

A Study on Performance-Related Musculoskeletal Disorders During Chinese Opera Training

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To cite this article:

Tai-Jui Wang, Chih-Long Lin, Rungtai Lin. A Study on Performance-Related Musculoskeletal Disorders During Chinese Opera Training. *Science Journal of Public Health*. Vol. 10, No. 1, 2022, pp. 43-59. doi: 10.11648/j.sjph.20221001.16

Received: January 8, 2022; **Accepted:** January 26, 2022; **Published:** February 9, 2022

Abstract: The goal of this research approach is to achieve training effectiveness as great as in olden times using modern methods of performance-related musculoskeletal disorders (PRMDs), mental models, and ergonomic analysis. The purpose of this study explored the situation of PRMDs among Chinese opera performers and assessed the severity, frequency, continuance, and locations of PRMDs. This study also identified the treatments used for PRMDs, contributing factors to PRMD development, and the perceptions of the Chinese opera community regarding PRMDs. This research used a questionnaire modified from the Nordic Musculoskeletal Questionnaire (NMQ). The questionnaire involved a total of 108 responses from 43 professionals and 65 students. For the nonparametric methods, independent-samples kruskal-wall is test, a one-way ANOVA (k samples), was used at multiple comparisons (all pairwise) significance level of .05. Chi-square tests were used to distinguish differences and relationships among the variables in self-report questionnaires between participants. Cross tabulations were applied to describe the univariate relationships among the items of independent and dependent variables for comparison of nominal and interval variables. For the parametric methods, the independent sample t-test was used at a two-tailed significance level of .05 for comparison of nominal and interval variables. One-way ANOVA and linear regression analysis was used to identify the relationship among variables and predicted factor between regions of the body with PRMDs and other self-report independent variables. The results indicate the most significant and frequent PRMD symptoms experienced after training and working for the nine body regions (neck: increased 41.7%, shoulders: increased 46.3%, upper back: increased 33.3%, elbows: increased 24.1%, wrists/hands: increased 50.0%, lower back/hips: increased 44.4%, thighs: increased 24.1%, knees: increased 52.8%, ankles/feet: increased 25.9%). According to our knowledge, this is the first research to examine the relationship among the self-reports severity and frequency of PRMDs in Chinese opera population. Therefore, the Chinese opera performing arts population requires more information regarding PRMDs for developing treatment and prevention strategies according to scientific methods. Hopefully, the PRMD-related problems from traditional Chinese opera training and work places reported in this study can be mitigated in the near future.

Keywords: Chinese Opera, Performance Training, Ergonomics, Performance Related Musculoskeletal Disorders, Subjective Discomfort Rating

1. Introduction

Chinese opera is a theatrical art in which music, song, dance, speech, and acrobatics are mixed to create a unique form of musical drama for centuries. Performance-related musculoskeletal disorders (PRMDs) might be a frequent occurrence for Chinese opera performers in training and

working. In Taiwan, Peking opera, Taiwanese opera, Hakka opera, and other varieties of traditional Chinese opera possess various aspects of acting training that might cause performers to be particularly susceptible to PRMDs. Several studies have examined PRMDs, and different data sources show that people in fields such as music, dance, martial arts, and sports are vulnerable. Most studies related to Chinese opera performances have described various musculoskeletal,

metabolic, and nutritional disorders that may considerably affect the health-related quality of life of dancers [1]. Hincapié, Morton, and Cassidy (2008) organized data from relevant evidence into tables related to the prevalence and associated factors, incidence and risk factors, diagnosis, treatment, economic costs, and prevention of musculoskeletal injuries and pain in dancers. In a 1995 study on wrist injuries in adolescent gymnasts of a Chinese opera school, radiographic surveys enabled researchers to conclude that chronic, repetitive stress in the wrists of adolescent gymnasts results in a localized growth disturbance of the distal radius with resultant ulnar-plus variance. Physical stress injuries may lead to permanent sequelae, even in asymptomatic individuals [2]. Moreover, for musicians, ignorance of the major implications of their activities is a critical factor to consider, and can lead to the avoidance of employing preventive measures that can cause health-related problems over time [3].

Currently, instructors personally demonstrate step-by-step the special techniques and stunts in Chinese opera performance. Such techniques are learned through long-term practice; however, forcing students into correct techniques while training by using physical punishments is evidently counter-productive and therefore impermissible. Moreover, in recent years, young students have begun to resent the hard work involved in the five types of disciplines in the Chinese opera training curriculum. They lack perseverance, and their physical skills are unsatisfactory, loose, and desultory; thus, complex routines have become increasingly scarce. When these sequences are not perfectly timed and tightly organized during execution, they fail to obtain appreciation from

audiences, causing the standard of Chinese opera to steadily decline. Therefore, achieving high-quality effectiveness and mitigating PRMD problems are critical. As has been found in multiple studies in different fields, psychosocial factors related to the training and working of Chinese Opera performers may indeed have an impact on them [4].

The goal of this research approach is to achieve training effectiveness as great as in olden times using modern methods of performance-related musculoskeletal disorders (PRMDs). But in the very beginning, how to achieve the effectiveness as great as in the old time? According to our research, no other PRMD studies have researched Chinese opera. Thus, for explaining made on the basis of limited evidence from Chinese opera field, and based on the methodology of most related studies to Chinese opera performances as a starting point for further investigation. The aim of this study was assuming on:

1. Some of these symptoms may develop or exaggerate due to psychosocial factors Chinese opera performers do not experience PRMDs frequently after training and working.
2. PRMDs do not occur in most body parts because of different roles and the types of discipline.
3. Chinese opera performers use proper treatments in the management of PRMDs.

Therefore, the purpose of this study explored the situation of PRMDs among Chinese opera performers and assessed the severity, frequency, continuance, and locations of PRMDs. This study also identified the treatments used for PRMDs, contributing factors to PRMD development, and the perceptions of the Chinese opera community regarding PRMDs.



Figure 1. The framework of the five types of disciplines in Chinese opera performance.

2. Training Background and Theoretical Framework

This study evaluated PRMD problems of professionals and students in traditional Chinese opera training and work places. Seven main factors (“five methods,” “roles,” “four skills,” “make-up,” “costumes,” “music,” “scenery and props”) contribute to the complex and stylized performance of Chinese opera. For specific training-related problems, the theoretical approach of this study focuses on only five of these seven main factors (“five methods,” “roles,” and “four skills,” “costumes,” and “props”), which are the foundational performing skills of Chinese opera. These skills concern the hands, eyes, head, feet, legs, and body, which present the movements of a Chinese opera performer’s physical capabilities (figure 1).

For the specific categories of the “roles”, there are four main roles categorized in sheng (the male roles), tan (the Female roles), ching (the Painted-face roles), and chou (the Clown roles). The male characters (sheng) can be divided into mature man, young man, and militant, according to age, position, and personality. The Female characters (tan) can be divided into old ladies, young ladies, young maidens, female warriors, and militant young maidens, according to age, position, and personality. The Painted-face characters (ching) are one of the most unique aspects of Chinese opera. They are the colorful use of face painting to indicate the personalities of the roles being portrayed. A red face indicates a loyal, honest, straightforward, and trustworthy character while a white face reflects cunning and scheming and scheming. Black denotes bravery and justice, and green signifies a violent and tough character. The Clown characters (chou) include “wen-chou” and “wu-chou.” “Wen-chou” clowns speak perfect Mandarin and are adept at satire. “Wu-chou” clowns are skilled in martial arts. All of the above occupational categories have each his own work and responsibilities, and their training requires various appropriate subject courses and teaching materials.

This paper focuses on three types of human-body-oriented disciplines that can be described as “basic exercises” (ji-ben-gong), “mat-work acrobatics” (tan-zi-gong), and “hand-prop martial routines” (ba-zi-gong); and two types of performing-prop-oriented disciplines that can be described as “costume exercises” (fu-shi-gong) and “prop exercises” (dao-ju-gong). They are all crucial foundations in the traditional Chinese opera curriculum. Performers must first master all such physical training attributes before they can perform stylized programs. This is because every movement in Chinese opera performance, whether major (e.g., martial sequences or tumbling acrobatics) or minor (e.g., the raise of a hand or flick of a foot), has a prescribed and highly specific style and program of execution. A performer cannot perform properly without the strictest and most precise training. Performers must also master all the performing-prop-oriented disciplines simultaneously. This is because every performer in Chinese opera must wear numerous, highly specific stylized

costumes and carry certain props depending on their role. Therefore, without the strictest and most precise training, actors cannot perform properly with their props.

2.1. Ji-ben-gong - Basic Exercises

According to the Dictionary of the Stagecraft of Traditional Chinese Drama [5], approximately eight series comprising a total 333 items are involved in the orientation of ji-ben-gong, which is the basic physical training required for the performance of Chinese opera. This training utilizes a performer’s entire body, where gesturing and acrobatics are defined precisely by tradition both in method and in symbolic choreography. Therefore, in expressive movements or gestures, relevant parts of the body must be rigorously and precisely trained to attain perfect stances and routines. For example, highly exact gestures of the head, neck, shoulders, chest, waist, legs, arms, hands, fingers, feet, eyes, mouth, etc., should be performed. These movements traditionally describe both the characters and their moods, and enhance the atmosphere of the scene. This is what the audience comes for. Thus, the first step toward an excellent performance is practicing these basic gestures and movements. This is the foundation for all types of performing factors, and each gesture or full movement must be performed with utmost exactitude. This is a vital part of the education for performers. The syllabus for ji-ben-gong basic training is scheduled in an 8-y curriculum comprising 16 terms progressing from simple to complex; additionally, basic training differs for male and female roles.

2.2. Tan-zi-gong - Mat-Work Acrobatics

According to the Dictionary of the Stagecraft of Traditional Chinese Drama [5], approximately six series comprising a total 183 items are involved in the orientation of tan-zi-gong. Mat-work acrobatics is practiced entirely on mats or a thick carpet, hence the name tan-zi (literally, “carpet”). Training includes somersaults, rolls, falls, leaps, and vaults, which are practiced on mats or carpets for protection, just as gymnastics training is performed on mats in the West. The varieties of such movements and their basic forms are rooted in fundamental movements. However, actors often develop myriad variations as a result of their particular physical endowments and hard work. Hence, mat-work acrobatics form a crucial component of the Chinese opera curriculum. Instructors must determine the physical type and ability of each student and instruct them accordingly. The instructor must further explain in detail the particular principles of each acrobatic movement. Thus, a systematic plan of training progress may be followed. A full recourse to theories and principles of physical exercise must be applied in the training process to realize the full potential of each student.

