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Assessing and Reporting Normative Data and Correlations in Adolescent Non-Professional Dancers

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ASSESSING AND REPORTING NORMATIVE DATA AND CORRELATIONS IN ADOLESCENT NON-PROFESSIONAL DANCERS

By

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This thesis by Alexandrea Mills Holley is recommended for approval by the student's Thesis Committee and Department Head in the School of Health and Human Performance and by the Assistant Provost of Graduate Education and Research.

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ABSTRACT

ASSESSING AND REPORTING NORMATIVE DATA AND CORRELATIONS IN ADOLESCENT NON-PROFESSIONAL DANCERS

By

Alexandrea Mills Holley

Objective: The purpose of the current study was to gather normative data and determine if there was a correlation for multiple measures in adolescent dancers, specifically in relation to the hip joint including: balance, muscular strength, endurance, and flexibility. Design: Descriptive Correlation. Setting: Laboratory. Participants: Thirty-one female volunteers (mean age 12.52 ± 2.26), were recruited to participate in the university IRB approved study. Interventions: During the testing, the participants filled out a qualitative questionnaire, had their anthropometric data measured, and were assessed on flexibility of the hamstring. Functional measurements of muscular strength and endurance of the hip flexor, sacrum imbalance, and postural stability were analyzed for each dancer. Main Outcome Measure: There were no significant relationships between measures of strength and flexibility. Holley Protocols for measures of balance, strength, flexibility, and endurance were found to be valid and reliable. Conclusion: There are many factors to consider with relation to the adolescent dancer, further research is needed to help predict flexibility, strength, endurance, and balance measurements.

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This thesis follows the format prescribed by the Journal of Dance Medicine and Science and the School of Health and Human Performance of Northern Michigan University.

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I. MANUSCRIPT

INTRODUCTION

The ultimate differences between conventional athletes and dancers lie in the expressivity involved in performance and the extreme range of motion used. Dancers are often taxing their abilities by combining an athletic performance with high aesthetic standards.[1] Participation in dance for performance, competition or recreation is becoming increasingly popular in the younger population.[2,3,4] Recognizing that dance is a popular form of physical activity for non-professional adolescents (age 10-17 years) suggests a tremendous amount of variables to consider such as skill, age, body type, and time spent dancing. It is perhaps because of the wide range of these variables that we lack research regarding the adolescent age group as dancers.

Research on adolescent dancers, has to date, focused predominantly on injury incidence.[5–9] Adolescents are prone to incur more severe dance-injuries than younger populations.[9–11] Injuries may result from inadequate experience, improper balance, and landing technique.[11,12] The adolescent female that uses dance as a form of recreation is susceptible to multiple factors that may influence their skill level and predispose them to injury.

Adolescent individuals, dancers or not, range in their rate and time of maturation with varying levels of joint range of motion (ROM), body structure, and anatomical developments.[12,13] The precise movement required of dancers uses refined physical skills that involve hours of technique classes and rehearsals. Dance discipline varies for each dancer, and some participate in multiple sports, different styles of dance, and other activities. Specific to dance, components include cardiovascular fitness, flexibility, body composition, neuromuscular coordination, and muscular strength, power, and endurance.[14] A dancer's strength, balance, and flexibility are used to complete patterns of movement which are considered necessary for dancing. Using a dancer's full ROM is essential for maximizing the expressivity of the movement needed for dance preformance.[15] Researchers have demonstrated that supplemental strength training and improving balance and coordination may reduce the occurrence of dance related injuries.[13,16]

A dancer's back and lower extremities were found by Schoene[6] and Shan[8] to sustain the most injuries while dancing. The fundamental positions of dance include an external rotation of the hip combined with extreme ranges of flexion and extension.[17,18] These positions will directly affect the sacroiliac (SI) joint.[19,20] Researchers have demonstrated how low back pain may be caused by dysfunction of the SI joint.[21] Dysfunction of the SI joint and the onset of the adolescent growth spurt both stress the neuromuscular coordination of the dancer and may affect their balance.[13,21]

