Bird, 2016).

In Australia, PRMD is reported to manifest similarly in children and adults; however, that research did not evaluate only pianists but also other types of performing artists (Ranelli et al., 2015). The PRMD similarity between these two groups could be explained by the fact that such research did not go deep enough into the pathologies of the expert artists. In Moñino's study, only 2 out of the 20 pianists studied were concert pianists (Moñino et al., 2017). The expert pianists were better represented in Ferrario's research with 8 soloists out of the total 19 pianists (Ferrario et al., 2007), however, little attention was paid to young performing artists, vulnerable as well (Nawrocka et al., 2014) since Blackie et al. suggest that research should also focus on performing artists below university level (Blackie et al., 1999). More research on the prevalence of PRMD is needed on both young pianists and experts.

Argument for the research method selected

The prevalence of PRMD based on repertoire was not studied before in Romania, however, PRMD prevalence in performing artists was studied worldwide. During 2000-2013, 94.44% of the articles published studied orchestra performers and used questionnaires, except for one study which used telephone interviews (Silva et al., 2015). The questionnaire most frequently used was the "Nordic Musculoskeletal Questionnaire" (Nawrocka et al., 2014) which is not specialized for musicians. Due to the specific aspects of muscle and skeletal use in music performance, no standard questionnaires are commonly used in music-performance research (Stanhope et al., 2019). This study, therefore, required a questionnaire asking specific questions about the repertoire practiced and PRMD.

METHODS

Study no. 1

Over 80 emails were sent (November, 2019 – May, 2020) to worldwide reputed European pianists, via their individual web pages. Data gathered regarded demographic information; protection of subjects' anonimity upon filling in the questionnaire; study purpose and a link to the questionnaire; and subjects' written confirmation for willingly agreeing to fill out the questionnaire and to processing personal and questionnaire data. The questionnaire contained 33 questions organized in sections which gathered data regarding personal lifestyle and data, performances history as expert pianists,

musculoskeletal pathologies and the relation between repertoire and PRMD symptoms.

The first part of the questionnaire gathered demographic information (gender, age, height, weight), information regarding the duration of their expertise as soloists, their respective current professional status as well as information about the dominant hand and lifestyle that included alcohol or drug usage over the previous 5 days, current therapies, daily ingestion of coffee, black tea, energy drinks, fruits and vegetables, hours of night sleep observed, activity status and fitness. Similar questions were found in Ling et al.'s questionnaire (Ling et al., 2016). However, this study added questions regarding sleep schedule since sleep deprivation leads to a state of hyperalgesia (heightened sensivity to pain) (Lautenbacher et al., 2006) and alcohol usage over what is considered as the daily consumption standard (i.e. 1 to 2 standard drinks per day based on gender according to the Centrer for Disease Control (*Facts about Moderate Drinking | CDC*, 2021)) heightens the manifestation of musculoskeletal symptoms (Kok et al., 2016).

The second section was structured into questions requiring statements about the days of the week and the time of the day when the subjects normally practice on a weekly basis; the number of concerts performed in one calendaristic year; resting time between concerts; specific music style of concert repertoire; time span dedicated to practicing such repertoire, daily; and awareness of specific movements needed for expressing musical meaning.

The third section was concerned with information about: pain or disconfort symptoms and level felt by the pianist in specific bodily locations over the previous 12 months; location of discomfort preventing the pianist from performing musical activity; hospitalization history related to musculoskeletal pathologies; most strained anatomic segment during practice and frequency; and location of musculoskeletal discomfort symptoms at arm level.

Overexertion syndromes in pianists tend to be symmetrical and bilateral (Bird, 2016). As a consequence, the questions about the symptoms took into consideration both arms.

The concluding section was structured into questions regarding: discomfort associated with a specific repertoire; the music style most frequently causing the pianist to feel disconfort; nature, intensity and spread of discomfort; time span of discomfort from debut to disappearance; consequences of discomfort upon practicing and concert life; measures of relief at the time discomfort was felt; and prophylactic suggestions for avoiding musculoskeletal diseases made by the expert pianists to the young pianists.

Study no. 2

Study no. 2 applied the same assessment method on a group of high-school pianists taught in various institutions. A similar questionnaire was distributed online to high-schools and colleges and received answers during November, 2019 – March, 2020.

The questionnaire was almost identical to the expert pianists, except for the section requiring answers regarding their *solo activity* and the ascertainment of each pianist's current *status* (*a student)*.

The specific terminology associated with epidemiology is: the "risk factor is any condition describable and proven to be associated with occurrence of specific morbid states more frequently than expected"; the risk factor is proven when "relative risk >1 and attributable risk >0." The "relative risk (RR) indicates by how many times the disease risk is higher in the subjects exposed to it." The "attributable risk (AR) indicates by how much the risk is higher in exposed subjects as compared to subjects not exposed" and measures excess risk in exposed subjects, for example "risk part due to risk factor in the non-exposed." The risk fraction attributed to the exposed subjects (RA%) indicates "what percentage of the subjects exposed to risk is attributed to the risk factor" (Mincă, 2005).

