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A study of the relationship between physical stature and footstool and chair height in guitar performance.

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A STUDY OF THE RELATIONSHIP BETWEEN PHYSICAL STATURE AND FOOTSTOOL AND CHAIR HEIGHT IN GUITAR PERFORMANCE

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CHAPTER 1

Introduction

It is important for the classical guitar instructor to start beginning guitar students with the proper posture and footstool height when sitting with the guitar. On the average footstool, there are only three or four different heights to be used for all of the different body sizes of guitar students. It is the responsibility of the instructor to know what footstool height will best suit each individual student's body size. Guitar instructors are usually very knowledgable about their music and instrument, but generally have little knowledge about the anthropometric characteristics of the professional guitarist. It is hoped that with a better understanding of the anthropometric characteristics of different guitarists, the instructor will be better prepared to begin students with a seating position and footstool height that are correct for them.

Because of the many music-related injuries that have been observed in the past few years, it is obvious that playing an instrument is not only a musical endeavor but also a physical skill. Just as important as knowing how one's instrument works is knowing how one's body functions in relation to the instrument. Musicians generally take extreme care in the maintenance of their instruments. But how well do they care for their bodies? Similar to an athlete, the musician should not only incorporate exercise and a proper diet, but also place importance on the correct form or posture while preparing the body for a strenuous workout with his or her instrument. In order to prevent possible injury, understanding the physical skill involved in the performance of an instrument is just as important as understanding the musical skill.

The physiological aspect of playing an instrument is often a neglected area of study, especially for the guitarist. Research on selected sources of string pedagogy and physiology done by Fray (1979) showed what studies were done in the area of physiology and what studies were needed. Fray's research showed that most of the studies dealing with physiology incorporated instrumentalists other than guitarists. Compared to these other instrumentalists, guitarists seem to be behind in the area of physiology. "We have yet to arrive at a common understanding regarding the most effective use and training of the mind and body in playing the guitar; such an understanding, resulting in a tradition of high-level instruction and performance, has long been achieved for other instruments, notably the piano and the violin." (Shearer, 49)

Little research has been done with the sitting position of classical guitarists. However, there have been a few good articles by guitarists about the guitarist's sitting position. Usually the articles identify little if any scientific research to support the statements made by these performers. Teachers often believe what technique works for them should also work for their students, without taking into account the vast differences among individuals. "The teacher must know not only music but he must be trained in all aspects of human behavior." (Brody, 28)

Christopher Berg, associate professor of music at the University of South Carolina, wrote an article on seating and placement of the guitar and the relationship that seating and guitar placement has to the development of solid technique. Berg's article explains the importance of body awareness and gives a description of a "basic seating" position with the guitar (363-4). The author does state that "there are innumerable differences between individuals: the length of the torso in relation to the rest of the body, or the length of the arms in relation to the torso, to name only a few" (363). With all of these differences, is the conventional three or four position footstool adequate to accommodate the body size difference among guitarists?

Charles Duncan in his book The Art of Classical Guitar Playing states that "Matters such as the exact height of the chair and stool are secondary" (10). He then goes on to say: "How high one sets it [the footstool] depends upon (1) the height of the chair (lower chair, lower footstool; higher chair, higher footstool); and (2) the length of the torso in relation to the leg (the longer the torso, the higher the footstool, and vice versa). A tall player with a long torso may have to elevate the left leg to the point that the lower bout of the instrument is supported by the top rather than the inside of the right thigh" (11).

Correct sitting posture with one's instrument is a responsibility that begins with the teacher. If the height of the chair and footstool is left up to the student to discover what best suits him or her, then problems in posture may arise which are not detected until after an injury occurs. What at first seems natural to the student may not always be the best posture. Dannemann states: "Paradoxically, the more 'natural' are the movements first chosen, the more limited and strenuous will be the playing skills later" (33). It is up to the teacher to know what seating position will work best for each individual based on physical characteristics.

For the reasons stated above, teachers should be aware of the mechanics of the guitar student. Otto Ortman stated: "The concert pianist if he chooses may work as he will, remaining his own problem, or perhaps finding his own solution; but the teacher, selling lessons in physiological mechanics hour after hour, day after day, should at least know the tools with which he works" (Altman, 50). The same thing may be said for guitarists and guitar teachers. With a better understanding of body mechanics, the guitar instructor will not only have more confidence in setting up the beginner with a seated posture that works best for him or her, but also will have the ability to detect fundamental mechanical problems before a possible injury occurs.

CHAPTER 2

The Problem

The purpose of this investigation is to determine what, if any, relationship exists between physical stature and the preferred height of the guitar footstool and chair among professional guitarists. Preferred footstool height refers to the distance of the foot above the ground. Physical stature refers not only to height, but also to the length of limbs as well as other body segments. According to Duncan, there is a direct relationship between the length of one's torso to the height of the footstool; "the longer the torso, the higher the footstool, and vice versa." (11). As a basic hypothesis the investigators began with the idea that there was a direct relationship between the height of the footstool and chair to the physical stature of professional classical guitarists, as suggested by Duncan.

Delimitations

The criterion for the subjects was that they be at least 21 years of age and have taught or performed guitar professionally for four years or more. Twelve of the 25 subjects were chosen from a nation-wide group of guitarists who met in Denver, Colorado to take part in a week long seminar in 1987. The rest of the subjects were chosen from the Kansas City, Missouri and Omaha, Nebraska area.

Limitations

Many of the circumference measurements had to be taken over clothing. The investigator avoided this type of measurement where possible. Another limitation is the sample size. A larger sample would make any generalizations to the population more credible. Because this pilot study was descriptive in nature, no control group was used.

Significance of Study

Findings in this research could lead to the following contributions to the field of guitar education:
(1) improved beginning guitar education; (2) better instructor confidence in placing the height of the footstool for the beginning student; (3) information about the physical stature of guitarists; (4) information about injuries many guitarists experience due to possible improper sitting position; and, (5) possible re-design of the guitar footstool.

CHAPTER 3

Review of Related Literature

Although there have been measurement studies concerning the sitting position (Dempster, 1955; Akerblom, 1948; Life & Pheasant, 1984; and Shackel et al., 1968), there are no known scientific studies of the guitarists' seated posture. One must begin by reviewing the research done on the sitting and standing posture, the posture of other related instrumentalists and look at how these relate to the guitar position. Because understanding some basic anthropometrical aspects of the human body is important in understanding posture, literature will also be reviewed in relation to this area.

Marion Broer states, in Efficiency of Movement, the similarities and differences between sitting and standing posture: "Since all sitting enlarges the base of support and places the center of gravity of the body close to the base much of the strain of standing in which the relatively high center of gravity must be kept over a small base, is eliminated. The system of levers that must be held erect is much shorter, being only the trunk, head, and neck and therefore, is easier to control. However, the same basic principles of keeping the various body segments in line which apply to standing, also apply to sitting regardless of the particular purpose for sitting or the type of chair used" (139).