2.3. Ba-zi-gong - Hand-prop Martial Routines

According to the Dictionary of the Stagecraft of

Traditional Chinese Drama [5], approximately 12 series comprising a total 438 items are involved in the orientation of ba-zi-gong, which is the discipline of performing martial routines that involves hand props, weapons of various types, or “fighting” barehanded. Because the weapons are called dao-chiang-ba-zi in traditional Chinese opera, the term ba-zi-gong has been adopted for this course of training. The first step entails individual practice involving various types of weapons. This includes not only methods of deployment but also choreographed routines and stunts. The ensuing step is training in combat routines, involving two or more persons using hand props or weapons. There are differences in weapon types as well as in combat routines. Routines involving more than two persons are called dang-zi; thus, certain routines are known as si-gu-dang, liu-gu-dang, or ba-gu-dang. The combat routines of ba-zi-gong are numerous and extremely complex. These routines entail myriad variations with different weapons, as in sword (dao) versus sword, spear (qiang) versus spear, large sword (da-dao), double sword, single sword, long spear, double spear, hammer (chui), club (gun), two-pronged lance (gi), hook (gou), I-shaped reel (guai-zi), staff (guai), and hoop (quan). Each weapon has its own particular routines, and when two persons are in combat, they employ various sets of routines related to one of the seven main factors: “four skills” (singing, speaking, acting, and fighting). The discipline in “fighting” or martial routines is ba-zi-gong.

2.4. Fu-shi-gong - Costume Exercises

According to the Dictionary of the Stagecraft of Traditional Chinese Drama [5], approximately nine series comprising a total 171 items are involved in the orientation of fu-shi-gong. Costumes generally refer to what a performer wears on stage. They can be traced back to the mid-fourteenth century, and they have since changed gradually and continually. In general, a performer's costume primarily designates his or her role on the stage regardless of when or where the action takes place. The costume must distinguish the sex and status of a character at first glance. Concerning symbolism, Chinese opera costumes may be regarded as having the main function of distinguishing people from all professions: noble or humble, civil or military, and in or out of office.

2.5. Dao-ju-gong - Props Exercises

According to the Dictionary of the Stagecraft of Traditional Chinese Drama [5], approximately 18 series comprising a total 173 items are involved in the orientation of dao-ju-gong. Armaments are typically made of wood, rattan, or bamboo, except for certain swords, knives, and clubs. They are wrapped in cloth strips or painted gold on the blade or the top. When actors wave the armaments, the armaments appear to be real, thus creating a vivid performance. Another type of prop, the horsewhip, represents a horse. The audience can admire the posture of an actor riding on it like on a real horse. The audience is concerned

about what happens to the characters, not about whether the devices are real.

2.6. The Integrated Example of the Five Types of Disciplines

The integrated example has both the body-oriented and the performing-props oriented disciplines which the wu-dan role (one of the four main roles with martial arts) in a combat with other four performers (martial arts role) are presenting in the final of this section (figure 2). This example was conducted to identify the factors that how the wu-dan role control or manipulate such high-risk performances. So, in terms of the relationships among performers' body-oriented skills and performing-props oriented effectiveness, the female warrior character (wu-dan) deflecting tasseled spears with her foot in a battle, is not so simple as just putting one in hard training as people imagine. To summarize the observations from field study of performing and literature of this research, it implies that the performer's height, the length and weight of props, the distance in between performers, the jumping and flipping methods of the wu-dan role with other martial arts roles, the inclined projectile motion of throwing tasseled spears, and the probability of miss-throwing have a highly potential effect on the performance being successful or not. This seems to indicate the qualitative results that the factors reflect a highly positive attitude towards the techniques of body-oriented and props-oriented skills. However, in the absence of statistically signify results, no definite conclusion can be drawn that using modern methods of performance-related musculoskeletal disorders (PRMDs) is on the right track of research approach.

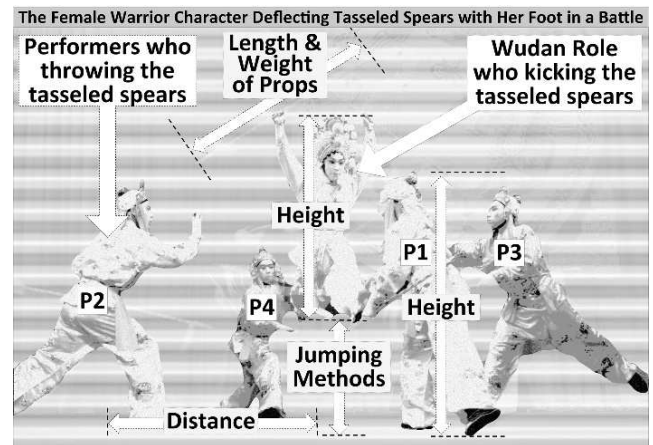


Figure 2. The wu-dan role deflecting tasseled spears with her foot in a battle.

3. Methods

3.1. Data Collection Measures

The number of Chinese opera performers in Taiwan is lower than that in China. According to our research, among four professional Chinese opera groups and one Chinese opera school in Taiwan, a total of 167 professionals and a total of

562 students are in this field. On an academic level, conducting any form of survey involves ethical consideration. In this study, protecting the information of the participants was paramount. The questionnaires underwent a proper ethical evaluation, and all data were collected in compliance with the ethics of data protection, anonymity, and confidentiality. According to the National Science Council of Taiwan, research project is permissible to proceed without any review by institutional ethics committee to those who is not minors, inmates, aboriginal, pregnant women, the disabled, the mentally ill and other improper coercion by free will or not be able to make those decisions for the study, and at public occasions the anonymous, non-interactive and not of interventional studies and information impossible to collect from the individual identification of the specific circumstances.

3.2. Procedure

For the participants of student group, the study was introduced to students in the classroom through brief presentations to class groups by the teacher and researcher. Participation information sheets were distributed to all eligible students for the completion of the questionnaires. And those who under 16 years old students, Chinese opera school is very different than other 12-grade schools in Taiwan. The students live in school five days a week for 8 years long-term training starting from 10 to 18 years old. Their parents signed the contract with school from the very beginning. So, for any purpose of educational activities, there is no need to ask parents' permission and proved by parents in advance. For the participants of professional groups, the study was introduced to them in their company through brief presentation by the researcher. Participation information sheets were distributed to all eligible professionals for the completion of the questionnaires. Thus, the teachers of the class and principal of Chinese opera school and the professional groups were properly informed by the researcher.

3.3. Participants

Initially, a total of 120 questionnaires were delivered to the target respondents, who were professionals from two of the four groups of students from the school of Chinese opera. Surveys were returned by 108 participants (43 professionals from two of four groups and 65 students from the Chinese opera school). A total of 20 males and 23 females were professionals, and 15 males and 50 females were students. Whether the participants were professionals or students, all of them had learned according to the same pedagogical system of the Chinese opera school in Taiwan.

3.4. Research Methods

The quantitative questionnaires adopted in this research were based on a modified version of the Nordic Musculoskeletal Questionnaire (NMQ) [6-8]. The questions regarded musculoskeletal aches and pains to assess the severity of PRMDs among nine body sites (neck, shoulders,

upper back, elbows, wrists/hands, lower back/hips, thighs, knees, and ankles/feet) during the training and performing of Chinese opera. The questionnaire involved a total of 108 responses. When the participants completed the fundamental data and work description portions of the questionnaires, binary choice (Y/N) questions were used to associate PRMDs with the nine body regions. The severity of each PRMD symptom was measured on a 10-point scale in the questionnaires. The respondents were asked to rate the most recent 3-mo occurrence of each PRMD symptom type. Data on the severity of PRMD symptoms must be treated with caution. The position of body parts subject to discomfort, the frequency of occurrence of each of the symptoms, and PRMDs in relation to working and training were determined to the distribution of PRMDs among Chinese opera performers. The NMQ has been extensively applied to various types of occupations in different industries, and can be adopted and modified in accordance with the characteristics of such industries [9-10].

The performer health questionnaire contains four items that were used as evaluation factors among the participants: a) personal data information (sex, age, height, weight, main working/training activity, starting age of Chinese opera performance activity, exercise routine), b) performance activity participation (public performances, career satisfaction, goal achievement, resting time before performance, exercise, diet, prevention exercises, practice hours per day, practice months per year, practice days per week, relaxation techniques), c) musculoskeletal problems (neck, shoulders, upper back, elbows, wrists/hands, lower back/hips, thighs, knees, and ankles/feet), and d) therapeutic treatment (ignored the disorders, using a pain patch, healed by themselves, wore protective equipment, Chinese massage, and conventional medicine). Some questions were more effective for gathering information for thematic analysis than others. As in item B of the questionnaires, the participants provided not only the numeric data but also the text of the question that explained more specifically.

3.5. Data Analysis

Furthermore, an electronic data analysis program was used to facilitate analysis. The main program used was SPSS 18 because of its versatility in statistical analysis. SPSS is a proven fundamental analysis program that numerous researchers have used successfully. Moreover, thematic analysis, which is one of the most direct methods for textual analysis that can be applied to a range of media and cultural artifacts, was applied for analyzing the content [11]. The substantial amount of text from questionnaires can be time consuming to analyze. However, thematic analysis can identify, analyze, and report themes from the data, which were analyzed using NVivo Version 11 software. After qualitative analysis, transforming numerical data on psychosocial and physiological factors for supporting quantitative analysis is an effective method for collecting empirical evidence. The thematic analysis categorized certain topics from the item B of the questionnaires such as burdens of costume and props, time

consuming acting, self-actualization, others' expectations, interpersonal problems, and training problems. All these topics were transformed into psychosocial and physiological factors.