RESULTS

Results are shown comparatively. Although the tables contain a wealth of information, only the data in discussion for this study will be addressed herein.

14 worldwide reputed soloist pianists filled-out the questionnaire in study no. 1, out of which only 57.14% live as predominantly concert pianists; the others teach music as a parallel career.

25 of the high-school pianists filled-out the questionnaire in study no. 2. The pianists' demographic data from the two studies is found in Table 1. Notably, female subjects (70%) prevail in high school as opposed to the expert group with 35.71% female solo pianists. Overweight subjects IMC (25.71) were found only in the expert group.

All of the subjects in study no. 2 met the following criteria: student status; major instrument-piano; no musculoskeletal pathologies ever having led to hospitalization.

None of the student subjects took drugs or drank more than the standard alcohol consumption over the previous 5 days. None of the expert pianists took drugs, nor was any hospitalized for any musculoskeletal pathology. However, 28.57% of the expert pianists had a more-than-standard alcohol consumption over the previous 5 days, and 14.28% were under statins/aspirin medication.

Table 1. Demographic data

Results pianists high-school		**Results expert/concert/solo pianists**
Sex	Female = 72% Male = 28%	Female = 35.71% Male = 64.29%

Age	Mean = 16.32 SD = 1.15	Mean = 43.28 SD = 13.75
IMC	21.44	25.79
Dominant hand	Right = 72% Left = 4% Ambidextrous = 24%	Right = 78.57% Ambidextrous = 21.43%
Regular intake of coffee, black tea or energizers	Yes = 20% No = 80%	Yes = 85.71% No = 14.29%
Consumption of fruits and vegetables	Daily = 52% Several times / week or month = 48%	Daily = 57.14% Several times / week or month = 42.85%
Sleep hours / night:	Mean = 7.48 SD = 0.822597512	Mean = 7.78 SD=0.57
Physical activity	Regular training at least 2-3 times/ week = 20% Light activities at least 4 times / week or inactive = 80%	Regular training at least 2-3 times / week = 42.85% Regular training for sporting events = 7.14% Light activities at least 4 times / week or inactive = 50%

Table no. 2 indicates the subject's music performing life in years of concert life, daily routine, number of concerts performed per year, and time out from the soloist performing-artist life.

Table 2. Piano solo/concert performing artist life

Criteria	**Results pianists in high-school**	**Results solo/concert pianists**
Concert peforming years	Mean = 8.92 SD = 2.73	Mean = 27.57 SD = 14.20
Daily practicing routine	7 days = 64% 5-6 days = 28% 3-4 days = 8%	7 days = 71.42% 4-5 days = 14.28% 3-4 days = 7.14% Depends of the repertoire studied = 7.14%
	After 12 a.m. = 32% After 7 p.m. 19 = 20% Before 12 a.m. = 16% Other = 32%	After 12 a.m. = 35.71% After 7 p.m. = 14.28% Before 12 a.m. = 7.14% No particular routine = 21.42% Other (never at lunch time) = 14.28%
Nuber of concerts over calendar year, as a soloist:	1-2 concerts = 44% 2-5 concerts = 28% 5-10 concerts = 16% 10-15 concerts = 12%	Over 40 concerts = 42.85% 20-30 concerts = 35.71% 10-20 concerts = 7.14% Almost 10 concerts = 14.28%
Time out delay in-between concerts held as a soloist :	Several hours = 12% Several days = 32%	Several hours = 50% Several days = 14.28%

	Several weeks = 24% Several months = 24% None = 8%	Several weeks = 7.14% None = 28.57%

Table 3 indicates musculoskeletal discomfort over the latest 12 months, per specific levels.

Table 3. Musculoskeletal discomfort felt over the latest 12 months

Criteria	Results pianists high-school	Results piano soloist
Location of quoted felt discomfort over the latest 12 months:	Neck = 12% Shoulders = 4% Wrist / hand = 16% Knee = 8% Ankle / leg = 8% No such troubles = 44%	Shoulders = 28.57% Supero-posterior thorax (cervical area) = 7.14% Infero-posterior thorax (lombar area) = 7.14% Knee = 7.14% Wrist / hand = 7.14% No such problems = 42.85%
Location of quoted symptoms felt, preventing music performance over latest 12 months:	Supero-posterior thorax (cervical area) = 8% Infero-posterior thorax (lombar area) = 8% Wrist / hand = 13% No such troubles = 71%	No such problems = 57.14% Shoulders = 14.28% Supero-posterior thorax (cervical area) = 7.14% Infero-posterior thorax (lombar area) = 7.14% Wrist / hand = 7.14% Elbow = 7.14%
Location of symptoms in arm :	Arm joints = 24% Forearm = 24% Palm = 16% Fingers = 4% Other = 4% Whole arm = 2%	No such problems = 57.14% Fore arm = 14.28% Shoulders = 14.28% Wirst / hand = 7.14% Elbow = 7.14%

Table 4 indicates pianistic repertoire taken as a risk factor for symptom occurence, in percentages.