A review of postural studies done for both standing and sitting postures shows that posture can be related to health (Hansson, 1945; Akerblom, 1948; Basmajian, 1965). "There are many clinical evidences for the effect of poor body mechanics and health. It is true that we all know of persons with poor body mechanics enjoying apparently perfect health. It must be remembered that our body is wonderfully adjusted to compensate for partial deficiency and also that many persons are satisfied with second or third degree health" (Hansson 947).

Correct posture must be encouraged from the start. Researchers agree that "the earlier such posture teaching occurs, the better, since age intensifies muscular habits" (Hansson 951). According to Basmajian, "The muscular mechanism of the body which counteracts gravity makes up the essence of the study of posture" (27). He goes on to say, "Muscular activity is called upon to approximate this posture or, if the body is pulled out of the line of gravity, to bring it back into line" (28). If the guitarist holds a sitting position with the center of gravity outside the base of support, the muscles will be active in maintaining this position. If held for a long time the muscles can become strained or even injured.

Scientific research by Bengt Akerblom supports this statement. Electromyography was used by Akerblom in order to discover which muscles are in action during differing postures (1948). He states, "When sitting upright without support at least some of the joints of the vertebral column are in a position of unstable equilibrium. It is very probable that the gravity line often falls so far in front of the axis of the joints of the vertebral column that the work imposed on the muscles of the back is quite a lot greater than that which they can carry out continuously, with the natural result that the back becomes tired" (180).

Studies done to assess the height of chair compared to physical measurements have been done (Akerblom, 1945; Dempster, 1955; Shackel, Chidsey and Shipley, 1968; Floyd and Ward 1968). They agree that a back-rest is important for a chair to supply the proper support for the best sitting position. However, there are some problems in using a back-rest. "The more the chair supports the body the more the muscles can rest but the less free the body is to perform various tasks which may be demanded of it" (Broer, 139). Broer also states that, "Without the lower back supported, the entire upper body alignment is upset. The back of the chair should support the back of the individual regardless of the type of chair" (151).

Although much of the research already completed shows the importance for support of the lower back, most guitarists sit at the front edge of the chair or bench giving no support to their lower backs. Could this lack of support in the lower back region be one cause of the back pain experienced by not only guitarists but other musicians as well?

The science of physiology is becoming a greater concern of musicians as a result of the many music-related injuries that have been identified. David Fray, in his dissertation An Annotated Bibliography for the String Teacher: 100 Selected Sources from String Pedagogy, Physiology, and Related Disciplines (1929-1978) says: "The interest in things physiological is not a recent development by any means" (2). Although a physiological approach to string pedagogy begins early in the 20th century, Fray's "time-line of physiological string pedagogy" shows that most of the work has been done in the last twenty years (13).

As a way of becoming more in tune with one's physiological characteristics, body awareness is becoming just as important for the musician as it has been for the athlete. Yoga is one method that is used to achieve a greater body awareness. Yoga has been the study of many artists in relation to their instruments (Menuin, 1972; Altman, 1969). Yehudi Menuin called Yoga guru Mr. B.K.S. Iyenger his "best violin teacher" (11). "Through body awareness, one learns to detect tension, to control it, and finally to achieve relaxation and efficient body movement" (Phillips, 45).

Another technique incorporating body awareness is the

Alexander Technique. Although no formal studies done on the F.M. Alexander Method in relation to the guitarist were found, pianists, violinists and vocalists, among others, have studied the Alexander Technique in order to achieve increased body awareness leading to improved posture (Jones, 1976 and Richter, 1976).

In "The Importance of Eutonie (tension-balance) in Music Education", Gerda Alexander states the importance of body awareness for the musician:

> Technical insufficiency, muscular cramps, stress and nervous patterns could be avoided during the years of study if music teachers would understand that the pre-requirement for playing an instrument, or for singing, is experience and knowledge of the functioning of one's own body instrument. This knowledge must be based on the:
>
> (1) understanding of the importance of deep body awareness, the development of a keen perception of body image leading to sensitivity of the tactile sense.
>
> (2) understanding of the importance of posture without strain in sitting, standing or moving in connection with the functions of finger, hand, arm, shoulder and leg.

> (3) freeing of natural, unconscious breathing, reached through correct 'tension balance' with a minimum of energy expenditure particularly in the areas of the diaphragm, stomach, intercostal and pelvic muscles (27).

Summary

In order to prevent possible injuries due to poor posture in the sitting position of guitarists, it is important for the classical guitar instructor to have a knowledge of the anthropometric and physiological characteristics of the individual guitar student.

In review of the research done on the sitting posture, most agree that it is important for the lower lumbar region of the back to be supported while sitting for any length of time. Researchers also agree that because age intensifies muscular habits, it is important to encourage correct posture from the start.

Body awareness is important for the musician. Yoga and the Alexander Method are two ways that musicians are learning more about their body and its movements. By becoming more physiologically aware of body mechanics, the musician can learn more about the physical skill involved in the performance of his or her instrument.

CHAPTER 4

Procedure

The subjects of this study were professional classical guitarists from Nebraska, Kansas, Missouri, New Mexico, Iowa, Wisconsin, Colorado, Kentucky, Ohio, and Minnesota. The sample consisted of 25 male classical guitarists who have taught or played professionally for four years or more and were 21 years of age or over.

Each subject was first asked to complete an information form (Appendix 1). This form determined the age, sex, weight, if the subject had any disabilities, how long the subject taught or performed professionally, their primary source of income, with whom have they studied guitar, if they practice and perform with a footstool, pad, adjustable piano bench, any "normal" chair available or some other form not listed, if they have ever experienced any injury because of the guitar, and how long they have used the sitting position they now employ. The subjects were assured of confidentiality of their responses and were given the option of withdrawing from the study at any time.

After the form was completed, anthropometric measurements were taken by the investigator. The measurements consisted of circumferences and linear measurements. These measurements were modeled after those used by Dempster (1955; 229-231). Both left and right measurements were taken where applicable (See Appendix 2). The measurements were taken to the nearest centimeter using a measuring tape. For an exact definition of the measurements and the measurement process, refer to Appendix 3. Measurements were also taken with the guitar in the performing position. After the measurements were completed, the subject was then asked to play a piece of music of his choice after which the complete measurements were repeated to insure accuracy. If there was more than a centimeter difference between the first and second measurement, a third measurement was taken for that specific part. This entire measurement process took approximately 30 minutes.

The mean, standard deviation and a Pearson Correlation Coefficient were calculated for each of the variables. All levels of significance were reported. The Pearson Correlation Coefficient was used to determine the relationship between variables. A Factorial Analysis and a Multiple Regression Analysis were also computed.