Sustaining injuries as a dancer could impact the long-term health of the individual. With the high rate of injuries in the adolescent population and the popularity of dance growing,[9] the need for preventative action increases. Currently, the research lacks information on injury free, adolescent, recreational dancers. Perhaps it is this way for a reason, as the very definition of adolescence reveals multiple variables. However, this will not change, and the research must start somewhere. With respect to the dancer's full ROM, previous research demonstrates that a lack of muscular strength could negatively impact the SI joint, resulting in poor posture and balance.[21] A common movement in dance that demonstrates the leg's ROM and takes into account the flexibility of the hamstring, strength of the hip flexors, and the dancer's ability to balance on one leg is the grande battemente. The grande battemente is a fully extended leg lift and is seen in multiple styles of dance lifted above the waist line in the front of the body (sagittal plane) using hip flexion.[22] The purpose of this study was to gather normative data and correlations for measures of balance, muscular strength and endurance, and flexibility for adolescent dancers, specifically in relation to the hip joint.

METHODS

Experimental Design. A quasi-experimental research design was used to gather normative data on adolescent dancers in the Marquette area. The variables included in this descriptive-correlation study were the flexibility of the hamstring, hip flexion with regards to muscular strength and endurance, sacrum imbalance, and functional balance for dancers.

Research Participants. The subjects were a convenience sample engaged with the help of the local dance community in Marquette, Michigan. Ethical approval was provided by the Northern Michigan University Institutional Review Board (HS15-684) (Appendix A). Consent and assent forms (Appendix B and C) were gathered from the local dance wear store, Second Skin Shop. Dancers were recruited via fliers at the shop, distributed at local dance studios, handed out during community dance programs, and spread by email and word of mouth. Thirty-one adolescent female dancers between the ages of 10 and 17 volunteered to participate (see Table 1 for descriptive data). This age range takes into account the World Health Organization's definition of adolescents (between 10 and 19) and the age the person is considered a legal adult in the United States, 18.[23,24]

All dancers self-selected into the current study by returning their consent and assent forms. The dancers were scheduled for data collection if they were enrolled in a dance program and between the ages of 10 and 17. Exclusion criteria included current injuries to the lower extremities and lack of enrollment in a current dance program. There were no male participants in this study.

Data collection included a questionnaire, anthropometric measurements of height, weight, and leg length; and measurements of flexibility, strength, endurance, possible sacrum imbalance, and balance. All participants had the option to drop out of the study at any time.

Questionnaires. A questionnaire was used to provide qualitative data on age and experience of the individual and subjective data including, their perceived dominant leg, their general knowledge of dance, and which skill between flexibility, strength, and balance they value (Appendix D).

Instrumentation. Balance was measured by using the Biodex Balance System (Biodex Medical System, Inc., Shirley, New York, USA). The Biodex Balance System has been validated for measuring dynamic balance.[25,26]

The Biodex System 4 Pro dynamometer (Biodex Medical System, Inc., Shirley, New York, USA) was used to measure the hip flexor force production. The Biodex System has been validated for isometric and isokinetic torque measurements by multiple studies.[27,28]

A high-speed Casio ExLIM-1 video camera and camera tripod were used to assess the data along with motion analysis software (MaxTRAQ 2D, Innovision Systems Inc, Columbiaville, MI, USA).

Procedures. After receiving parental consent and child assent forms, the child was scheduled for their measurements. Upon arriving to the Physical Education and Instructional Facility (PEIF) located at Northern Michigan University, the child was asked to first complete a questionnaire. The dancer’s better leg was recorded as the preferred leg (PL) per questionnaire response. After the questionnaire, the young dancer watched an instructional video, becoming familiar with subsequent measurements. Next, anthropometric measurements of height, weight, and leg length (measured from the greater trochanter to the lateral malleolus while in the standing position) were recorded. Then participants began a 5 minute warm-up of unilateral leg swings back and forth between flexion and extension. Notably, during all measurements, participants were asked to use their PL, recorded from the questionnaire.

Following the warm-up, dancers were assessed on flexibility, muscular strength, muscular endurance, sacrum imbalance, and balance. All rest periods between repeated measures were based on the intensity and number of repetitions, 30 to 60 seconds of rest was sufficient for all measurements.[29] Flexibility was tested first using two methods, a modified back saver sit-and-reach test (MBSSR) and the Holley Vertical Kick Test (HVKT). An assisted forward leg hold and drop, the Holley Hold (HH) was used as the first technique for measuring muscular endurance while the second used a unilateral isometric hip flexion (IMHF). The dance participants also completed the following tests: a sacrum screening consisting of two tests to determine sacrum imbalance, the standing flexion test (STFT) and the stork flexion test (SKFT); a muscular strength test for unilateral isokinetic hip flexion (IKHF); and finally, a one-legged balance measure was taken.