Table 4. Repertoire and associated symptoms

Criteria	Results high-school pianists	Results solo/concert pianists
Felt disconfort at arm level, especially when practicing a specific type piano repertoire.	Yes = 48% No = 52%	Yes = 21.42% No = 78.58%
Style music causing discomfort at musculoskeletal level, in arms, was:	Romantic = 20% Classical = 16%	Romantic = 14.28%

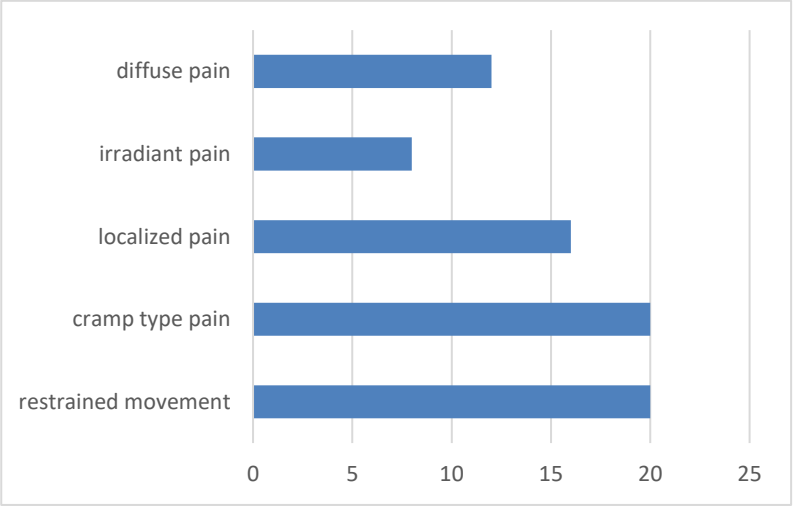
	Modern = 4% Baroque = 4% Other = 4%	No discomfort = 57.14% Depends of specific composition = 7.14% In passages played loud and fast = 7.14% No relation = 7.14%
Quoted discomfort intensity:	Moderate = 36% Weak = 24% Very weak = 20% Strong = 16%	Very weak = 64.28% Weak = 14.28% Moderate = 14.28% Strong = 7.14%
Quoted discomfort time delay, since occurrence to vanishing point:	Several days = 44% Over 3 months = 12% Several weeks = 4%	Several days = 35.71% No discomfort = 50% Several weeks = 7.14% Over 3 months = 7.14%

Analysis of Study no. 2

Due to the fact that the results regarding the appearance of symptoms and the studied repertoire are in a higher percentage than 26.58% in study no. 2, other results from the questionnaire completed by high-school pianists will be presented.

As seen in Table 5, discomfort is claimed to be felt in relation to performing a specific type of piano repertoire. Moreover, an equal percentage (20%) is attributed to both muscular cramp and restrained movement in high-school pianists.

Table 5. Discomfort as pertaining to performing a specific type of piano repertoire



The epidemiologic risk factors were calculated for Study no. 2. The subjects physically inactive, yet claiming symptoms, manifested RR=1.10, RA=0.08, and RA%=9.41%. The subjects who performed only Romantic repertoire manifested

RR=1.51, RA=0.34, and RA%=34% as compared to the subjects who currently practiced a combined Baroque-Classical-Romantic-Modern repertoire. The Classical-only repertoire group, as compared to the combined Baroque-Classical-Romantic-Modern repertoire, manifested RR=1.51, RA=0.34, and RA%=34%. The pianists aware of their bodily movements, only sometimes manifested RR=1.44, RA=0.31, and RA%=31%. Ways of tackling PRMD are indicated in Table 6, whereas pianistic attitude in the context of PRMD is indicated in Table 7. As seen, over 40% of the pianists chose to go on practicing, in spite of PRMD issues.