CHAPTER 5

Results

Table 1 displays mean scores and standard deviations for 33 of thc variables. The definitions of the variable labels are shown in Table 2. Of the 25 subjects, 24 used a footstool, one used a guitar cushion, three used a cushion only while practicing, preferring the conventional footstool when performing. Four of the 25 subjects used an adjustable piano bench, 20 used any "normal" chair available and one used some other type of chair not listed in the survey. For 36% of the subjects, their primary income was from teaching; 28% of the subject's primary income was from performing; 20% of the subjects earned their primary income from some other source; and 16% earned the majority of their income from both teaching and performing.

Sixty-five percent of the subjects surveyed had not experienced injury related to guitar performance. Thirty-five percent did experience a guitar-related injury. All but one of the injuries reported were of back pain. Most of the subjects who reported back injury specified that the pain was in the lower back. One subject said that the lower back pain he experienced occurred when he began playing the guitar but has not experienced back pain for eight years. This subject was also the only one to mention an injury other than back ache. He said his wrists, hands, and forearms are subject to frequent muscular tension or even pulled muscles if he does not warm up properly. Pulled muscles, however, are difficult to define by individual reporting.

The age of the subjects ranged from 21 to 41 years with a mean of 31.680 (See Table 1). No disabilities were reported that would significantly affect this anthropometric study. Asthma, however, was reported by one subject. The mean LOP(length of time performing professionally) was 135.130 months (about 11 years). The mean LUSP(length of time using the sitting position the subjects presently employed) was 79.667 months (about 6½ years).

A Pearson Correlation Coefficient was computed as a preliminary analysis on all of the measurements. The left and right measurements of like body parts were highly significant at the .05 level. In order to limit the number of variables the left and right measurements were combined for another Pearson Correlation Coefficient analysis. These results are shown in Table 3. Although there were many high correlations between body parts, stature did not correlate highly to "height of chair" or "ball of foot to floor" (footstool height). This is contrary to Duncan's belief that the length of the torso is related to footstool height.

Since the analyses showed many high correlations, a factor analysis was computed to see how the variables would factor (See Table 4). These factors may help in limiting the number of variables for future research. For example, where two body measurements are highly correlated, a single measurement may be taken. As stated above, the left and right measurements are so highly correlated they become redundent.

A Cluster Analysis was computed. Because of the many high correlations, this analysis did not yield significant information. A Multiple Regression Analysis was computed comparing all of the variables to the dependent variable BALLFT (the height of the footstool). Although this analysis showed many high correlations among the variables, the analysis showed CALF (the circumference of the calf) as the factor that would predict footstool height.

The most significant analysis was the Pearson Correlation Coefficient which showed such a high correlation between the left and right measurements that these measurements could be combined. Also significant was the finding that of all the high correlations of the variables of this study, the relation of physical stature was not highly related to the chair height (HGTCHAIR) or the height of the footstool (BALLFT).

TABLE 1

Means and Standard Deviations of Variables

Variable Labels	Mean	Sd
AGE	31.680	6.156
DISAB	.043	.209
LOP	135.130	82.126
LUSP	79.667	69.497
SHOULDER	110.432	8.944
CHEST	98.628	5.164
WAIST	88.832	8.191
ICREST	89.036	6.426
PUBICS	100.048	5.667
STATURE	177.210	6.184
SITHGT	135.108	4.651
HEELFLR	14.146	3.104
BALLFT	15.052	3.771
GUITARKN	19.990	4.233
HEADFLR	133.010	4.707
HGTCHAIR	45.590	2.350
SITCHAIR	18.752	6.953
WIDCHAIR	40.719	1.696
HEELHGT	2.365	.737
FFC	16.777	7.472
ANKLE	24.176	2.569

TABLE 1 (Continued)

Means and Standard Deviations of Variables

Variable Labels	Mean	Sd
CALF	37.124	2.821
MIDARM	29.934	2.343
U3FORE	26.614	1.533
WRIST	17.051	.677
STOE	33.230	1.777
FOREARM	27.434	1.236
KNEEHGT	51.725	2.463
FOOTF	25.322	4.911
HANDLEN	19.695	.855
GTRLENGTH	99.550	2.049
GTRWIDTH	23.910	.388
GTRDEPTH	10.06	.325

Note: See Table 2 for Definitions of Variable Labels

TABLE 2

Definitions of Variable Labels

Variable Labels	Definitions
DISAB	Presence or Absence of Disabilities
LOP	Length Time Performing
INCOME	Source of Income
INJURY	Injury from Playing Guitar
LUSP	Length of Time Used Sitting Position
U3FOREL	Upper 3rd of Left Forearm
U3FORER	Upper 3rd of Right Forearm
SITHGT	Sitting Height
STOEL	Left Shoulder to Elbow
STOER	Right Shoulder to Elbow
KNEEHGTL	Left Knee Height
KNEEHGTR	Right Knee Height
FOOTFL	Left Foot at Floor
FOOTFR	Right Foot at Floor
HANDLENL	Left Hand Length
HANDLENR	Right Hand Length
HEELFLR	Heel to Floor
BALLFT	Ball of Foot to Floor
GUITARKN	Front of Guitar to Knee
HEADFLR	Head to Floor
HGTCHAIR	Height of Chair or Bench

TABLE 2 (Continued)

Definitions of Variable Labels

Variable Labels	Definitions
SITCHAIR	Where Sit on Chair or Bench
WIDCHAIR	Depth of Chair or Bench
HEELHGT	Shoe Heel Height
GDLENGTH	Guitar Length
GDWIDTH	Guitar Width
GDDEPTH	Guitar Depth
FFC	Distance of Footstool from Chair

TABLE 3

Pearson Correlation Coefficients

	SHOULDER	CHEST	WAIST	ICREST	PUBICS	ANKLE
SHOULDER		.5935	.4648	.4685	.6325	.1654
		(25)	(25)	(25)	(25)	(25)
		P= .001	P= .010	P= .009	P= .000	P= .215
CHEST			.6642	.6424	.6023	.0637
			(25)	(25)	(25)	(25)
			P= .000	P= .000	P= .001	P= .381
WAIST				.9236	.7580	.2455
				(25)	(25)	(25)
				P= .000	P= .000	P= .118
ICREST					.7438	.1404

TABLE 3 (Continued)

Pearson Correlation Coefficients

	SHOULDER	CHEST	WAIST	ICREST	PUBICS	ANKLE
ICREST					(25)	(25)
					P= .000	P= .252
PUBICS						.1989
						(25)
						P= .170
CALF	.6382	.5660	.5992	.5263	.6252	.2596
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .000	P= .002	P= .001	P= .003	P= .000	P= .105
MIDARM	.7702	.6263	.3587	.3370	.5356	.2763
	(25)	(25)	(25)	(25)	(25)	(25)

TABLE 3 (Continued)