The prevalence of PRMDs in each body region is determined the items of independent and dependent variables are in below:

- A. Independent variables (Nominal): 1) the groups of students and professionals, 2) sex, 3) role types (four main roles, four main roles with martial arts, martial arts role, supporting role, musician, and wardrobe), 4) years of experience, 5) physiological factors (burdens of costume, burdens of props, and time consuming acting), 6) the three types of human-body-oriented disciplines, 7) psychosocial factors (self-actualization, others' expectations, interpersonal problems, and training problems), 8) choice of treatments (ignored the disorders, healed by themselves, using a pain patch, wore protective equipment, conventional medicine, Chinese massage), 9) before and after phases of working and training (nine body regions), 10) leave of absence.
- B. Dependent variables (Interval): 1) the level of lassitude (measured on a 10-point scale), 2) the continuance of symptoms (nine body regions measured on "no symptoms", "within a day", "within a week", "more than a week and within a month", and "more than a month"), 3) the frequency of PRMDs for pain, stabbing, and tingling (nine body regions measured on "no symptoms", "more than five times a week", "three times a week", "once a week", "three times within three months", and "once within three months"), and 4) the severity of PRMDs (nine body regions measured on a 10-point scale).

For the nonparametric methods, independent-samples kruskal-wallis test, a one-way ANOVA (k samples), was used at multiple comparisons (all pairwise) significance level of .05. This hypothesis test was applied to summarize the distributions of the severity of PRMDs on nine body regions were the same across categories of those independent variables. Chi-square tests were used to distinguish differences and relationships among the variables in self-report questionnaires between participants. Differences were evaluated using chi-square tests at a two-tailed significance level of .05. Cross tabulations were applied to describe the univariate relationships among the items of independent and dependent variables.

For the parametric methods, the independent sample t-test was used at a two-tailed significance level of .05 for comparison of nominal and interval variables such as role types, and the three types of human-body-oriented disciplines. One-way ANOVA and linear regression analysis was used to identify the relationship among variables and predicted factor between regions of the body with PRMDs and other self-report independent variables. In addition, two of dependent variables, the continuance of symptoms and the frequency of PRMDs, were also selected into the equation of regression analysis at a stepwise method (Criteria:

probability of F to enter $\leq .050$; probability of F to remove $\geq .100$).

4. Results

A total of 108 participants represented approximately 167 professionals (participation rate = 25.7%) and 562 students (participation rate = 11.6%) from the total population of Chinese opera performers in Taiwan. In the professional group, the average age was 32 (± 14) y, the average height was 163.9 (± 13.5) cm, and the average weight was 60 (± 19.7) kg. The average experience of each professional was 19.2 (± 6) y. In the student group, the average age was 17.8 (± 3.5), the average height was 161.9 (± 15) cm, and the average weight was 54.3 (± 24.5) kg. The average experience of each student was 6.5 (± 4) y.

4.1. In Which Body Parts Pain Occurs More Severity and Frequently

For the results of nonparametric methods, independent-samples kruskal-wallis test were first used that shown in table 1. This hypothesis test summarized the severity and frequency of PRMDs on nine body regions with those independent variables. As shown in table 2, chi-square tests and cross tabulations were used to distinguish differences and relationships among the variables. The participants reported higher occurrences of PRMDs after working and training each of the nine body parts. The evidence invalidates the hypothesis that the Chinese opera performers did not experience PRMDs frequently after training and working. The test revealed a highly significant relationship for the phases after working and training between the frequency of reported pain and its severity on the nine body regions (neck: increased 41.7%, shoulders: increased 46.3%, upper back: increased 33.3%, elbows: increased 24.1%, wrists/hands: increased 50.0%, lower back/hips: increased 44.4%, thighs: increased 24.1%, knees: increased 52.8%, ankles/feet: increased 25.9%).

For the methods of nonparametric statistic, the items of independent and dependent variables shown some significant results as in the table 1. Although this evidence is highly significant, additional findings revealed significant results regarding the frequency and severity of PRMDs. Another statistic of parametric methods, the independent sample t-test was analyzed among variables for supporting the results of nonparametric methods. As shown in table 3, the occurrences of PRMD of the groups of students and professionals and the before and after phases of training and working have been assessed. From the most of result, there were not much different significant shown to nonparametric statistic. However, the result on that the frequency of PRMDs for pain, stabbing, and tingling on the lower back/hips shown a significant evidence was because the prevalence of student group worse than professionals.

Moreover, a parametric method which the linear regression analysis was then run on the factor scores and used to test the hypothesis that the severity of PRMDs pain

could be predicted by the independent variables. Statistics were based only on cases for which before and after phases of working and training as a selected variable. Tables 5 and 6 summarizes the results which the independent and dependent variables using a stepwise method entered into the regression analysis. There were no variables entered into the equation while in the case of after phase on shoulders and thighs. The ANOVA F statistic was highly significant on nine regions of body between the phases of before and after. Therefore, the model's ability to explain the variation in the severity of PRMD pain caused by some of the independent variables.

4.2. Which Roles and the Types of Discipline Experience Pain Most

For the six roles, the results of nonparametric methods shown no strong relationships between the PRMDs overall. Only the results for the neck, shoulders, elbows, and ankles/feet were statistically significant according to the chi-square tests (neck: $N=68$, 63.0%; $\chi^2=68.392$; $p=.014$; shoulders: $N=72$, 66.7%; $\chi^2=89.106$; $p=.000$; elbows: $N=36$, 33.3%; $\chi^2=75.689$; $p=.003$; ankles/feet: $N=45$, 41.7%; $\chi^2=80.304$; $p=.001$). Although this evidence above is significant, additional findings revealed significant results both in the frequency of PRMDs and the continuity of PRMDs for 1 d, 1 to 7 d, more than 1 wk, and more than 1 mo. The participants reported on knees showed a significant result ($\chi^2=32.629$; $p=.037$; $SE=.086$), and on ankles/feet showed a significant result ($\chi^2=62.222$; $p=.000$; $SE=.075$). The level of lassitude reported by participants which categorized among six roles revealed no significant result ($\chi^2=45.448$; $p=.111$; $SE=.104$).

Moreover, for the methods of parametric statistic, the independent sample t-test was analyzed among variables for supporting the results of nonparametric methods. As shown in table 4, the occurrences of PRMD of the four main roles with martial arts vs. martial arts role and musician vs. martial arts role have been assessed. From the most of result, there were significant shown on neck, lower back/hip, knees, and ankles/feet. However, the result on that the severity and frequency of PRMDs was evidently because the prevalence of the martial arts role worse than the other five types of role category.

Additional findings revealed no significant results regarding the severity of PRMDs with role types and the types of discipline. One-way ANOVA was analyzed among the disciplines of training on neck ($F=2.272$, $p=.108$), shoulders ($F=.835$, $p=.437$), upper back ($F=.188$, $p=.829$), elbows

($F=.780$, $p=.461$), wrists/hands ($F=2.129$, $p=.124$), lower back/hips ($F=2.316$, $p=.104$), thighs ($F=3.032$, $p=.052$), knees ($F=.143$, $p=.867$), ankles/feet ($F=1.430$, $p=.244$). But the corresponding analysis of those three types of disciplines with post hoc test (LSD) multiple comparisons, where appropriate, were used to identify subgroup differences. There was only a significant result on neck for comparisons ("mat-work acrobatics" (tan-zi-gong) – "basic exercises" (ji-ben-gong): mean difference=1.305*, $p=.037$; "basic exercises" (ji-ben-gong) – "mat-work acrobatics" (tan-zi-gong): mean difference=-1.305*, $p=.037$). Therefore, the result on that the severity and frequency of PRMDs was evidently because the prevalence of "mat-work acrobatics" (tan-zi-gong) worse than "basic exercises" (ji-ben-gong) in the category of three types of human-body-oriented disciplines.

4.3. Which Are the Preferred Treatment Approached Used by the Responders

As shown in table 7, there is little evidence to validate the hypothesis that Chinese opera performers use proper treatments in the management of PRMDs. Statistics were based only on the cases for the groups of students and professionals as a selected variable. Table 7 summarizes the results which the variables using a stepwise method entered into the regression analysis. There were no variables entered into the equation while in some cases calculated the nine body regions. The ANOVA F statistic was significant only on the group of students' neck, upper back, elbows, and ankles/feet; and was significant on the groups' wrists/hands, lower back/hips, and thighs both students and professionals. Therefore, the model's ability to explain the severity of PRMD pain associated with the choice of treatments used by both students and professionals only the "conventional medicine" shown no significant result.

In addition to the evidence that was found between students and professionals, an awkward issue is that the professionals seem preferring choose to ignore the disorders on wrists/hands and lower back/hips. For the mentioned treatments for managing PRMDs, students preferred to take Chinese massage on neck, upper back, and lower back/hips, and a significant on wore protective equipment for their wrists/hands. There was a choose by student groups that they healed by themselves on elbows. And final agreement between students and professionals on thighs, both of groups that use pain patch were significant.

Table 1. Hypothesis test summary (Independent-Samples Kruskal-Wallis Test).

The severity of PRMD on	The groups		Sex		Role types		years of experience		Physiological factors	
	Sig.	Decision	Sig.	Decision	Sig.	Decision	Sig.	Decision	Sig.	Decision
neck	.000	X	.279	O	.016	X	.205	O	.945	O
shoulders	.006	X	.155	O	.440	O	.369	O	.539	O
upper back	.057	O	.873	O	.467	O	.342	O	.649	O
elbows	.790	O	.203	O	.465	O	.288	O	.893	O
wrists/hands	.001	X	.073	O	.213	O	.405	O	.549	O
lower back/hips	.327	O	.788	O	.031	X	.186	O	.236	O
thighs	.918	O	.510	O	.166	O	.529	O	.835	O
knees	.348	O	.012	X	.113	O	.606	O	.886	O
ankles / feet	.747	O	.060	O	.035	X	.597	O	.897	O

The frequency of PRMD on	The groups		Sex		Role types		years of experience		Physiological factors	
	Sig.	Decision	Sig.	Decision	Sig.	Decision	Sig.	Decision	Sig.	Decision
neck	.024	X	.409	O	.361	O	.660	O	.709	O
shoulders	.143	O	.374	O	.873	O	.628	O	.861	O
upper back	.233	O	.339	O	.685	O	.199	O	.642	O
elbows	.887	O	.279	O	.564	O	.118	O	.884	O
wrists/hands	.019	X	.853	O	.717	O	.516	O	.354	O
lower back/hips	.027	X	.493	O	.041	X	.201	O	.623	O
thighs	.740	O	.752	O	.124	O	.103	O	.303	O
knees	.867	O	.769	O	.686	O	.648	O	.316	O
ankles / feet	.980	O	.149	O	.042	X	.438	O	.517	O

Asymptotic significances are displayed. The significance level is .05.