Table 6. Management symptoms due to practicing a musical instrument

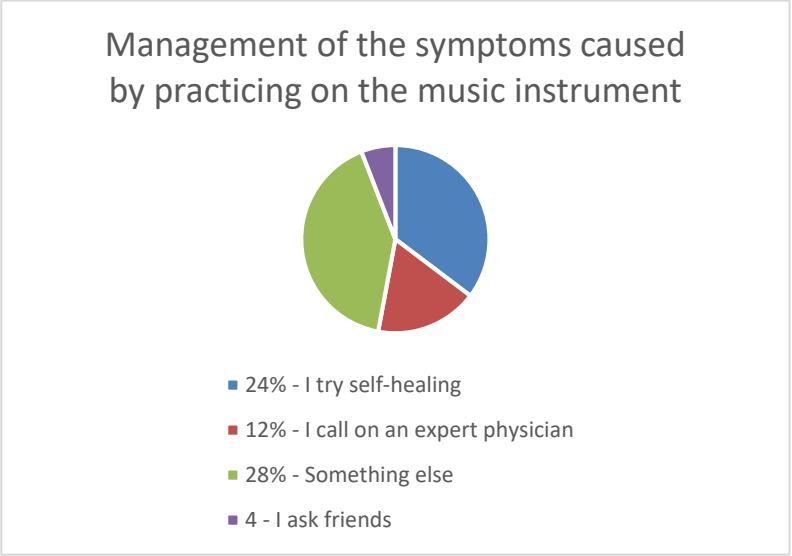
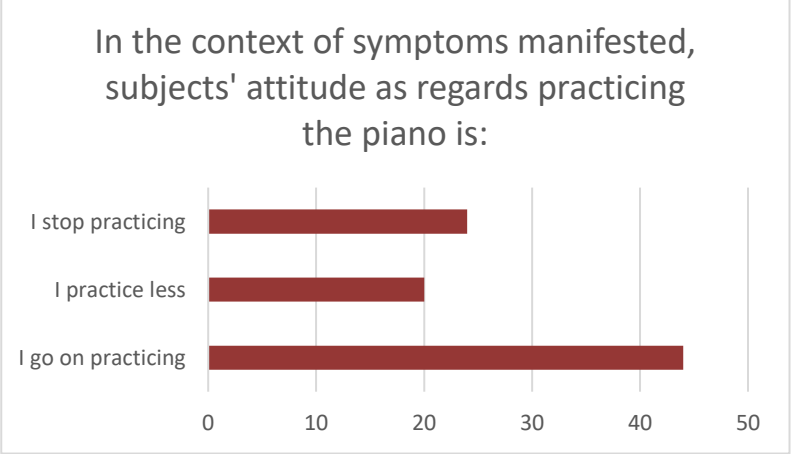


Table 7. The subjects' attitude in the context of PRMD (question no. 32)



RESEARCH FINDINGS AND DISCUSSION

The results are interpreted in the context of the relation between repertoire rehearsed and the occurrence of PRMD symptoms, various risk factors, treatment management and prophylaxis, as well as solutions for the future.

Results explained

21.42% of the solo/concert/expert pianists confirm the existence of a relation between the repertoire studied and PRMD as compared to 48% of the high-school pianists.

The solo pianists assert that the symptoms are caused by the repertoire practiced (Romantic repertoire 14.28%), specific compositions (7.14%), and passages performed loud and fast (7.14%).

The lower incidence of PRMD in the expert group may be attributable to the varied repertoire approached by the solo pianists, ranked as follows (per music styles): 42.85% of the performing artists play all type of pianistic repertoire; 7.14% play all the repertoire except for Baroque; 21.43% play Classical repertoire; 14.28% Romantic repertoire and 14.28% play Modern repertoire. Such repertoire was practiced as follows: 1-2 hours per day by 28.57% of the pianists; 3-4 hours per day by 42.86% of the pianists; 4-5 hours per day by 7.14% of the pianists; and 6-7 hours per day by 21.43% of the pianists. It is important to note that pianists who practice all repertoires combined study them equally (7.14%), alternately, and always varied (also 7,14%).

Another possible cause for the lower incidence of PRMD in the expert group might be that their body adapted in time by optimizing posture and eliminating undue tension (Watson, 2009). Performing artists can play up to their physical limits when they feel that they need to, and sometimes even much longer.

Given the relatively few hours of daily practice (i.e. up to 4 hours per day in 71.42% of pianists for 7 days per week), it can be safely assumed that their body adapted to the movements of the repertoire practiced along an average of 27.57 years of performing-artist life. This, too, could determine the lower prevalence of PRMD.

Moreover, the expert pianists are relatively young (age average = 43.28; SD = 13.75). It is, however, possible, that in advanced age, due to the organism's degeneration, the threshold level of adaptation and modulation to outer factors would be lower, whereas PRMD might manifest higher prevalence due to the repertoire practice. As Bragge also reported, heightened prevalence of PRMD in senior pianists (Bragge et al., 2008) may be related to aging.

The questionnaires did not take into consideration the debut age of piano practice; nevertheless, considering that the pianists intensely performing are also soloists (42.85% of the pianists reporting over 40 de concerts per year), the debut age, meaning of the initiation into piano performance, is believed to have been relatively young.

Another factor to take into consideration for the lower incidence of repertoire-related PRMD in solo pianists can be the fact that musicians accept pain as a result of their work, or experience fear of reporting symptoms, worrying for consequences upon their careers (Ignatiadis et al., 2008). These aspects were also not investigated in this study.

21.42% of expert pianists who confirmed a relation between piano repertoire and PRMD symptoms is a significant percentage. Their symptoms are diverse (7.14% strong symptoms), as are the time periods between symptom onset and offset (35.71% days, 7.14% weeks or 7.14% over 3 months).