Pearson Correlation Coefficients

	SHOULDER	CHEST	WAIST	ICREST	PUBICS	ANKLE
MIDARM	P= .000	P= .000	P= .039	P= .050	P= .003	P= .091
U3FORE	.6952	.5271	.3744	.3472	.5965	.1466
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .000	P= .003	P= .033	P= .045	P= .001	P= .242
WRIST	.3476	.3885	.0204	-.0377	.2443	-.0597
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .044	P= .027	P= .461	P= .429	P= .120	P= .388
STATURE	.3457	.4229	.0375	.0826	.3078	-.3844
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .045	P= .018	P= .429	P= .347	P= .067	P= .029

TABLE 3 (Continued)

Pearson Correlation Coefficients

	SHOULDER	CHEST	WAIST	ICREST	PUBICS	ANKLE
SITHGT	.3177	.2175	-.2839	-.1989	.0643	-.2420
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .061	P= .148	P= .085	P= .170	P= .380	P= .122
STOE	.2157	.2494	.0715	.0513	.2327	-.3252
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .150	P= .115	P= .367	P= .404	P= .131	P= .056
FOREARM	.3227	.1533	-.0066	-.0792	.0979	-.0665
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .058	P= .232	P= .487	P= .353	P= .321	P= .376
KNEEHGT	.1184	.2905	.0234	.0377	.1542	-.3548

TABLE 3 (Continued)

Pearson Correlation Coefficients

	SHOULDER	CHEST	WAIST	ICREST	PUBICS	ANKLE
KNEEHGT	(25)	(25)	(25)	(25)	(25)	(25)
	P= .287	P= .079	P= .456	P= .429	P= .231	P= .041
FOOTF	.2724	.4522	.4188	.4653	.3613	.1048
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .094	P= .012	P= .019	P= .010	P= .038	P= .309
HANDLEN	-.0154	.2503	-.0118	.0190	.1018	-.3990
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .471	P= .114	P= .478	P= .464	P= .314	P= .024
HEELFLR	-.1058	-.1824	-.3475	-.2764	-.2891	-.3055
	(24)	(24)	(24)	(24)	(24)	(24)

TABLE 3 (Continued)

Pearson Correlation Coefficients

	SHOULDER	CHEST	WAIST	ICREST	PUBICS	ANKLE
HEELFLR	P= .311	P= .197	P= .048	P= .096	P= .085	P= .073
BALLFT	-.0483	-.1588	-.2621	-.1459	-.1858	-.1617
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .411	P= .229	P= .108	P= .248	P= .192	P= .225
GUITARKN	.4123	.2820	-.0101	-.0093	.2576	.0291
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .023	P= .091	P= .481	P= .483	P= .112	P= .446
HEADFLR	.1732	.0825	-.2636	-.2433	-.0701	-.3225
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .204	P= .348	P= .101	P= .121	P= .370	P= .058

TABLE 3 (Continued)

Pearson Correlation Coefficients

	SHOULDER	CHEST	WAIST	ICREST	PUBICS	ANKLE
HGTCHAIR	-.0248	-.0801	-.5021	-.4668	-.3249	-.1196
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .453	P= .352	P= .005	P= .009	P= .057	P= .285
SITCHAIR	.0307	-.2543	-.3384	-.3853	-.4153	-.0413
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .443	P= .115	P= .053	P= .031	P= .022	P= .424
WIDCHAIR	-.1575	-.1096	-.3961	-.4411	-.5369	-.2248
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .231	P= .305	P= .028	P= .015	P= .003	P= .146
HEELHGT	-.0402	.3098	.0498	.0651	.1019	.0752

TABLE 3 (Continued)

Pearson Correlation Coefficients

	SHOULDER	CHEST	WAIST	ICREST	PUBICS	ANKLE
HEELHGT	(24)	(24)	(24)	(24)	(24)	(24)
	P= .426	P= .070	P= .409	P= .381	P= .318	P= .363
GDLENGTH	.1603	.2134	-.1002	-.1086	-.2064	-.2200
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .222	P= .153	P= .317	P= .303	P= .161	P= .145
GDWIDTH	-.1195	-.0481	-.1714	-.1115	-.2025	-.0226
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .285	P= .410	P= .206	P= .298	P= .166	P= .457
GDDEPTH	-.0612	.1973	.2828	.2134	.1881	-.2908
	(25)	(25)	(25)	(25)	(25)	(25)

TABLE 3 (Continued)

Pearson Correlation Coefficients

	SHOULDER	CHEST	WAIST	ICREST	PUBICS	ANKLE
GDDEPTH	P= .386	P= .172	P= .085	P= .153	P= .184	P= .079
FFC	.2924	.1248	-.2013	-.1414	-.0832	-.1061
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .083	P= .281	P= .173	P= .255	P= .349	P= .311

	CALF	MIDARM	U3FORE	WRIST	STATURE	SITHGT
CALF		.7213	.7250	.5050	.3648	.1564
		(25)	(25)	(25)	(25)	(25)
		P= .000	P= .000	P= .005	P= .036	P= .228

TABLE 3 (Continued)

Pearson Correlation Coefficients

	CALF	MIDARM	U3FORE	WRIST	STATURE	SITHGT
MIDARM			.8656	.6154	.4026	.2199
			(25)	(25)	(25)	(25)
			P= .000	P= .001	P= .023	P= .145
U3FORE				.6756	.4364	.2163
				(25)	(25)	(25)
				P= .000	P= .015	P= .149
WRIST					.6172	.4597
					(25)	(25)
					P= .001	P= .010
STATURE						.7081

TABLE 3 (Continued)

Pearson Correlation Coefficients

	CALF	MIDARM	U3FORE	WRIST	STATURE	SITHGT
STATURE						(25)
						P= .000
STOE	.2318	.1629	.1846	.2805	.8300	.5041
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .132	P= .218	P= .188	P= .087	P= .000	P= .005
FOREARM	.5010	.4782	.5047	.5144	.6198	.4257
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .005	P= .008	P= .005	P= .004	P= .000	P= .017
KNEEHGT	.3275	.2280	.2773	.4739	.8923	.5968
	(25)	(25)	(25)	(25)	(25)	(25)

TABLE 3 (Continued)

Pearson Correlation Coefficients

	CALF	MIDARM	U3FORE	WRIST	STATURE	SITHGT
KNEEHGT	P= .055	P= .136	P= .090	P= .008	P= .000	P= .001
FOOTF	.4051	.4569	.5604	.3318	.3711	.1712
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .022	P= .011	P= .002	P= .053	P= .034	P= .207
HANDLEN	.3113	.1982	.2503	.4504	.7302	.5450
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .065	P= .171	P= .114	P= .012	P= .000	P= .002
HEELFLR	-.4495	-.2965	-.2848	-.1029	-.0743	.2018
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .014	P= .080	P= .089	P= .316	P= .365	P= .172

TABLE 3 (Continued)