Decision: O=Retain; X=Reject.

Table 1. Continued.

The severity of PRMD on	Three type disciplines		Psychosocial factors		Before and after phases		Leave of absence	
	Sig.	Decision	Sig.	Decision	Sig.	Decision	Sig.	Decision
neck	.107	O	.374	O	.141	O	.026	X
shoulders	.525	O	.869	O	.308	O	.009	X
upper back	.859	O	.256	O	.000	X	.017	X
elbows	.580	O	.076	O	.000	X	.001	X
wrists/hands	.168	O	.763	O	.045	X	.006	X
lower back/hips	.101	O	.143	O	.033	X	.000	X
thighs	.027	X	.834	O	.000	X	.002	X
knees	.828	O	.497	O	.106	O	.000	X
ankles / feet	.252	O	.803	O	.000	X	.000	X

The frequency of PRMD on	Three type disciplines		Psychosocial factors		Before and after phases		Leave of absence	
	Sig.	Decision	Sig.	Decision	Sig.	Decision	Sig.	Decision
neck	.122	O	.661	O	.000	X	.147	O
shoulders	.987	O	.840	O	.000	X	.392	O
upper back	1.00	O	.064	O	.000	X	.086	O
elbows	.871	O	.486	O	.000	X	.011	X
wrists/hands	.219	O	.622	O	.057	O	.081	O
lower back/hips	.525	O	.023	X	.000	X	.132	O
thighs	.022	X	.610	O	.000	X	.026	X
knees	.419	O	.216	O	.004	X	.061	O
ankles / feet	.394	O	.279	O	.000	X	.000	X

Asymptotic significances are displayed. The significance level is .05.

Decision: O=Retain; X=Reject.

Table 2. The severity of PRMDs: before and after phases of working and training.

The severity of PRMDs in before (B) and after (A) phases of training and working		The 10-point scale of pain (1=Discomfort ~ 10=Intolerable)											Total of pain increased in after phases
		No pain	1	2	3	4	5	6	7	8	9	10	
neck***	B	78.7%	.0	5.6	7.4	3.7	.9	1.9	.9	.0	.9	.0	21.3%
$\chi^2=48.001$; $p=.000$; $SE=.073$	A	37.0%	.9	.0	5.6	10.2	7.4	6.5	2.8	7.4	.9	.0	41.7%
shoulders***	B	79.6%	.0	.9	2.8	10.2	3.7	1.9	.9	.0	.0	.0	20.4%
$\chi^2=38.302$; $p=.000$; $SE=.060$	A	33.3%	1.9	1.9	.9	6.5	13.0	7.4	8.3	2.8	3.7	.0	46.3%
upper back***	B	89.8%	.0	.9	1.9	.0	.9	.0	4.6	.9	.9	.0	10.2%
$\chi^2=34.659$; $p=.000$; $SE=.085$	A	56.5%	.9	3.7	3.7	2.8	9.3	5.6	4.6	1.9	.9	.0	33.3%
elbows***	B	90.7%	.9	2.8	2.8	.0	.0	.9	.9	.9	.0	.0	9.3%
$\chi^2=58.805$; $p=.000$; $SE=.092$	A	66.7%	.9	.0	2.8	5.6	6.5	1.9	1.9	3.7	.9	.0	24.1%
wrists / hands*	B	82.4%	.0	.0	4.6	5.6	1.9	1.9	1.9	.9	.9	.0	17.6%
$\chi^2=20.995$; $p=.021$; $SE=.069$	A	32.4%	.9	2.8	5.6	9.3	8.3	5.6	13.0	.9	2.8	.9	50.0%
lower back / hips***	B	84.3%	.0	2.8	.0	3.7	.9	3.7	2.8	.9	.9	.0	15.7%
$\chi^2=37.222$; $p=.000$; $SE=.070$	A	39.8%	.0	.9	.9	1.9	7.4	13.9	10.2	8.3	.0	.9	44.4%
thighs***	B	88.9%	.0	.9	.9	2.8	3.7	.9	1.9	.0	.0	.0	11.1%
$\chi^2=43.875$; $p=.000$; $SE=.077$	A	64.8%	1.9	.9	2.8	2.8	1.9	2.8	5.6	2.8	1.9	.9	24.1%
knees***	B	87.0%	.9	3.7	.0	1.9	2.8	.0	.0	1.9	1.9	.0	13.0%
$\chi^2=36.546$; $p=.000$; $SE=.086$	A	34.3%	.9	.9	3.7	12.0	11.1	6.5	8.3	4.6	2.8	1.9	52.8%
ankles / feet***	B	84.3%	.0	.9	.0	1.9	2.8	3.7	2.8	.9	1.9	.9	15.7%
$\chi^2=45.187$; $p=.000$; $SE=.074$	A	58.3%	.0	.0	2.8	.9	4.6	2.8	5.6	6.5	2.8	.0	25.9%

Statistical analysis chi-square tests for the severity of PRMDs: before and after phases of working and training

p = two-tailed significance ($p < .05 = *$, $p < .01 = **$, $p < .001 = ***$), SE = standard error.

Table 3. Summary of independent samples t-test (the severity and frequency of PRMDs).

The severity of PRMD on	the groups of students (S) and professionals (P)								before (B) and after (A) phases of training and working							
	Mean (S)	Mean (P)	F	t	df	p	Lower	Upper	Mean (B)	Mean (A)	F	t	df	p	Lower	Upper
Neck	2.06	4.42	2.591	-4.685	106	.000	-3.354	-1.360	2.81	3.70	20.132	-1.771	57.797	.082	-1.883	.115
Shoulders	2.88	4.30	.902	-2.607	106	.010	-2.509	-.341	3.23	4.27	60.343	-2.521	94.789	.013	-1.859	-.221
upper back	1.80	2.95	13.225	-1.936	73.220	.057	-2.341	.034	1.85	5.91	.996	-4.823	106	.000	-5.734	-2.393
elbows	1.69	1.47	.614	.445	106	.658	-.786	1.240	1.39	3.70	.020	-2.772	106	.007	-3.966	-.658
wrists/hands	2.71	4.77	1.458	-3.783	106	.000	-3.139	-.980	3.25	4.84	13.667	-3.003	42.632	.004	-2.666	-.524
lower back/hips	3.89	3.21	.970	1.074	106	.285	-.578	1.944	3.32	5.24	30.401	-3.097	33.121	.004	-3.176	-.658
thighs	1.94	1.81	.530	.218	106	.828	-1.009	1.258	1.53	4.75	5.109	-6.226	22.735	.000	-4.289	-2.149
knees	3.35	3.88	.039	-.861	106	.391	-1.750	.690	3.39	4.71	1.449	-1.482	106	.141	-3.087	.446
ankles / feet	2.54	2.84	1.533	-.447	106	.656	-1.623	1.026	1.99	6.24	9.009	-7.111	32.321	.000	-5.462	-3.030

The frequency of PRMD on	the groups of students (S) and professionals (P)								before (B) and after (A) phases of training and working							
	Mean (S)	Mean (P)	F	t	df	p	Lower	Upper	Mean (B)	Mean (A)	F	t	df	p	Lower	Upper
neck	1.75	2.56	7.434	-2.349	101.128	.021	-1.483	-.125	1.59	3.87	20.784	-8.091	60.088	.000	-2.845	-1.717
shoulders	2.00	2.53	5.175	-1.492	98.761	.139	-1.246	.176	1.87	3.55	13.665	-5.157	51.837	.000	-2.325	-1.022
upper back	1.35	1.77	.328	-1.116	106	.267	-1.148	.321	1.30	3.45	14.620	-6.942	24.023	.000	-2.796	-1.515
elbows	1.17	1.14	.013	.084	106	.933	-.673	.732	.86	4.10	3.172	-6.375	106	.000	-4.251	-2.234
wrists/hands	1.85	2.70	10.767	-2.550	102.850	.012	-1.514	-.189	2.03	2.89	13.691	-2.658	44.980	.011	-1.513	-.209
lower back/hips	2.12	1.35	4.779	2.400	101.533	.018	.134	1.414	1.49	3.53	2.882	-4.853	106	.000	-2.866	-1.204
thighs	1.18	1.30	.118	-.317	106	.752	-.854	.619	.88	4.08	.486	-6.573	106	.000	-4.176	-2.241
knees	2.28	2.19	11.011	.238	99.848	.813	-.667	.849	2.02	3.71	18.325	-4.593	27.142	.000	-2.449	-.937
ankles / feet	1.32	1.33	.014	-.007	106	.994	-.706	.701	.97	3.24	.980	-5.360	106	.000	-3.107	-1.429

Statistical independent samples t-test for the severity and frequency of PRMDs: the groups of students and professionals; before and after phases of working and training

p = two-tailed significance (p < .05=*, p < .01=**, p < .001=***).

Table 4. Summary of independent samples t-test (the severity and frequency of PRMDs).