Measurements. First, the MBSSR was used to measure hamstring flexibility.[30–32] During the test, the dancer performed a single-leg sit-and-reach on a bench with measuring tape; the best of 3 tries was recorded. The dancer used their PL outstretched in front of them with the untested leg (UL) placed on the floor with their knee at approximately 90°. The outstretched leg had the sole of the foot lined up on the measuring tape. Each participant was asked to reach as far forward as possible and hold for 2 seconds while maintaining full extension of the knees, arms, and fingers, the hands placed on top of each other with the tips of the middle fingers evenly placed and palms down. The score of the most distant point on the bench reached was recorded out of the 3 trials.

The second flexibility test was not an established assessment. For the purposes of this study it was termed the Holley Vertical Kick Test (HVKT). To calculate the HVKT, bright spherical markers were placed on the lateral condyle of the femur, greater trochanter of the femur, and lateral trunk of the PL for each participant. Each dancer was allowed to choose whether they started in a parallel position or in ballet's first position. The participant used their UL as their base standing leg and positioned that side of their body about a foot from the wall while placing their hand on the wall for stabilization, as they would a barre in class. The arm on the working side of the body was raised to a high fifth position, or held above the shoulder. Each participant was asked to perform a series grande battements en devant (GBD), translation in dance "large beats in front," or simply "big front kicks." During the GBD, both legs remained fully extended and each GBD started with the heels lined up. Three GBD were performed correctly before proceeding. The researcher, an expert in the dance, determined when the 3 GBDs had been done correctly. A video recording and subsequent examination of the movement was completed using motion analysis software (MaxTRAQ 2D, Innovision Systems Inc, Columbiaville, MI, USA). The angle was calculated when the leg reached the highest point and was measured with reference to the markers and reported as the angle of hip flexion by subtracting the angle found from 180°.

The Holley Hold muscular endurance test has not been established. The HH was completed on the same video at the same location as the HVKT with the same markers. The dancer was instructed to complete an assisted leg lift by grabbing the medial side of the PL heel with the ipsilateral hand and extending the leg to its greatest height, keeping both legs straight. Once there, they were instructed to hold for 2 seconds before releasing the leg, trying to maintain it at the greatest height they could for 4 seconds. After a short 30 second break, the dancer repeated this test once more. The data recorded came from review of the video and motion software as above, and included the angle of the assisted hold at the highest point and the angle of the dropped hold, taken 2 seconds after the release. To complete the measurement for endurance, the difference between the highest angle and the released angle measure was recorded.

Sacrum imbalance was assessed using 2 flexion tests. The STFT and SKFT were completed as recommended by Hayek and collegues.[33] The STFT was done 3 times followed by the SKFT, alternating between right and left legs 3 times. Each assessment was completed by the same research assistant whom received training. The STFT was reported as either symmetrical or imbalanced on the right or the left side. The SKFT was recorded as either a pass, even sacrum, or failed, uneven sacrum, on the associated side. The majority score was recorded for all 3 tests.

Muscular strength was measured on the Biodex System 4 Pro dynamometer. An adjusted protocol, the Holley Protocol, evaluated the strength of unilateral isokinetic hip flexion (IKHF) with the participant in the standing position. The PL was attached to the dynamometer resistance adapter (specific to knee flexion/extension) with a Velcro strap fitted slightly superior to the knee. The top of the dynamometer was used as a steady handhold to ensure stability. The greater trochanter of the PL was lined up with the dynamometer axis as an anatomical reference. If necessary, the subject's UL was on a riser to ensure proper alignment of the dynamometer axis and joint. A goniometer was used to calibrate the dynamometer at 0° in the standing position. The range of motion was then limited for the flexion/extension of the hip from 0° to 120° of hip flexion. The Biodex Advantage software program performed gravity correction automatically using a static torque measure obtained at 90° of hip flexion. A self-selected familiarization of GBD repetitions were completed while strapped into the Biodex to ensure the Velcro was in place, followed by 30 seconds rest. Two trials of 5 GBDs with 60 seconds of rest in between were completed by the dancer. They were instructed to keep their UL heel on the floor, arm up, and to kick as hard as they could during the repetitions. The isokinetic torque of hip flexion was assessed at 300 degrees per second. The range of motion, peak torque, angle of peak torque, and torque at 90° were recorded.