Pearson Correlation Coefficients

	CALF	MIDARM	U3FORE	WRIST	STATURE	SITHGT
BALLFT	-.3913	-.2034	-.1941	-.1309	-.1771	.0953
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .029	P= .170	P= .182	P= .271	P= .204	P= .329
GUITARKN	.2220	.4934	.5131	.4458	.3658	.3873
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .149	P= .007	P= .005	P= .014	P= .039	P= .031
HEADFLR	.0007	.0953	.0772	.3933	.6856	.7820
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .499	P= .325	P= .357	P= .026	P= .000	P= .000
HGTCHAIR	-.1930	-.2229	-.2134	.0029	.2372	.6909

TABLE 3 (Continued)

Pearson Correlation Coefficients

	CALF	MIDARM	U3FORE	WRIST	STATURE	SITHGT
HGTCHAIR	(25)	(25)	(25)	(25)	(25)	(25)
	P= .178	P= .142	P= .153	P= .495	P= .127	P= .000
SITCHAIR	-.1303	.0679	.1195	.1531	-.4079	-.1921
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .272	P= .376	P= .289	P= .238	P= .024	P= .184
WIDCHAIR	-.2469	.0291	-.0338	.1766	-.1361	-.0839
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .122	P= .446	P= .438	P= .205	P= .263	P= .348
HEELHGT	-.1156	.0600	.1073	.0040	.0943	.1991
	(24)	(24)	(24)	(24)	(24)	(24)

TABLE 3 (Continued)

Pearson Correlation Coefficients

	CALF	MIDARM	U3FORE	WRIST	STATURE	SITHGT
HEELHGT	P= .295	P= .390	P= .309	P= .493	P= .331	P= .175
GDLENGTH	-.2565	.0109	-.1269	-.0511	.0949	.0460
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .108	P= .479	P= .273	P= .404	P= .326	P= .414
GDWIDTH	-.4487	-.3335	-.3908	-.4777	-.2774	-.0204
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .012	P= .052	P= .027	P= .008	P= .090	P= .461
GDDEPTH	.0697	-.0100	.1138	.2388	.1619	-.3197
	(25)	(25)	(25)	(25)	(25)	(25)
	P= .370	P= .481	P= .294	P= .125	P= .220	P= .060

TABLE 3 (Continued)

Pearson Correlation Coefficients

	CALF	MIDARM	U3FORE	WRIST	STATURE	SITHGT
FFC	-.0598	.2388	.1869	.2782	.1158	.2844
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .391	P= .131	P= .191	P= .094	P= .295	P= .089

	STOE	FOREARM	KNEEHGT	FOOTF	HANDLEN	HEELFLR
STOE		.5227	.7950	.2386	.6153	-.2523
		(25)	(25)	(25)	(25)	(24)
		P= .004	P= .000	P= .125	P= .001	P= .117
FOREARM			.6274	.4279	.6049	-.3903
			(25)	(25)	(25)	(24)

TABLE 3 (Continued)

Pearson Correlation Coefficients

	STOE	FOREARM	KNEEHGT	FOOTF	HANDLEN	HEELFLR
FOREARM			P= .000	P= .016	P= .001	P= .030
KNEEHGT				.4235	.7783	-.3320
				(25)	(25)	(24)
				P= .017	P= .000	P= .056
FOOTF					.4842	-.4639
					(25)	(24)
					P= .007	P= .011
HANDLEN						-.1754
						(24)
						P= .206

TABLE 3 (Continued)

Pearson Correlation Coefficients

	STOE	FOREARM	KNEEHGT	FOOTF	HANDLEN	HEELFLR
BALLFT	-.4139	-.4147	-.4395	-.3276	-.2197	.9282
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .022	P= .022	P= .016	P= .059	P= .151	P= .000
GUITARKN	.3334	.2200	.2565	.2150	.1624	-.2263
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .056	P= .151	P= .113	P= .156	P= .224	P= .144
HEADFLR	.5685	.4709	.6051	.1828	.5643	.3869
	(25)	(25)	(25)	(25)	(25)	(24)
	P= .002	P= .009	P= .001	P= .191	P= .002	P= .031
HGTCHAIR	.2784	.1800	.2592	-.1159	.1561	.1447

TABLE 3 (Continued)

Pearson Correlation Coefficients

	STOE	FOREARM	KNEEHGT	FOOTF	HANDLEN	HEELFLR
HGTCHAIR	(25)	(25)	(25)	(25)	(25)	(24)
	P= .089	P= .195	P= .105	P= .291	P= .228	P= .250
SITCHAIR	-.4121	-.1907	-.4372	-.2890	-.4133	.1278
	(24)	(24)	(24)	(24)	(24)	(23)
	P= .023	P= .186	P= .016	P= .085	P= .022	P= .281
WIDCHAIR	-.1188	.1992	-.1768	-.0450	-.0877	-.0311
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .290	P= .175	P= .204	P= .417	P= .342	P= .443
HEELHGT	-.0197	.0864	.1443	.3829	.2263	-.2535

TABLE 3 (Continued)

Pearson Correlation Coefficients

	STOE	FOREARM	KNEEHGT	FOOTF	HANDLEN	HEELFLR
HEELHGT	(24)	(24)	(24)	(24)	(24)	(24)
	P= .464	P= .344	P= .250	P= .032	P= .144	P= .116
GDLENGTH	.0740	.0287	-.1066	-.1087	-.2296	.3250
	(25)	(25)	(25)	(25)	(25)	(24)
	P= .363	P= .446	P= .306	P= .303	P= .135	P= .061
GDWIDTH	-.1218	-.3567	-.2968	-.0674	-.3376	.1267
	(25)	(25)	(25)	(25)	(25)	(24)
	P= .281	P= .040	P= .075	P= .374	P= .049	P= .278
GDDEPTH	.2231	-.1796	.0882	-.0332	.0124	.0277
	(25)	(25)	(25)	(25)	(25)	(24)

TABLE 3 (Continued)

Pearson Correlation Coefficients

	STOE	FOREARM	KNEEHGT	FOOTF	HANDLEN	HEELFLR
GDDEPTH	P= .142	P= .195	P= .338	P= .437	P= .477	P= .449
FFC	-.0068	-.0533	.0749	-.0483	-.1011	.1903
	(24)	(24)	(24)	(24)	(24)	(24)
	P= .488	P= .402	P= .364	P= .411	P= .319	P= .186

	BALLFT	GUITARKN	HEADFLR	HGTCHAIR	SITCHAIR	WIDCHAIR
BALLFT		-.2447	.2872	.0003	.1363	-.1026
		(24)	(24)	(24)	(23)	(24)
		P= .125	P= .087	P= .499	P= .268	P= .317

TABLE 3 (Continued)