Initially, 42.86% of concert pianists had symptoms that prevented them from performing music; of these, only 21.42% consider the repertoire as a causative factor. Future research is needed in order to investigate other possible causal factors, mostly the impact of stress as a causative factor for PRMD. Performing over 40 concerts per year means psychological pressure and a high percentage of coffee intake (81.71%) may be a coping strategy for stage fright and performance anxiety with lasting metabolic effects.

The case of 48% of high-school pianists reporting repertoire-associated PRMD represents a significant issue. 16% of the expert pianists experienced high intensity of symptoms while 44% of the student pianists manifested similar, slightly weaker, or weak symptoms; however, the students did not see it as an issue. 36% of student pianists manifested symptoms while practicing Romantic repertoire, whether by itself or associated with other types of repertoire. The importance of the relation between PRMD and the Romantic repertoire when practiced by itself is noted in its high occurrence, respectively in 20% of the student pianists.

An epidemiological analysis of this data indicates the following risk factors: practicing/performing a uniquely Romantic repertoire (or uniquely Classical repertoire) yields a 1.51 times higher risk to cause PRMD symptoms than the repertoire containing various period styles. 34% of symptoms in high-school pianists are due to this risk factor that explains the low PRMD occurrence in expert pianists that perform a varied repertoire.

Such significantly worrying percentage in young pianists could also be due to faulty approach of the repertoire practiced, a misunderstanding of the Romantic piano technique as "[p]rofessional performing artists familiar with a musical composition will approach working schemes significantly differently from the beginners not familiar with the same composition" (King & Prior, 2016). The answers of the pianists in high-school could also be explained by the fact that high-school music curriculum does not particularly introduce modern or contemporary repertoire (Neculai, 2006). Nevertheless, could physical activity in soloist pianists act as a protective factor?

Physical inactivity – risk or protection factor?

Physical activity differs in the two target groups: 20% of the student pianists are involved in light physical activities 2-3 times per week, as compared to the much higher rate (42.85%) of the expert pianists.

Physical inactivity in students corroborates with the intense piano practice activity: 92% of the students practice 5-7 days per week, which unevenly solicits the musculoskeletal system, only specific muscular groups being activated at the expense of others. Besides practicing the stretching of muscles involved directly in piano playing, specific practice should be introduced in order to train the other muscular groups. 2009 Nobel Prize winner Elizabeth Blackburn asserted that the shortening of telomeres (i.e.

organism aging) relates to the stress experienced and, in a special way, manifests stronger in sedentary people (Corbyn, 2017).

Physical activity leads to an important bonus which is emotional stability (Klickstein, 2009). Richard Norris recommends that musicians should include a compound-type of gym routine such as activities for fortifying musculature, cardio-vascular activation and flexibility development drills (Norris, 1997).

Naturally, such routine should be moderate in order to prevent affection by micro trauma of the sarcomeres that would aggravate micro-inflammation and the perception of muscular pain (Despopoulos & Silbernagl, 2003). In conclusion, besides the varied piano repertoire, regular physical activity such as swimming, jogging and gym workouts for expert pianists can also act as a protective strategy against PRMD.

Location of symptoms over the prior 12 months

In a research run on 225 (10-16 years old) performing artists (64 pianists included), 60.4 % felt pain in the neck and 44.4% in the wrist (Nawrocka et al., 2014). In a study of Furuya et al., PRMD-related pain locations were as follows: in young pianists – fingers and hand whereas in senior pianists – thorax and neck (Furuya et al., 2006). The present study yielded similar results.

Locations of the more frequent symptoms, over the prior 12 months, in high-school students were: wrist and hand (16%), neck region (12%), shoulders (4%), knees (8%) and ankle wrist or foot (8). The expert pianists indicated the following locations for symptoms: shoulders (28.57%), supero-posterior thorax (cervical area, 7.14%), infero-posterior thorax (lumbar area, 7.14%), hand wrist or hand (7.14%) and the knee area (7.14%). A special note should be made of the presence of symptoms in the leg areas, specifically knees and ankles.

Physician Lockwood asserted that 79% of the adolescent performing-artists think pain occurrence to be normal while overcoming the technical difficulties in the compositions practiced (Klickstein, 2009). As 12% of the pianist students manifest chronic symptoms in a matter of 3 months of practice while 44% manifest symptoms already after practicing for a matter of days, the need for prevention strategies, prophylactic management and treatment becomes obvious.

Prophylactic management of PRMD in pianists

Musicians can prevent muscular injuries if they are informed about healthy habits and lifestyle. Musicians who are aware of their bodily movements adopt postures in which they preserve their balance, avoid excessive muscular tension, reason why their performance seems effortless (Klickstein, 2009). The expert pianists say they are fully aware of the specific moves needed for rendering musical sense for 71.42% of the practicing time, which can diminish PRMD in relation to the repertoire rehearsed, and be a protective factor against PRMD. Conversely, lack of bodily-motion awareness during piano study is a risk factor for high-school pianists (symptom risk is 1.1 times higher and 9.41% attributable to this factor).