The severity of PRMD on	four main roles with martial arts (A) vs. martial arts role (B)								martial arts role (B) vs. musician (C)							
	Mean (A)	Mean (B)	F	t	df	p	Lower	Upper	Mean (B)	Mean (C)	F	t	df	p	Lower	Upper
Neck	2.15	6.71	.443	-4.434	60	.000	-6.102	-2.308	6.71	3.50	1.232	2.317	13	.037	.217	6.212
Shoulders	3.42	5.43	.962	-1.831	60	.072	-4.206	.186	5.43	2.63	.734	1.866	13	.085	-.443	6.050
upper back	2.04	4.14	1.111	-1.843	60	.070	-4.393	.180	4.14	2.00	.001	1.163	13	.266	-1.839	6.124
elbows	1.62	1.57	1.567	.048	60	.962	-1.894	1.987	1.57	.88	.215	.781	13	.449	-1.230	2.623
wrists/hands	3.20	4.57	.480	-1.226	60	.225	-3.610	.867	4.57	5.88	.000	-.934	13	.367	-4.320	1.712
lower back/hips	4.00	5.00	2.296	-.799	60	.428	-3.504	1.504	5.00	.63	1.315	3.700	13	.003	1.820	6.930
thighs	2.33	2.14	1.002	.151	60	.880	-2.257	2.626	2.14	.00	22.489	2.121	6.000	.078	-.329	4.615
knees	3.85	5.71	6.600	-2.492	13.391	.027	-3.467	-.252	5.71	1.50	1.726	4.017	13	.001	1.948	6.481
ankles / feet	2.85	5.86	2.679	-2.201	60	.032	-5.732	-.273	5.86	.00	11.702	4.642	6.000	.004	2.770	8.944

The frequency of PRMD on	four main roles with martial arts (A) vs. martial arts role (B)								martial arts role (B) vs. musician (C)							
	Mean (A)	Mean (B)	F	t	df	p	Lower	Upper	Mean (B)	Mean (C)	F	t	df	p	Lower	Upper
neck	2.11	2.71	4.521	-1.039	9.262	.325	-1.917	.707	2.71	3.00	.703	-.325	13	.750	-2.183	1.611
shoulders	2.25	2.43	1.196	-.228	60	.820	-1.698	1.350	2.43	2.38	.963	.054	13	.958	-2.086	2.193
upper back	1.38	2.29	.473	-1.209	60	.232	-2.400	.592	2.29	1.13	.160	1.118	13	.284	-1.082	3.403
elbows	1.15	2.29	1.980	-1.596	60	.116	-2.570	.289	2.29	1.25	.025	.869	13	.401	-1.539	3.610
wrists/hands	2.04	2.14	2.681	-.147	60	.884	-1.560	1.347	2.14	2.75	.003	-.895	13	.387	-2.073	.859
lower back/hips	2.16	1.71	7.897	1.037	12.370	.319	-.491	1.390	1.71	.38	.011	2.558	13	.024	.208	2.470
thighs	1.47	1.86	.260	-.474	60	.637	-2.005	1.236	1.86	.00	17.274	2.414	6.000	.052	-.025	3.740
knees	2.36	2.71	5.385	-.597	9.573	.564	-1.667	.966	2.71	1.38	1.767	1.452	13	.170	-.654	3.332
ankles / feet	1.38	2.14	2.455	-1.072	60	.288	-2.181	.659	2.14	.00	10.989	3.873	6.000	.008	.789	3.497

Statistical independent samples t-test for the severity and frequency of PRMDs: role types (four main roles with martial arts vs. martial arts role; martial arts role vs. musician)

p = two-tailed significance (p < .05=*, p < .01=**, p < .001=***).

Table 5. Regression analysis models: the cases for the before and after phases of training and working associated with the severity of PRMDs.

Predictors (Before phase)	neck				Shoulders				upper back			
	B	SE	Beta(β)	t	B	SE	Beta(β)	t	B	SE	Beta(β)	t
The groups	.985	.306	.163	3.217**	EV	EV	.031	.661 ns.	.518	.245	.094	2.115*
Sex	EV	EV	-.030	-.627 ns.	EV	EV	-.016	-.364 ns.	EV	EV	-.067	-1.459 ns.
Role types	-.263	.118	-.106	-2.236*	EV	EV	-.005	-.125 ns.	EV	EV	.024	.512 ns.
years of experience	EV	EV	-.042	-.594 ns.	EV	EV	-.014	-.311 ns.	EV	EV	-.104	-1.613 ns.
Three type disciplines	EV	EV	-.049	-.967 ns.	EV	EV	.053	1.230 ns.	EV	EV	.001	.021 ns.
Physiological factors	EV	EV	.020	.444 ns.	EV	EV	-.005	-.105 ns.	EV	EV	.028	.606 ns.
Psychosocial factors	EV	EV	-.013	-.277 ns.	EV	EV	.007	.149 ns.	EV	EV	.020	.409 ns.
continuance of symptoms	1.544	.132	.714	11.713***	1.671	.109	.778	15.268***	1.717	.149	.765	11.491***
The frequency of PRMDs	.282	.102	.162	2.764**	EV	EV	.079	1.464 ns.	.208	.097	.143	2.147*
Model summary and ANOVA	R= .919; R ² = .844; Adjusted R ² = .834; F=85.411***; ns. p>.05; *** p<.001				R= .920; R ² = .846; Adjusted R ² = .843; F=228.759***; ns. p>.05; *** p<.001				R= .906; R ² = .821; Adjusted R ² = .813; F=105.418***; ns. p>.05; *** p<.001			

Predictors (after phase)	neck				Shoulders				upper back			
	B	SE	Beta(β)	t	B	SE	Beta(β)	t	B	SE	Beta(β)	t
The groups	EV	EV	.016	.137 ns.					4.250	.656	.965	6.484***
Sex	EV	EV	.006	.054 ns.					EV	EV	-.122	-.802 ns.
Role types	.924	.248	.433	3.721**					EV	EV	-.058	-.390 ns.
years of experience	EV	EV	-.067	.620 ns.					EV	EV	.060	.337 ns.
Three type disciplines	EV	EV	-.016	-.137 ns.					EV	EV	-.063	-.368 ns.
Physiological factors	EV	EV	-.040	-.343 ns.					EV	EV	-.096	-.650 ns.
Psychosocial factors	EV	EV	.143	1.247 ns.					EV	EV	.127	.769 ns.
continuance of symptoms	EV	EV	-.141	-1.122 ns.					EV	EV	.049	.294 ns.
The frequency of PRMDs	EV	EV	-.071	-.610 ns.					EV	EV	-.067	-.403 ns.
Model summary and ANOVA	R= .859; R ² = .738; Adjusted R ² = .712; F=28.194***; ns. p>.05; *** p<.001				No variables were entered into the equation.				R= .919; R ² = .844; Adjusted R ² = .805; F=21.653***; ns. p>.05; *** p<.001			

EV=Excluded Variables from the predictors in the model.

Table 5. Continue.

Predictors (Before phase)	elbows				wrists/hands			
	B	SE	Beta(β)	t	B	SE	Beta(β)	t
The groups	EV	EV	-.042	-1.061 ns.	EV	EV	.056	1.024 ns.
Sex	EV	EV	.046	1.140 ns.	EV	EV	-.098	-1.942 ns.
Role types	EV	EV	-.078	-1.864 ns.	EV	EV	-.015	-.291 ns.
years of experience	EV	EV	.011	.265 ns.	EV	EV	.006	.114 ns.
Three type disciplines	EV	EV	.035	.883 ns.	EV	EV	-.008	-.150 ns.
Physiological factors	EV	EV	-.026	-.653 ns.	EV	EV	.080	1.588 ns.
Psychosocial factors	EV	EV	.001	.027 ns.	EV	EV	.033	.649 ns.
continuance of symptoms	1.150	.164	.498	7.001***	1.208	.174	.539	6.923***
The frequency of PRMDs	.361	.100	.225	3.598**	.322	.097	.202	3.312**
Model summary and ANOVA	R= .924; R ² = .853; Adjusted R ² = .848; F=181.879***; ns. p>.05; *** p<.001				R= .885; R ² = .782; Adjusted R ² = .775; F=101.853***; ns. p>.05; *** p<.001			

Predictors (after phase)	elbows				wrists/hands			
	B	SE	Beta(β)	t	B	SE	Beta(β)	t
The groups	EV	EV	-.230	-1.329 ns.	EV	EV	.309	1.545 ns.
Sex	EV	EV	-.067	-.361 ns.	EV	EV	.063	.292 ns.
Role types	EV	EV	.004	.023 ns.	EV	EV	.270	1.310 ns.
years of experience	EV	EV	-.271	-1.709 ns.	EV	EV	.092	.405 ns.
Three type disciplines	EV	EV	-.225	-1.064 ns.	EV	EV	.411	2.091 ns.
Physiological factors	EV	EV	.096	.520 ns.	EV	EV	.040	.163 ns.
Psychosocial factors	EV	EV	.300	1.622 ns.	EV	EV	.173	.822 ns.
continuance of symptoms	1.970	.399	.868	4.933**	.927	.375	.514	2.471*
The frequency of PRMDs	EV	EV	-.306	-1.732 ns.	EV	EV	-.340	-1.659 ns.
Model summary and ANOVA	R= .868; R ² = .753; Adjusted R ² = .722; F=24.332***; ns. p>.05; *** p<.001				R= .514; R ² = .264; Adjusted R ² = .221; F=6.106*; ns. p>.05; *** p<.001			

EV=Excluded Variables from the predictors in the model.

Table 6. Regression analysis models: the cases for the before and after phases of training and working associated with the severity of PRMDs.

Predictors (Before phase)	lower back/hips				thighs			knees			ankles / feet					
	B	SE	Beta(β)	t	B	SE	Beta(β)	t	B	SE	Beta(β)	t	B	SE	Beta(β)	t
The groups	EV	EV	.025	.657 ns.	EV	EV	-.020	-.560 ns.	EV	EV	.003	.057 ns.	EV	EV	.042	1.137 ns.
Sex	EV	EV	-.029	-.844 ns.	EV	EV	.011	.309 ns.	EV	EV	-.054	-1.129 ns.	EV	EV	.010	.259 ns.
Role types	EV	EV	-.067	-1.890 ns.	EV	EV	-.045	-1.290 ns.	EV	EV	.001	.026 ns.	EV	EV	-.064	-1.740 ns.
years of experience	EV	EV	.013	.332 ns.	EV	EV	.011	.309 ns.	EV	EV	-.019	-.404 ns.	EV	EV	.053	1.402 ns.
Three type disciplines	.479	.230	.072	2.080*	EV	EV	.007	.186 ns.	EV	EV	.013	.274 ns.	EV	EV	.018	.482 ns.
Physiological factors	EV	EV	-.005	-.144 ns.	EV	EV	-.020	-.567 ns.	EV	EV	.039	.833 ns.	EV	EV	.029	.768 ns.
Psychosocial factors	EV	EV	-.035	-.976 ns.	EV	EV	.056	1.608 ns.	EV	EV	.025	.521 ns.	EV	EV	-.004	-.116 ns.
continuance of symptoms	1.451	.132	.622	10.980***	1.718	.138	.694	12.487***	1.268	.128	.589	9.885***	.446	.232	.189	1.922 ns.
The frequency of PRMDs	.586	.091	.286	6.415***	EV	EV	.038	.758 ns.	.293	.082	.187	3.557**	.975	.114	.508	8.530***
Model summary and ANOVA	R= .905; R ² = .903; Adjusted R ² = .898; F=199.651***; ns. p>.05; *** p<.001				R= .941; R ² = .885; Adjusted R ² = .883; F=359.417***; ns. p>.05; *** p<.001				R= .897; R ² = .805; Adjusted R ² = .799; F=124.224***; ns. p>.05; *** p<.001				R= .939; R ² = .881; Adjusted R ² = .876; F=159.756***; ns. p>.05; *** p<.001			