Pearson Correlation Coefficients

	BALLFT	GUITARKN	HEADFLR	HGTCHAIR	SITCHAIR	WIDCHAIR
GUITARKN			.2083	.0515	.2908	.1413
			(24)	(24)	(23)	(24)
			P= .164	P= .406	P= .089	P= .255
HEADFLR				.5389	-.1895	-.0054
				(25)	(24)	(24)
				P= .003	P= .188	P= .490
HGTCHAIR					-.0062	.1766
					(24)	(24)
					P= .489	P= .205
SITCHAIR						.6313

TABLE 3 (Continued)

Pearson Correlation Coefficients

	BALLFT	GUITARKN	HEADFLR	HGTCHAIR	SITCHAIR	WIDCHAIR
SITCHAIR						(23)
						P= .001
HEELHGT	-.1851	.1462	-.0690	.1526	-.2253	-.0340
	(24)	(24)	(24)	(24)	(23)	(24)
	P= .193	P= .248	P=374	P= .238	P= .151	P= .437
GDLENGTH	.2674	.0478	.1252	.1094	.0151	.4346
	(24)	(24)	(25)	(25)	(24)	(24)
	P= .103	P= .412	P= .275	P= .301	P= .472	P= .017
GDWIDTH	.1218	.1636	-.0566	.3247	-.0596	.1614
	(24)	(24)	(25)	(25)	(24)	(24)

TABLE 3 (Continued)

Pearson Correlation Coefficients

	BALLFT	GUITARKN	HEADFLR	HGTCHAIR	SITCHAIR	WIDCHAIR
GDWIDTH	P= .285	P= .223	P= .394	P= .057	P= .391	P= .226
GDDEPTH	.0255	-.0905	-.0753	-.4070	.1255	-.0398
	(24)	(24)	(25)	(25)	(24)	(24)
	P= .453	P= .337	P= .360	P= .022	P= .279	P= .427
FFC	.2205	.3101	.5114	.3131	.5394	.1981
	(24)	(24)	(24)	(24)	(23)	(24)
	P= .150	P= .070	P= .005	P= .068	P= .004	P= .177

TABLE 3 (Continued)

Pearson Correlation Coefficients

	HEELHGT	GDLENGTH	GDWIDTH	GDDEPTH	FFC
HEELHGT		-.0238	.1223	-.1861	-.1968
		(24)	(24)	(24)	(24)
		P= .456	P= .285	P= .192	P= .178
GDLENGTH			.5434	.0422	.0072
			(25)	(25)	(24)
			P= .002	P= .421	P= .487
GDWIDTH				-.2653	-.0129
				(25)	(24)
				P= .100	P= .476
GDDEPTH					.1190

TABLE 3 (Continued)

Pearson Correlation Coefficients

	HEELHGT	GDLENGTH	GDWIDTH	GDDEPTH	FFC	
GDDEPTH						(24)
						P= .290

Note: Coefficient / Cases / 1-Tailed Sig

TABLE 4

Factor Analysis

F1	F2	F3	F4	F5
SHOULDER	ANKLE	WAIST	HEELFLR	HGTCHAIR
CHEST	STATURE	ICREST	BALLFT	GTRWIDTH
CALF	SITHGT	PUBICS	FFC	GTRDEPTH
MIDARM	STOE	SITCHAIR		
U3FORE	FOREARM	WIDCHAIR		
WRIST	KNEEHGT			
FOOTF	HANDLEN			
GUITARKN	HEADFLR			

CHAPTER 6

Discussion

Although the Pearson Correlation Coefficients showed many high correlations, there was a finding of no significant relationship between physical body stature to footstool height and chair height. This finding disagrees with Duncan (11) who stated that the length of the torso is directly related to the height of the footstool. This belief is not uniquely Duncan's. Many guitarists believe that the length of the torso or leg length is related to the footstool height. Findings in this research found no significant relationship between stature and footstool height or chair height. There were, however, many high correlations between the other variables, most of which were between the body measurements.

To check the validity of this finding a Multiple Regression analysis was computed relating each of the variables to the dependent variable footstool height (ball of foot to floor). These results showed the independent variable CALF as the factor which most predicted footstool height. CALF was not clearly the factor which most predicted footstool height. The Multiple Regression analysis like the other analyses in this study again showed many high correlations, and the independent variable CALF was the factor which was the highest of many high predictors of of footstool height. One can conclude from these results that there are many variables that affect the height of the footstool. This finding would agree with Berg who stated that there are many differences among individuals, and many variables affect how we sit with the guitar (363).

The means of the body measurements of this study are highly correlated to Dempster's (1955) measurements. The high standard deviations also correspond to Dempster's data. The mean LOP (Length of time performing) was 135.130 months (about 11 years). The mean LUSP (Length of time using the sitting position the subjects presently employed) was 79.667 months (about 6½ years). From these results one can deduce that most guitar students will change their footstool height and/or sitting position several times in their careers. One reason for this phenomenon could be because some guitarists begin guitar study on their own, without the guidance of a qualified instructor. What feels comfortable to the beginning student could very well be the reinforcement of bad postural habits used in every day life. This poor posture is not a problem at a young age. The human body has a way of protecting itself. According to Hansson (1945), this protective mechanism is reduced as one gets older. With prolonged use of an unhealthy posture, the musician may eventually experience discomfort, many times leading to an injury. These results suggest the importance for the guitar instructor knowing the characteristics of good posture. As stated previously, "the earlier such posture teaching occurs, the better, since age intensifies muscular habits" (Hansson 951).

Although only one subject used the guitar cushion during performance, three subjects used the guitar cushion for practice but used the footstool when performing. The reasons for not practicing with the conventional footstool were not stated by the subjects. One might assume, however, that these guitarists are looking for an alternative to the footstool when they practice their instruments for long periods of time. One reason why guitarists are reluctant to incorporate the guitar cushion in performance may be for aesthetic reasons. People are used to seeing a guitarist with a footstool. After all, Andres Segovia used one for over 80 years.

Only four.of the 25 subjects used an adjustable piano bench. Twenty subjects used any "normal" chair available. One could conclude that the majority of guitarists are not very concerned with what they sit on in performance.

Although proper chair height in relation to stature was found to be important for a "healthy" posture (Akerblom, 1948; Floyd and Ward, 1968; and Grandjean, 1969), this research found no significant relationship between the height of chair and stature. The mean HGTCHAIR (Chair height) was 45.590 cm. The mean KNEEHGT (Knee-height) was 51.725. This would correspond to Akerblom's statement that "the height of the chair should not be greater than the length of the lower leg, measured without shoes" (158). However, KNEEHGT was not significantly related to HGTCHAIR in this present study. Since the KNEEHGT was not significantly related to HGTCHAIR in this study, one may assume that the subjects did not take knee-height into consideration when choosing a chair or bench to sit on when these measurements were taken.