Injury due to overexertion can be prevented and successfully treated in early stages by heightening awareness of problem recognition. The solution is offered by the

subjects themselves: 48% of the students and 57.14% of the expert pianists recommend, as a prophylactic method for their younger colleagues, that the piano techniques applied should consider all of the individual's anatomic and physiological aspects.

Prevention seems to have always been the best medicine (Norris, 1997). The need for information and counseling in order to prevent overexertion caused by musculoskeletal problems is also signaled in the second Moñino experiment (Moñino et al., 2017). Blackie et al. explain the high prevalence of PRMD in pianists (93%) as due to subjects not having or applying injury prevention education (Blackie et al., 1999). As a follow-up to this research, the authors advance the introduction, in the national curriculum, of courses in PRMD methods of prevention and treatment.

PRMD treatment management in the pianists' vision

This research indicates that the current treatment management of symptoms in arms is faulty in young subjects; to be more specific: 24% of the students self-medicate (4% of whom confess to using analgesic medication), 28% ticked *other*, 4% call a friend and only 12% go to see a qualified medical professional. 7.14% of the expert pianists (who believe that the symptoms are caused by their repertoire) self-treat, 7.14% are taking no initiative and 21.42% ask for medical care.

In the context of symptoms occurring in students, 4% of the pianists would use physiotherapy and 4% would use physical exercise as a management strategy. Students' attitude regarding piano practice during PRMD is worrying: 44% would keep practicing through their pain, the long-term consequences being the possible cessation of an artistic-performance career.

Prognosis is not more favorable for expert pianists. The question to all expert pianists was *what they would do if they felt discomfort in their arms*. Answers accounted for 35.71% that would keep practicing, 21.42% that would study less, and 21.42% that would stop practicing while 7.14% would use some relaxation technique such as yoga, meditation, and mental drills and 7.14% would take a physiotherapy treatment.

Continuous practice while in pain heightens the risk of additional injury due to overexertion of joints and compensatory muscles (Blackie et al., 1999). Further research may yield more data about the dangers of overexertion that would persuade pianists to change their practice habits.

FURTHER RESEARCH ON REPERTOIRE PERFORMED AND ITS EFFECT ON THE MUSCULOSKELETAL SYSTEM

If the results yielded by Study 2 were extrapolated to a 100.000 high-school pianists group, then 80.000 would be affected from a musculoskeletal standpoint. Even if such a scenario is not yet backed by factual data it is something to take into consideration given the current findings.

The piano repertoire practiced

The questionnaires regarding the repertoire and its effect upon pianist's musculoskeletal system could be supplemented with further questions.

In Blackie's study, the pianists evaluated their ability to meet repertoire requirements on a scale from 0 to 100 (Blackie et al., 1999). Introduction of similar questions would help the performing artists understand their risks in order to avoid feelings of failure and dissatisfaction that may result in non-observance of repertoire's requirements, thus increasing subjects' perception of pain (Watson, 2009).

The psychological impact of PRMD symptoms could also be subject of more investigation. High-school pianists may be in a situation in which they cannot chose their repertoire and practicing an unwanted or misunderstood repertoire can be a stress factor that affects the musculoskeletal system.

In the research literature, only one indication is found for further research targeting instrumental repertoire practiced and PRMD. In *Performing Arts Medicine in Clinical Practicing* (Bird, 2016) a need is found for the performing artists to note which composers and compositions cause musculoskeletal problems and why. Statistic correlations could thus be drawn in the future by associating numeric scales (e.g. 1-10) for each repertoire. Open questions would also help identify the composers specifically related with pain symptoms occurrence, and the answers to such questions would support a performing artist's choice of repertoire, furthermore singling out the difficult passages for each music period.

Introducing open questions (and drawing on the expected results) would help student pianists by boosting their insight regarding possible PRMD symptoms that can occur and prevent them using a method of choice such as more frequent study breaks or alternative repertoires.

Bird (Bird, 2016) mentions that the study of certain specific, short passages can be correlated with the appearance of PRMD symptoms but does not specify the amelioration and avoidance of PRMD by introducing pauses or by varying bodily movements resulting from the study of a different repertoire.

The concert repertoire practiced, besides the stage pressure associated with the performance itself, leads to various results in pianists' questionnaire answers pertaining to the relation between repertoire and PRMD: performance pressure may induce PRMD in a student pianist regardless of the repertoire being Classical or Baroque. There are significant differences between levels of performance anxiety associated with stage activities such as chamber music, accompaniment or solo recital; measuring these differences may allow for better quantification in terms of the relation between performance anxiety and PRMD.

Also, an electronic wall piano is a completely different type of mechanism for the pianist to perform on as compared to the classical piano. The switch from an electronic piano to a classical piano may predispose to overexertion injury (Bird, 2016). Thus, the repertoire practiced and PRMD should also be correlated with the instrument type that the pianist mainly practices on. Besides such new viewpoints, questionnaires could also bring in further insight.

How to compile a questionnaire?