Predictors (after phase)	lower back/hips				thighs			knees			ankles / feet					
	B	SE	Beta(β)	t	B	SE	Beta(β)	t	B	SE	Beta(β)	t	B	SE	Beta(β)	T
The groups	EV	EV	.302	1.271 ns.					EV	EV	-.158	-.893 ns.	EV	EV	.236	1.340 ns.
Sex	EV	EV	-.002	-.011 ns.					EV	EV	-.130	-.719 ns.	EV	EV	-.223	-1.257 ns.
Role types	EV	EV	-.141	-.872 ns.					EV	EV	-.065	-.348 ns.	1.242	.544	.423	2.284*
years of experience	-.077	.033	-.340	-2.345*					EV	EV	-.241	-1.419 ns.	EV	EV	.027	.143 ns.
Three type disciplines	EV	EV	-.205	-1.518 ns.					EV	EV	.179	1.012 ns.	EV	EV	.132	.715 ns.
Physiological factors	EV	EV	-.062	-.408 ns.					EV	EV	-.234	-1.381 ns.	EV	EV	.019	.099 ns.
Psychosocial factors	EV	EV	-.053	-.344 ns.					EV	EV	.118	.656 ns.	EV	EV	-.168	-.952 ns.
continuance of symptoms	EV	EV	.225	1.236 ns.					2.621	.580	.794	4.518**	EV	EV	.240	1.388 ns.
The frequency of PRMDs	-.718	.219	-.469	-3.287**					EV	EV	.215	.997 ns.	EV	EV	-.236	-1.385 ns.
Model summary and ANOVA	R= .865; R ² = .748; Adjusted R ² = .690; F=12.890***; ns. p>.05; *** p<.001				No variables were entered into the equation.				R= .794; R ² = .630; Adjusted R ² = .599; F=20.417**; ns. p>.05; *** p<.001				R= .758; R ² = .575; Adjusted R ² = .515; F=9.479**; ns. p>.05; *** p<.001			

EV=Excluded Variables from the predictors in the model.

Table 7. Regression analysis models: the cases for the groups of students and professionals associated with the choice of treatments.

Predictors of treatments	Neck (students)				upper back (students)			
	B	SE	Beta(β)	t	B	SE	Beta(β)	t
ignored the disorders	EV	EV	-.015	-.124 ns.	EV	EV	-.071	-.578 ns.
healed by themselves	EV	EV	.166	1.400 ns.	EV	EV	.093	.745 ns.
using a pain patch	EV	EV	-.075	-.582 ns.	EV	EV	.088	.658 ns.
wore protective equipment	EV	EV	-.057	-.466 ns.	EV	EV	.214	1.739 ns.
conventional medicine	EV	EV	.136	1.153 ns.	EV	EV	.189	1.562 ns.
Chinese massage	1.816	.542	.389	3.353**	1.588	.610	.306	2.555*
Model summary and ANOVA	R= .389; R ² = .151; Adjusted R ² = .138; F=11.240**; ns. p>.05; *** p<.001				R= .306; R ² = .094; Adjusted R ² = .079; F=6.527*; ns. p>.05; *** p<.001			

Predictors of treatments	elbows (students)				Ankles/feet (students)			
	B	SE	Beta(β)	t	B	SE	Beta(β)	t
ignored the disorders	EV	EV	.072	.574 ns.	EV	EV	-.031	-.260 ns.
healed by themselves	1.873	.628	.352	2.980**	EV	EV	.081	.681 ns.
using a pain patch	EV	EV	.161	1.309 ns.	EV	EV	.115	.904 ns.
wore protective equipment	EV	EV	.087	.726 ns.	EV	EV	.011	.088 ns.
conventional medicine	EV	EV	.187	1.589 ns.	EV	EV	.007	.056 ns.
Chinese massage	EV	EV	.092	.749 ns.	2.695	.754	.411	3.574**
Model summary and ANOVA	R= .352; R ² = .124; Adjusted R ² = .110; F=8.881**; ns. p>.05; *** p<.001				R= .411; R ² = .169; Adjusted R ² = .155; F=12.771**; ns. p>.05; *** p<.001			

EV=Excluded Variables from the predictors in the model.

Table 7. Continued.

Predictors of treatments	wrists/hands (students)				lower back/hips (students)				thighs (students)			
	B	SE	Beta(β)	t	B	SE	Beta(β)	t	B	SE	Beta(β)	t
ignored the disorders	EV	EV	-.076	-.620 ns.	EV	EV	.019	.159 ns.	EV	EV	.005	.039 ns.
healed by themselves	EV	EV	.106	.859 ns.	EV	EV	.225	1.872 ns.	EV	EV	.090	.698 ns.
using a pain patch	EV	EV	.116	.904 ns.	EV	EV	-.086	-.654 ns.	1.525	.746	.249	2.043*
wore protective equipment	1.670	.766	.265	2.180*	EV	EV	-.048	-.385 ns.	EV	EV	.186	1.453 ns.
conventional medicine	EV	EV	-.003	-.025 ns.	EV	EV	.028	.232 ns.	EV	EV	-.033	-.255 ns.
Chinese massage	EV	EV	.127	1.000 ns.	2.160	.754	.340	2.866**	EV	EV	.106	.781 ns.
Model summary and ANOVA	R= .265; R ² = .070; Adjusted R ² = .055; F=4.751*; ns. p>.05; *** p<.001				R= .340; R ² = .115; Adjusted R ² = .101; F=8.261**; ns. p>.05; *** p<.001				R= .249; R ² = .062; Adjusted R ² = .047; F=4.174*; ns. p>.05; *** p<.001			

Predictors of treatments	wrists/hands (professionals)				lower back/hips (professionals)				thighs (professionals)			
	B	SE	Beta(β)	t	B	SE	Beta(β)	t	B	SE	Beta(β)	t
ignored the disorders	2.401	1.158	.308	2.073*	4.986	1.272	.522	3.919***	EV	EV	.052	.344 ns.
healed by themselves	EV	EV	.130	.868 ns.	EV	EV	.117	.874 ns.	EV	EV	-.049	-.317 ns.
using a pain patch	EV	EV	.070	.464 ns.	EV	EV	.059	.434 ns.	1.970	.856	.338	2.301*
wore protective equipment	EV	EV	-.041	-.259 ns.	EV	EV	.019	.132 ns.	EV	EV	-.030	-.190 ns.
conventional medicine	EV	EV	.130	.862 ns.	EV	EV	-.001	-.011 ns.	EV	EV	.048	.294 ns.
Chinese massage	EV	EV	-.130	-.868 ns.	EV	EV	.210	1.599 ns.	EV	EV	-.058	-.378 ns.
Model summary and ANOVA	R= .308; R ² = .095; Adjusted R ² = .073; F=4.298*; ns. p>.05; *** p<.001				R= .522; R ² = .272; Adjusted R ² = .255; F=15.356***; ns. p>.05; *** p<.001				R= .338; R ² = .114; Adjusted R ² = .093; F=5.295*; ns. p>.05; *** p<.001			

EV=Excluded Variables from the predictors in the model.

5. Discussion

5.1. How Frequently Do Chinese Opera Performers Experience the Severity of PRMDs After Training and Working

According to symptoms of the nine body regions, PRMDs occurred more frequently after both working and training, indicating statistical significance. This evidence invalidates the hypothesis that Chinese opera performers do not experience PRMDs frequently after training and working. Those who reported a higher frequency of PRMDs were considerably more likely to report higher levels of pain severity. As shown in tables 1, 2, 3, 5, and 6, all body parts in the professionals and students presented significant and frequent PRMD severity experienced after training and working.

According to the results of the students and professionals associated with the before and after phases, these may be presented a fact that students train for 5 d a week, whereas professionals decide when to practice and the performing are not scheduled as routine. Performers would have stopped practicing these movements using body parts in the regions where they were experiencing PRMDs. In other words, the student respondents would have still practiced these movements in class, even if they were experiencing PRMDs. This can explain the significant relationship and factors for the high levels of pain severity on most of body regions were likely caused by insufficient warm-up activities or especially the ignoring the disorders before working and training.

5.2. Where in the Body Regions of Roles and the Types of Discipline Experience Pain Most

Role types and the three types of human-body-oriented

disciplines influenced the frequency of PRMDs reported by participants. The percentages of the nine body regions constitute the evidence for invalidating the hypothesis that PRMDs do not occur in most body parts because of the type of discipline. The results show that the roles with martial arts involved a higher prevalence of PRMDs than other roles among all body regions in both the professionals and students. From a human factor of ergonomics standpoint, this makes sense because the roles of martial arts in general entail considerable number movements among all body regions. Therefore, it appears likely that the physiological differences observed before and the after these phases account for the differences in PRMDs experienced at these body locations. Specifically, for the condition of the lower back/hips, the results were highly significant, which is attributable to the daily training of students.

In general, Lower back/hip injuries are significant in Chinese opera performance training. However, the result of lower back/hip severity and frequency for the student group is higher than that for the professionals. This may be because students use their lower back/hips to practice more movements as they continue in their daily training programs. According to thematic coding, certain postures and movements of the three types of the human-body-oriented disciplines and the two types of performing-prop-oriented disciplines might have contributed the lower back/hips to bear heavier loads than do other body parts (presented in table 1, 2, 3, and 6). The youngest performers are generally more often assigned tasks that require training involving intense physical demands. They are prone to PRMDs because of a lack of performing experience. If someone had stopped practice at a young age because of PRMDs, or they were not suitable to be a performer, they would no longer be active in training programs, and thus would enter wardrobe training instead of performance study. Thus, in the student group, the participant

ratio of the four main roles and martial arts roles was higher than those of the professionals. “Four main roles” ranks first, and the role types are listed in order. “Four main roles with martial arts” for both groups contained the highest number of performers who experienced PRMDs in Chinese opera performance, whether in the training or professional status.