Of all the injuries reported, all but one referred to back pain. This must be an area of concern for the guitarist. As stated above, the research reviewed for this study stated the need for back support while sitting, specifically support in the lower lumbar region (Akerblom, 1945; Dempster, 1955; Shackel, Chidsey and Shipley, 1968; Floyd and Ward, 1968; Frankel and Nordin, 1980). Guitarists typically sit on the front edge of the chair or bench with no support for the back. The mean score for SITCHAIR (Where you sit on the chair or bench) was 18.752 cm. The mean for WIDCHAIR (Depth of chair or bench) was 40.719 cm. One can conclude that the average guitarist sits at about the halfway point of the chair or bench with no support to the back. Since most research agrees that back support is important in a healthy seated posture, the musician should consider whether the lack of support in the lumbar region is not the cause of backache. "Body position affects the loads on the lumbar spine. A forward-bending or twisted position causes higher stresses on the lumbar spine than does upright standing. Unsupported sitting also produces higher loads than does upright standing" (Frankel and Nordin, 285).

Akerblom says that "many authors maintain that it is advantageous to have a smaller back-rest applied only to the lumbar region. This should be of such a shape that the upper part of the trunk can overhang it backwards and thus the back-rest will support part of the weight of the upper part of the body. The position of the vertebral column will be somewhat similar to that of standing posture, though, of course, the lordosis will not be nearly so pronounced. If one were to sit in this position without any support the muscles would have to do a great deal of work in maintaining the balance, but this work is transferred to the back-rest" (163). One can assume that in maintaining the standard position of the seated classical guitarist without support for the back, the muscles are very active in order to support this position and would be subject to strain or even injury if poor posture is continued for an extended length of time.

Akerblom goes on to state that "when sitting upright without support at least some of the joints of the vertebral column are in a position of unstable equilibrium. It is very probable that the gravity line often falls so far in front of the axis of the joints of the vertebral column that the work imposed on the muscles of the back is quite a lot greater than that which they can carry out continuously, with the natural result that the back becomes tired" (180). The guitarist leaning over his or her instrument could very well be shifting the center of gravity forward thus causing back strain because of the extra work required to hold the position. From the research on sitting posture from several sources, it is conceivable that the cause of the back pain experienced by some guitarists is the lack of support in the lower back.

One concern in this research is the small sample size. With a much larger sample, more confidence could be placed in the results. The measurements should be limited to a few significant body parts taken on a much larger sample. The reason for the many variables in this research was to learn more about the physiological make-up of guitarists and their postural attitudes and to represent a pilot study for further research in this area.

Another concern was the limitation of measurements which had to be done over clothing. The subjects should ideally have been measured in a way that no clothing would prohibit the most accurate measurement. The problem with this was that many of the measurements had to be taken in public places. The measurement over clothing was avoided where possible.

Recommendations for Further Research

(1) The study should be repeated with a larger sample and more specific variables. Based on results from the factor analysis of this pilot study, the measurements could be limited to the following variables: SHOULDER, FOOTF, STATURE, KNEEHGT, SITCHAIR, WIDCHAIR, BALLFT and HGTCHAIR.

(2) A chair with an adjustable back-rest should be designed that is not as deep as the conventional chairs and is adjustable in height.

(3) An electromyographic test should be administered to several guitarists in their sitting positions to see exactly which muscles are in action to support the position held by most classical guitarists.

(4) A study should be done comparing the posture of a guitarist using a cushion to a guitarist incorporating the conventional footstool.

(5) Research should be done relating the Alexander Technique to the guitarist.

CHAPTER 7

Summary and Conclusions

It is the responsibility of the guitar instructor to know what footstool height and seated posture will best suit each individual student. Knowledge of the anthropometric characteristics of the human body and what researchers agree to be the "healthiest" sitting posture is important for the teacher when establishing the student's postural habits. Body awareness for the musician is as important as musical awareness. However, the physiological and mechanical aspects of playing an instrument are often neglected areas of study. Although there have been measurement studies concerning the sitting position (Dempster, 1955; Akerblom, 1948; Life & Pheasant, 1984; and Shackel et al., 1968), there are no known scientific studies of the guitarists' seated posture.

Although there were many high correlations between the variables, findings in the present investigation showed that there is no significant relationship between physical stature and the height of the footstool and chair. The fact that there were so many high correlations between variables shows that none were significant. The left and right measurements, however, were found to be highly related and were combined to reduce the number of variables in the study.

Of the injuries reported, back pain was the greatest complaint of the subjects. This could be due to the fact that guitarists generally do not use a back-rest but sit at the front edge of the chair or bench without back support causing greater activity in the back muscles needed to hold this posture. Researchers of the sitting posture agree that for a healthy posture a back-rest should be used if sitting for a long period of time. From these findings one could conclude that a chair designed to accommodate the guitarists' movements along with lower back support is needed.

The investigator recommends continued research concerning the seated posture among guitarists. A similar study with a larger sample size, the designing of a chair with an adjustable back-rest, an electromyographic test administered to guitarists, a comparison between guitarists who use the conventional footstool to those who use a guitar cushion, and research concerning body awareness and the guitarist are all projects which would lead to a greater understanding of the relationship between the instrument and the instrumentalist.

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APPENDIX 1

Professional Guitar Teacher/Performer Survey

Name____

Address______________________________________

City__________ State__________ Zip__________

Phone (home) ___________ (work) ___________

Age ___________ Sex ___________ Weight ________

1. Do you have any disabilities?__________________________

2. How long have you taught or performed professionally?

   ____

3. Which do you gain the most income from?

   Teaching_____ Performing_____ Other_____________

4. With whom have you studied guitar?____________________

5. Of the following, which one(s) do you practice and perform with?

   Footstool ____________________

   Pad ____________________

   Adjustable piano bench ____________________

   Any "normal" chair available ____________________

   Other (specify) ____________________

6. Have you ever experienced injury because of the guitar? If so, specify____

7. How long have you used the sitting position you now employ?____

APPENDIX 2

Circumferences

	Measurements		1st	2nd	(3rd)
1.	Shoulder (Sternal Angle)		____	____	____
2.	Chest (Xiphisternam)		____	____	____
3.	Waist		____	____	____
4.	Iliac Crest		____	____	____
5.	Pubic Symphysis		____	____	____
6.	Ankle	Left(L)	____	____	____
		Right(R)	____	____	____
7.	Calf	L	____	____	____
		R	____	____	____

Upper Limb Circumferences

1.	Mid-Arm	L	____	____	____
		R	____	____	____
2.	Upper Third of Forearm	L	____	____	____
		R	____	____	____
3.	Wrist (Styloids)	L	____	____	____
		R	____	____	____

Linear Measurements

1.	Stature		______	______	______
2.	Sitting Height (back straight)		______	______	______
3.	Shoulder to Elbow	L	______	______	______
		R	______	______	______
4.	Forearm	L	______	______	______
		R	______	______	______
5.	Knee Height	L	______	______	______
		R	______	______	______
6.	Foot at Floor	L	______	______	______
		R	______	______	______
7.	Hand Length	L	______	______	______
		R	______	______	______

Measurements with Guitar in Position

1.	Heel to Floor	______	______	______
2.	Ball of Foot to Floor	______	______	______
3.	Front of Guitar to Knee	______	______	______
4.	Head to Floor	______	______	______
5.	Height of Chair/Bench	______	______	______
6.	Where you sit on Chair/Bench	______	______	______
7.	Width of Chair/Bench	______	______	______
8.	Shoe Heel Height	______	______	______

9. Dimensions of Guitar	Length	______	______	______
	Width	______	______	______
	Depth	______	______	______
10. Footstool from Chair		______	______	______

APPENDIX 3

Definition of Measurements

Circumferences

1. Shoulder (Sternal Angle)

   Position: Standing, arms vertical.