The *DASH performing arts/sports module* questionnaire was validated for research on musicians. However, its drawbacks are the focus on arms only and unspecified pain intensity, (i.e. how intense was the pain if reported on a scale). *The Brief Pain Inventory* and *Chronic Pain Classification Scale* are two more questionnaires validated for research on musicians. One of the reasons why standard questionnaires are not in use is the high specificity of the results in individual musicians (Stanhope et al., 2019). Further drawbacks of other types of questionnaires (as in this research as well) is the choice of the useful data covered; hopefully the questionnaires of the future will consider such remarks, for better analysis of the relationship between the repertoire practiced and symptoms' occurrence.

Other questionnaire drawbacks are lack of discriminative terminology for the gamut of discomfort/pain not caused by other types of pathology as opposed to playing a musical instrument (Stanhope et al., 2019). The authors therefore advance the abbreviation AMSII ("afecțiuni musculo-scheletale cauzate de interpretarea instrumentală") for musculoskeletal affections caused by practicing/performing on a musical instrument as a Romanian equivalent for PRMD.

It would also be useful to introduce, besides the worded description of the symptomatic areas, the possibility to mark/tick the pain zones on especially-designed charts of the human body, as practiced elsewhere and mentioned in literature (Stanhope et al., 2019). Association of worded response with marks on a chart would prevent the lack of clarity which the researchers sometimes have to work with regarding the artists' understanding of the exact limits (like on a chart) of the anatomical segments believed to be symptomatic.

Even in the questionnaires currently in use there is a level of uncertainty noted, regarding the results; for instance, 4% of the pianists picked *other* for the location of the symptoms felt in arms. It will be also noted that anatomical terminology is little understood, a fact shown by the discrepancy between the indication of symptomatic areas felt during the prior 12 months (posterior thorax area not mentioned) and the symptomatic areas which prevented engaging in musical performance over the previous 12 months (posterior thorax area indicated). Location of symptoms could result in more accurate answers if correlated with a more accurate answer made possible by the use of charts and open-type questions, to which the pianist could answer textually.

It is quite interesting to note that left-hand dominant pianists are not found in the group of solo/expert pianists, possibly due to the fact that the years of practicing rendered such pianists ambidextrous, a hypothesis waiting validation while also making note of which piano repertoire led to such a result. The effects seen may be used for the recovery of patients having suffered from various pathologies (e.g. vascular brain accident) whom are able to improve their motor deficit by practicing an especially-designed piano repertoire. Further research could render more accurate the questionnaire's terminology by introducing the AMSII idiom in Romanian and body charts for the subjects to mark their symptoms' location on.

CONCLUSIONS

A group of 25 student pianists in national music high schools and colleges filled out a three-section questionnaire distributed online. The main target was to validate a possible relation between PRMD symptoms and the repertoire practiced and performed.

The results indicate that 48% of the students realize that there is a relation between their repertoire and the PRMD musculoskeletal symptoms they experience and 36% of the pianists feel that the symptoms are due to a very specific repertoire (Classical or Romantic). The modern/contemporary compositions in high-school pianist student's repertoire is not well represented and it can be an explanation of its absence in the student answers. Further research could examine more accurately the risk factors (at high-school level) for each music period repertoire and, also, the risks for highly difficult passages in the style of each music period.

Such results were compared with answers received on same questionnaire distributed to 14 worldwide reputed soloists/concert/expert pianists. Only 21.42% of the concert pianists believe that there is a relation between repertoire and PRMD symptoms' occurrence (Romantic repertoire 14.28%, particular pieces 7.14%, and high intensity and speed passages 7.14%). The lower PRMD rate may be attributable to the variety of repertoire performed by expert pianists. As a consequence, factors protecting against symptom occurrence could be the variation of repertoire performed and adopting an optimum life style that includes regular medium-intensity physical exercises leading to an optimal state of physical health. Worth noting is the fact that the pianists' artistic career did not exceed 30 years in this study while, in theory, the PRMD symptoms may possibly appear much more in older pianists.

To conclude with, negative effects of the piano repertoire are seen in young pianists and in pianists who play mostly a specific repertoire. The solutions could be the introduction of PRMD prophylaxis and management courses as soon as possible, which should impact pianists' approach principles to piano techniques in ways that are individually specific, as determined by each pianist's anatomy and physiological peculiarities.

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MUSIC STYLE - MUSCULOSKELETAL DISORDERS RELATIONSHIP ASSESSMENT QUESTIONNAIRE FOR PIANISTS

NAME : ..... I thereby declare my agreement to participate in the experiment run by Iulia Toma, Ph.D. Candidate in the Doctoral School of Music and Theatre from the West University of Timisoara. I also agree that the data gathered be used for research and the processing of data collected.

DATE: ..... Signature: .....