5.3. What Treatments Do Chinese Opera Performers Use for the Management of PRMDs

Participants were asked to self-report at which locations in the body they had experienced PRMDs. A limitation of the questionnaires is that limited information was gathered regarding where each PRMD symptom occurred in the body. Detailed information was collected for the region of the body where participants experienced PRMDs, along with the duration of the PRMD, but the specific type of injury or PRMD symptom in each body area was not specified. The question for ascertaining PRMD symptom location was placed before the body diagrams in the questionnaires; hence, the scope of answers is not entirely complete. Many of the participants did not provide enough details in their short answers to generate detailed coding information. For example, the participants may have documented the causes according to the particular aspect of performance and corresponding roles, without detailing them or differentiating between repertoires. Therefore, some information from the questions can be used for thematic analysis. However, future studies should address these concerns so that each body area corresponds to the type of PRMD symptom or diagnosed injury defined in addition to the location and duration supported by the differentiation of repertoires. Thus, there is little evidence of significant results to validate the hypothesis that Chinese opera performers use proper treatments in the management of PRMDs (presented in table 7).

The influence of these types of injuries on Chinese opera performers is somewhat different from the occupational conditions that generally occur. Otherwise, ignoring a disorder is unreasonable. Moreover, according to the thematic analysis, few of the performers believed that a knowledgeable teacher was the ideal resource for preventing the onset of PRMDs, even though the technical aspects of acting were not determined to be significant contributors to PRMDs. However, in the absence of statistically significant results, no definite conclusion can be drawn that using proper treatments or not associated with PRMDs among Chinese opera performers.

5.4. Statistical Limitations

To our knowledge, this is the first research to examine the relationship among the self-reports severity and frequency of PRMDs in Chinese opera population. In retrospect, this was not the most effective method for ascertaining information on PRMD symptom severity; a measure of the most severe event in a performer's history would have been more beneficial. The severity of each PRMD symptom was measured on a 10-point scale in the questionnaires. The respondents were asked to rate the most recent 3-mo occurrence of each PRMD symptom

type. Data on the severity of PRMD symptoms must be treated with caution. The wording of the question may have resulted in different interpretations. Some of the respondents may have rated their most recent PRMD occurrence directly at the symptom onset before they began to improve, whereas others may have rated their most recent PRMD occurrence as the final time they experienced the PRMD symptom, which may have been during treatment. However, regarding physiological and psychosocial factors also revealed a weak significant on neck, elbows, and lower back/hips. Thus, there is evidence to invalidate the hypothesis that no psychosocial or physiological relative factors frequently cause PRMDs. Because Chinese opera is a highly complex art form, PRMDs could not have been caused only by technical aspects, even though the evidence is not so strong and the raw data for thematic analysis acquired were not properly underwent. Therefore, adopting a well-designed research method for analysis of the prevalence of PRMDs in Chinese opera is the most crucial objective for future studies.

6. Conclusions and Future Work

The Chinese opera performing arts population requires more information about PRMDs for developing treatment and prevention strategies according to scientific methods. A long-term observation, structured interview, and self-report questionnaires should be established and used to support medical treatments for alleviating pain and treating various physical, mental, and emotional conditions. Given the exploratory nature of this study, any working or teaching implications based on these preliminary findings should be treated with caution. Several administrative and pedagogical implications can be drawn from this study. In addition, there is no other studies have applied methods for providing reliable estimates on the prevalence of PRMDs of various body regions in the Chinese opera population. Furthermore, any relative PRMD factors between professionals and students that might cause absence or injury regarding correlations among symptom causes during working and training are still unclear, and few of the participants were deemed to present such correlations. Notably, not every Chinese opera performer who earned a great reputation or high grades experienced PRMDs.

Thus, integrating modern methods of performance-related musculoskeletal disorders (PRMDs), mental models, and ergonomic analysis methodologies might produce a significant breakthrough in the application of administrative and pedagogical concerns in the traditional Chinese opera population, and might provide a means to analyze creative concepts for the three types of human-body-oriented disciplines and the two types of performing-prop-oriented disciplines in the future. Future research should investigate the convergence property of the proposed framework through 3D motion capture for performer movement comparison. Such experimental investigation may facilitate the enhancement of the proposed algorithm for efficiency purposes. The severity of PRMDs among Chinese opera

performers could be in a real two-phase of processes that the data of questionnaires and structured interview acquired. The process of 3D motion capture will investigate the data of movements in between the before and after phases. Meanwhile, the movements of training also could be reinforced through virtual routines to represent reality, such as 3D motion capture for the ergonomic analysis of human-body-oriented performing skills and digital interactive art installation as a teaching aid for interactive training activities in performing-prop-oriented performance skills; all of which must be evaluated using detailed methods. Therefore, 3D motion capture can be used for the future application of identifying detailed factors through a live demonstration involving visual blind spots and a rotating 3D doll perspective, to enhance the accuracy of movement observation. Analyzed data from 3D motion capture can benefit training. A database analysis can be applied to quantify and qualify cross-examination; individualized guidance can enable professionals and students to mitigate PRMD problems. Hopefully, the PRMD problems from traditional Chinese opera training and work places reported in this study can be mitigated in the near future.

Appendix

A Unique Art Form- Chinese Opera

The history of Chinese opera is not clear, but performances combining song and dance were popular as far back as the Warring States period (403–222 BC). A few centuries later, during the Han Dynasty (206 BC–AD 219), storytelling blended with song and dance, resulting in an elementary form of musical drama. Chinese opera is a unique art form demonstrated in front of a live audience, and it refines and combines the finest aspects of several opera styles from more than 300 regional opera styles in China. Although visual effects such as backgrounds, props, and lighting convey the setting and feel of a scene, they are not intended to create an actual sense of reality. Rather than attempting to approximate reality, Chinese opera has evolved into a stylized, abstract, and specific coherent art form, similar to ballet or modern dance. Using minimal props and effects, Chinese opera applies an extensive display of symbols to cue the audience to every action.

Chinese opera is a theatrical art in which music, song, dance, speech, and acrobatics are mixed to create a unique form of musical drama [12–14]. Although portions of a Chinese opera are sung, a typical Chinese musical drama is distinct from a Western style grand opera. For example, whereas a Western audience might be shocked to see their favorite diva perform a sword dance in the middle of an aria, such a sight is not uncommon in the context of Chinese opera. To understand how Chinese opera became such a mixture of performing arts, its origin must be explored. Chinese opera draws the raw material for its stories from historical records, popular legends, and folktales in China. Many of these types of materials tend to be didactic; therefore, unsurprisingly, Chinese operas often take the form of morality plays in

which virtue is glorified and evil conduct is punished. Because a Chinese opera is presented in an entertaining format, it manages to effectively bridge the gap between popular entertainment and social education. Therefore, Chinese opera is more than a mere entertaining show; it is also a window opened wide to Chinese culture.

There are two educational methods in Chinese opera. First, in the early years of the traditional method, the training of opera performers generally depended on the availability of private schools or tutors. Alternatively, some actors and actresses joined an opera troupe in their childhood to learn the performing arts. Sometimes the actors or actresses came from performing families, where they could observe their parents perform. Gradually, they learned the arts by themselves. Early training methods emphasized the close relationship between the tutor and apprentice. What the teacher taught was what the apprentice memorized. No standard textbooks or complete teaching materials were available. However, because of an insufficient number of teachers, many operas and skills that had been passed through generations by senior performers were lost when society and audiences changed. Furthermore, in such private training systems, apprentices had no time to study other general subjects. In modern society, broad knowledge is an absolute requirement for an artist.

In recent years, a modern method has been developed. The training of Chinese opera performers depends on the availability of a national college. The college is divided into advanced elementary school, middle school, vocational high school, and college. During their total study period of 12 years, most students are completely supported by the government and receive a vocational high school diploma and a bachelor's degree when they graduate. The curriculum includes general subjects, professional courses, and professional skills. The general subjects and professional courses meet the standards established by the Ministry of Education, whereas the professional skills vary according to the department requirements.

Currently, in the first 2 y of training, students concentrate on basic skills. During the remaining 6 years, students are divided into at least 11 groups according to the four main types of characters in Chinese opera to obtain specialized training for each of their particular roles. Although plays have their own personae, all personae fit into predetermined categories. Each category has its own singing and speaking style, movements, and appropriate costumes. The subdivisions within the categories vary from one regional form to another but, in general, there are four main role types: sheng (mature man, young man, or militant man), tan (old lady, young lady, young maiden, or militant maiden), ching (painted-face man or militant painted-face man), and chou (clown or militant clown). During the 8 years that a student spends in the school, he or she must attain a sufficient skill level in Chinese opera and pass courses in Chinese, English, history, geography, mathematics, and concepts of Chinese opera before graduation.

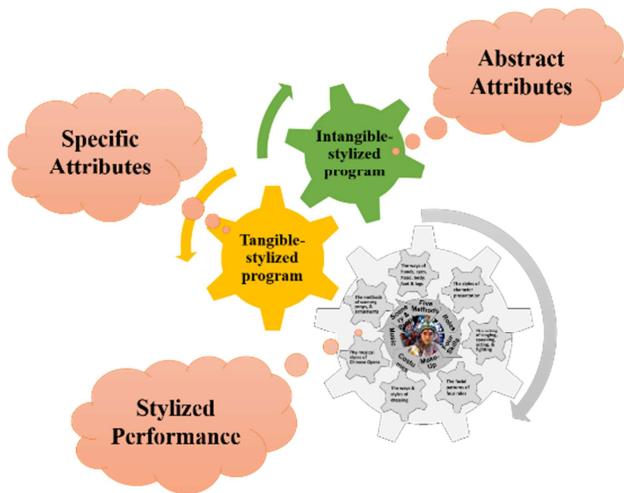


Figure 3. Two main types of symbolized performing styles in Chinese opera.