   Landmarks: The greater tubercle of the humerous located just distal to the anterior portion of the acromion process.

   Process: As the subject internally rotates his arm the greater tubercle will become palpable and can be used as a point for the measurement to be taken.

2. Chest (Xiphisternum)

   Position: Standing.

   Landmarks: The axilla (armpit) over the pectoralis major muscles.

   Process: The subject was instructed to lift arms so that the tape measure could be placed over the landmarks. The measurement was taken with the arms in the vertical position after the subject was instructed to relax.

3. Waist

Position: Standing, arms vertical.

Landmark: Navel.

Process: The circumference was measured at the point of the subject's navel.

4. Iliac Crest

Position: Standing, arms vertical.

Landmarks: Ilium - The bone easily seen or palpated on most subjects on the side of the pelvis.

Process: Measurement taken around the point of anterior superior iliac spine.

5. Pubic Symphysis

Position: Standing, arms vertical.

Landmarks: Because the pubic symphysis itself is not palpable, a parallel landmark the greater trochanter was used. This is the large prominance which may be palpated about four or five inches inferior to the most lateral portion of the iliac crest.

Process: The investigator palpated the prominance during internal and external rotation of the subject's thigh. The measurement was taken at the point of the greater trochanter.

6. Ankle (left and right)

Position: Standing.

Landmarks: The medial and lateral malleolus (expanded lower extremity of the fibula and tibia on the lateral and medial side of the leg at the ankle).

Process: Circumference measured around the medial and lateral malleolus.

7. Calf (left and right)

Position: Standing.

Landmark: Midway of the fibula and tibia at the most prominant point of the gas troc- nemius muscle.

Process: Circumference measured around the most prominant point of the gastrocnemius muscle.

Upper Limb Circumferences

1. Mid-Arm (left and right)

Position: Standing, arms vertical.

Landmarks: Biceps brachii (the large flexor muscle of the front of the upper arm) and Triceps brachii (the large extensor muscle that is situated along the back of the upper arm).

Process: Subject told to contract biceps for location of most prominant point. The measurement was taken at this point.

2. Upper Third of Forearm (left and right)

Position: Standing, forearm vertical and relaxed.

Landmark: Most prominant point of forearm.

Process: After the subject was told to let arm hang vertically, the circumference was measured at the most prominant part of the forearm.

3. Wrist (Styloids) (left and right)

Position: Standing, forearm in pronation.

Landmarks: Styloid process of radius (the lateral aspect of the wrist, proximal to the first metacarpal) and the styloid process of the ulna (the small projection on the medial aspect of the head of the ulna).

Linear Measurements

1. Stature

Position: Standing, back against wall.

Landmarks: Top of head and the floor.

Process: A straight edge was placed level on top of subject's head to the wall and the measurement was taken from this point to the floor.

2. Sitting Height (back straight)

Position: Sitting on the particular apparatus used by the subject with back straight against the wall.

Landmarks: Top of head and the floor.

Process: A straight edge was placed level on top of subject's head to the wall and the measurement was taken from this point to the floor.

3. Shoulder to Elbow (left and right)

Position: Standing, mid-arm vertical, forearm horizontal.

Landmarks: Shoulder joint and the lateral epicondyle.

Process: Upon location of the landmarks, the length of the shoulder to elbow was measured.

4. Forearm (left and right)

Position: Standing, mid-arm vertical, forearm horizontal.

Landmarks: Lateral epicondyle and the styloid process of the ulna.

Process: The measurement was taken of the distance between the landmarks.

5. Knee Height (left and right)

Position: Sitting, feet (without shoes) flat on the floor, calf perpendicular to the floor.

Landmarks: Patella and the floor.

Process: The measurement was taken from the medial patella to the floor.

6. Foot at Floor (left and right)

Position: Sitting, foot on tape measure.

Landmarks: Posterior of foot and the anterior medial toe.

Process: The distance between the landmarks was measured and recorded.

7. Hand Length (left and right)

Position: Standing, forearm horizontal, palmer surface of the hand facing up.

Landmarks: The most distal wrist crease at the proximal edge of the flexor retinaculum and the end of the middle finger.

Process: The distance between the landmarks was measured and recorded.

Measurements with Guitar in Position

1. Heel to Floor

   Position: Subject's most used playing position.

   Landmarks: Bottom of left heel and the floor.

   Process: The measurement was taken between the landmarks while the subject was playing.

2. Ball of Foot to Floor

   Position: Subject's most used playing position.

   Landmarks: Ball of left foot and the floor.

   Process: The measurement was taken between the landmarks while the subject was playing.

3. Front of Guitar to Knee

   Position: Subject's most used playing position.

   Landmarks: Point of contact between the front of the guitar and the left thigh and the patella.

   Process: The measurement was taken between the landmarks while the subject was playing.

4. Head to Floor

   Position: Subject's most used playing position.

   Landmarks: The top of the head and the floor.

   Process: A straight edge was used on the top of the head for a more precise measurement between the landmarks.

5. Height of Chair/Bench

Position: Measurement did not involve the subject.

Landmarks: The top of the front of the chair/bench and the floor.

Process: The measurement was taken between the landmarks.

6. Where you sit on Chair/Bench

Position: Subject's most used playing position.

Landmarks: Buttocks and the back of the chair/bench.

Process: The measurement was taken between the landmarks while the subject was playing.

7. Depth of Chair/Bench

Position: Measurement did not involve the subject.

Landmarks: Front of chair/bench seat and back of chair/bench seat.

Process: The measurement was taken between the landmarks.

8. Shoe Heel Height

Position: Subject's most used playing position.

Landmarks: Top of heel and bottom of heel on the side of subject's shoe heel.

Process: The measurement was taken between the landmarks while the subject was playing.

9. Dimensions of Guitar

Position: Measurement did not involve the subject.

Landmarks: Length - the base of soundboard to the tip of the head; Width - the narrowest sides of the soundboard; Depth - the narrowest side of the soundboard and the narrowest side of the back.

Process: The measurement was taken between the landmarks.

10. Footstool from Chair

Position: Subject's most used playing position.

Landmarks: Front of chair/bench and the first contact of the footstool.

Process: The measurement was taken between the landmarks while the subject was playing.