Sex: M / F
Nationality: .....
Age: .....years
Height: .....cm
Weight: ..... kg
Running years of concert activity, as a concert pianist: .....years

1. Professional status:
   - Concert pianist
   - Professor
   - Other: .....
2. Dominant hand is:
   - Right hand
   - Left hand
   - Both (ambidexterity)
3. Have ingested alcohol (more than 12 beer cans or 5 glasses of wine) in latest 5 days:
   - Yes
   - No
4. Have ingested drugs in latest 5 days:
   - Yes
   - No
5. Am under medication:
   - Yes (which medication? .....)
   - No
6. I regularly intake coffee / black tea / energizers:
   - Yes
   - No
7. I eat fruits and vegetables:
   - Daily
   - Several times / week
   - Several times / month
8. I sleep around 8 hours / night:
   - Yes
   - No (how many hours? .....)
9. I deem myself to be physically:

Inactive
I run light activities at least 4 hours / week
I regularly train at least 2-3 hours / week
I regularly physical training for sports competitions several times / week

10. The sports competitions I run cover more than 2-3 hours / week de:
Swimming
Tennis
Volleyball
Pilates
Other:
None

11. Have been hospitalized with musculoskeletal pathology:
Yes
No

12. Have felt discomfort / pain in latest 12 month in:
Neck
Shoulder
Elbow
Hand wrist / Hand
Supero-posterior thorax (cervical zone)
Infero-posterior thorax (lumbar zone)
Thighs
Knees
Leg joint / Leg
None of such problems

13. Have been hindered in latest 12 months as running my music activity by discomfort in:
Neck
Shoulder
Elbow
Hand wrist / Hand
Supero-posterior thorax (cervical zone)
Infero-posterior thorax (lumbar zone)
Thighs
Knees
Leg joint / Leg
None of such problems

14. My piano practice program / week runs for:
3-4 days
4-5 days
5-6 days
7 days
Other: .....

15. I practice in time interval:

Up to 12
After 12
Later than 19
Nights, after 22
Other: .....

16. Number of concerts held in a calendar year:
About 10 concerts
10-20 concerts
20-30 concerts
More than 40 concerts

17. Break time interval, after concert held, is:
Several hours
Several days
Several weeks
Several months
No break time interval

18. Concert repertoire I play is (style wise) predominantly:
Baroque
Classical
Romantic
Modern
Other: .....

19. I practice such repertoire / per day:
1-2 hours
3-4 hours
4-5 hours
6-7 hours
More than 8 hours

20. During practice I am aware of the specific moves needed to expression of musical sense:
Never
Sometimes
Always

21. During practice my most solicited anatomy segment is:
Fingers
Hand
Forearm
Elbow
Arm
Shoulder
Other: .....

22. Discomfort symptoms at musculoskeletal level of upper limb present:
Sometimes
Often

Never

23. Discomfort symptoms at musculoskeletal level of upper limb present in:
    - Upper limb joints
    - Fingers
    - Palm
    - Forearm
    - Arm
    - Shoulder
    - Other: .....
    - None of such symptoms

24. Have felt discomfort in upper limb especially when practicing a specific piano repertoire:
    - Yes
    - No

25. Music style responsible for discomfort felt in upper limbs muscles / bones is:
    - Baroque
    - Classical
    - Romantic
    - Modern
    - Other: .....
    - No discomfort at upper limbs level

26. Discomfort felt is describable as:
    - Pain
    - Restricted motion
    - Other: .....
    - No discomfort at upper limbs level

27. On a scale of 1 to 5 (1 = very weak, 5 = very strong), intensity of discomfort felt would be:
    - 1
    - 2
    - 3
    - 4
    - 5

28. Pain was:
    - Irradiant
    - Diffuse
    - Stabbing
    - Prikly
    - Aching
    - Cramping
    - Sharp
    - Intense

29. Time lapse in-between discomfort felt and gone is:
    - Several days

Several weeks
About 3 months
More than 3 months
None of such discomfort felt at upper limbs level

30. Discomfort felt limited my piano practicing / concert activity:
Yes
No
Never felt discomfort at upper limbs level

31. When I feel discomfort at upper limbs musculoskeletal level:
I call and expert physician
I try to treat myself
I call a friend
Other: .....
Never felt discomfort at upper limbs level

32. Under musculoskeletal discomfort at upper limbs, I tend to practice the piano:
On
Less
No more
No more and do sports
Under physiotherapy treatment
Under medication
Under relaxing techniques (Yoga, Mental training, Meditation)

33. The one prophylaxis method of musculoskeletal diseases I recommend to young pianists is:
Musculoskeletal relaxing courses
Upper limbs anatomy-physiology description courses
Adoption of a piano technique considering all of the anatomy-physiology individual aspects
No such method
Other: .....

*** What Is A Standard Drink? National Institute on Alcohol Abuse and Alcoholism Association. Pure alcohol standard dose = equivalent of 14 g pure alcohol is: mug of beer, glass of wine, shot of spirits. Accessed 10.05.2019 (URL: www.niaaa.nih.gov/alcohol-health/overview-alcohol-consumption/what-standard-drink).