There are two main types of symbolized performing styles in Chinese opera (figure 3). Chinese opera experts have indicated that the performing styles conveyed from the performer are tangible but that the performance methods are

intangible. The movements of a tangible-stylized program are controlled by the formation of an intangible-stylized program. Through the logical sequence of computer programming as a metaphor, the concepts of movement of a tangible-stylized program are similar to computer programming languages. However, the formation of an intangible-stylized program in Chinese opera performance is similar to compiling a series of computer languages as software for a final application.

According to Norman's "mental models" [15] and Chu's "performance attributes of Chinese opera" [16], 10 attributes enable a general audience, specifically prop and costume designers, to understand how a performance can be stylized and systemized in Chinese opera. These attributes are "rhythm," "reflection," "skill," "alienation," "norm," "appliance," "virtualization," "exaggeration," "program," and "liveliness." Thus, general designers do not have to be Chinese opera performers to design the props for a performance. However, because a performer has already mastered the training system, a performer can be a prop or costume designer for Chinese opera performances, as shown in figure 4.

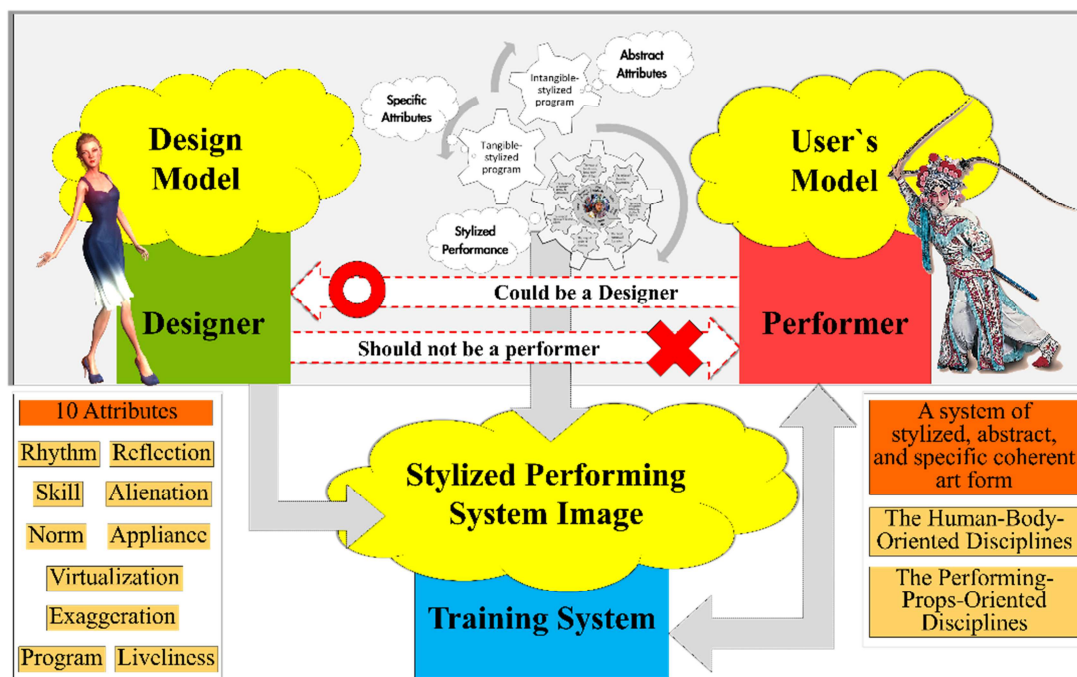


Figure 4. Performer vs. designer "mental model" analysis (redesigned from Norman, 1988).

According to Lin and Kreifeldt [17], and Wang and Lin [18], "ergonomics becomes even more relevant when it is necessary for a user to fulfill operational requirements in more complex systems." Thus, this study used an ergonomic analysis model to analyze the correlations of users, tools, and tasks in Chinese opera performance (figure 5). The figure depicts new ways of dressing and performing; no such concepts have existed in the field of Chinese opera training and performance. Thus, because one researcher in this study is a well-trained performer and experienced instructor at a Chinese opera school, there is no opposition to the ideas originating from not only the training system but also the performing stylized

system image. However, designers can understand Chinese opera only through circumstances involving the 10 attributes or through long-term participant experiences originating from the system image.

Finally, we determined a well-designed framework for exploring the identification, classification, and application of Chinese opera learning, and designed methods for both the props and movements of Chinese opera performance (figure 6). Therefore, the graphic representation in the figure provides a visualization of the distinguishing factors among sociology, physiology, and psychology. The framework proposes the following research approaches for the near future.

The Framework of Using Mental Models and Ergonomic Analysis in Chinese Opera Performance is a pre-survey for identifying the factors that support or impede the acceptance of the “designer model” and “performer model” as design tools for all Chinese opera performances. As shown in the figure, the framework was designed to represent the mentioned theoretical positions according to the flowchart in the figure, which presents the construction methods of the

framework. It highlights three perspectives among three approaches of knowledge areas in sociology, physiology, and psychology, which are applied to incorporate traditional Chinese opera performing skills, the methods of the mental model, and the ergonomic analysis methodologies into a blended system. Thus, the framework is a correlation process involving learning, performing, and designing, which are essential systems of the Chinese opera profession.

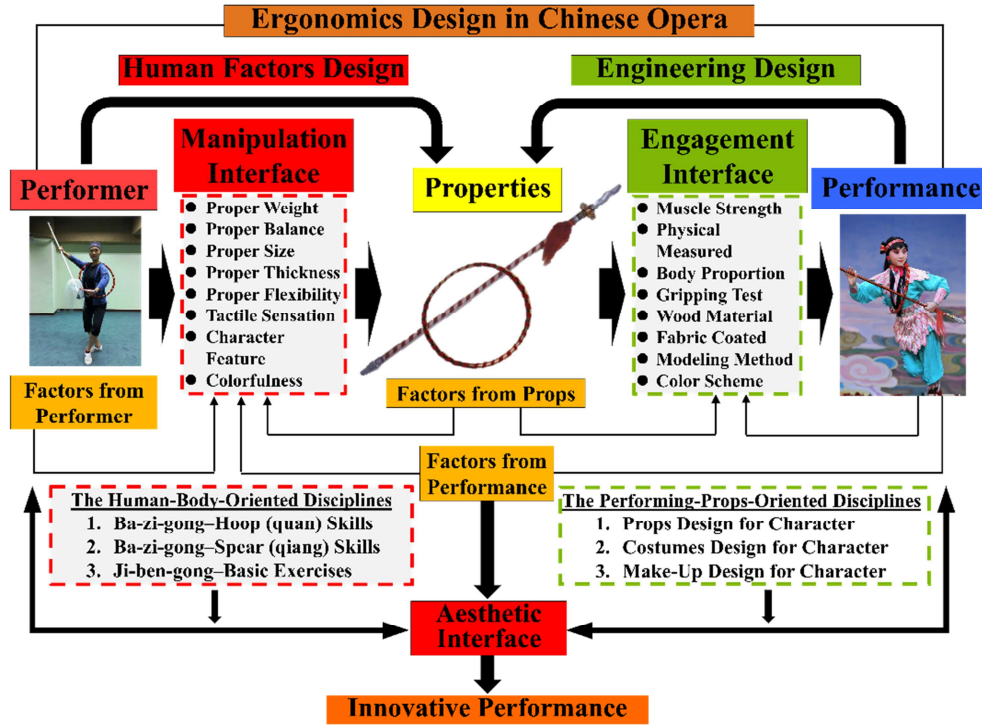


Figure 5. Ergonomic design in Chinese opera [17].

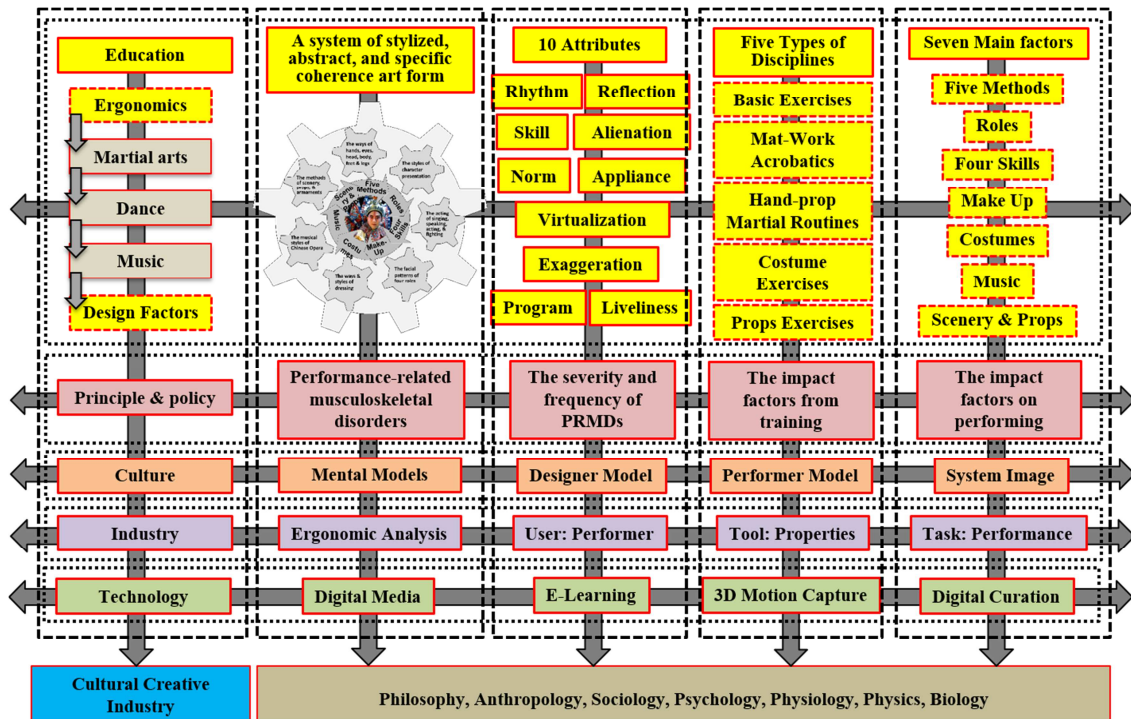


Figure 6. Framework of the research approach on Chinese opera.

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