The second strength endurance test also used the Biodex System 4 Pro dynamometer. The dynamometer was set up as above. The testing protocol was changed to reflect the Holley Protocol for testing of unilateral isometric hip flexion (IMHF). Three repetitions of an isometric contraction measured at 90° of hip flexion and held for 4 seconds followed by 1 minute of rest were completed. The isometric peak torque and impulse during the 4 second hold were recorded.

A postural stability test assessed the participant's ability to maintain their center of balance. The more the dancer deviated from their center of balance the higher their score. The Biodex Balance System was positioned with the handholds down and about a foot from the wall. The following Holley Protocol was used. The participant was asked to line up their UL on the platform matching the cursor to their center of gravity. The tracing and cursor were then turned off for the remainder of the trial. The participant performed 3 postural stability test trials for 20 seconds each with their PL lifted in front extended off the ground to about knee height. The dancer's arms were in a demi fifth position with arms raised to elbow height held out in front of the body in the shape of a circle. The platform is completely stable at the position 12. The lower the number the more unstable the platform becomes. At the start of the balance assessment, the platform was set at a 4; the platform decreased stability every 5 seconds from a 4 to a 3, then a 2, and finally a 1 during the test. Three trials were completed with 10 seconds of rest in between. The balance score was reported at the end of each trial. With the completion of all 3 trials the average score along with the average anterior/posterior and average lateral/medial scores were recorded.

Data Analysis. Analysis of the data was conducted using Statistical Package of the Social Sciences version 23.0 (SPSS). Frequency comparisons from the questionnaire were performed using a Chi-square test for independence. A Partial correlation was used to determine the relationship between hamstring flexibility, leg strength, leg endurance, and balance, controlling for the age and the experience of the dancer. A Chi-square test for independence was also used to determine whether experience was related to preference for improving flexibility, strength, or balance. A Multinomial Logistic Regression was used to determine if experience predicts the preference for improving strength, flexibility, or balance. A repeated measures analysis of variance (REANOVA) and intraclass correlation coefficient (ICC) were used to estimate the reliability of the Holley Protocols for testing strength, endurance, flexibility, and balance. If the measures between trials were not significantly different ($p > 0.05$) and the individuals maintained their ranks (ICC > 0.75[34]) the averages of the measurements were recorded. Ranks were assigned to related scores with different units of measure in order to make comparisons as seen in Table 2. A Wilcoxon Signed Ranks test (WSR) was used to determine the validity of the HVKT and the HH. An Independent T-test was used to compare balance scores as measured by the Biodex Balance System with the independent variable as what the subject thought about most, balance or other (strength and flexibility). Independent T-tests were also used to determine if an imbalance in the sacrum was significant within the dependent variables of flexibility, strength, balance, and endurance measurements.

Hypothesis. The Holley Protocols for testing were created to assess a dancer's hip flexion specific for the GBD. It was hypothesized that the Holley Protocol would be reliable and valid for measures of flexibility and endurance. The Holley Protocols for strength and balance were also predicted to be reliable. Dancers' strength and endurance were hypothesized to be correlated, but flexibility would not be related. Another hypothesis maintained the idea that as experience increased, so would the knowledge of the importance of strength. Finally, it was hypothesized that a sacrum imbalance would predict a lack in strength.

RESULTS

Flexibility. The means for all measurements can be found in Table 3. The HVKT was determined reliable as presented in Table 4, there was no difference found between the 3 trials measured ($p > 0.05$). The ICC was greater than 0.75 (average ICC = 0.983) showing that the participants maintained their ranks throughout the trials. A Wilcoxon

Signed Ranks test showed no significant difference between the MBSSR and the HVKT ($p = 0.176$). A Spearman Correlation showed that the MBSSR and HVKT were significantly correlated ($p = 0.006$). The correlation coefficient was reported as 0.481, signifying a moderate correlation with some movement between the rankings.

Strength. Using the Holley Protocol to measure strength is a reliable form of measurement for the peak torque, angle of peak torque, torque at 90°, and average torque. There were no differences between the trials (Table 4). The ICC is greater than 0.75 for all measures except for the angle of peak torque (average ICC = 0.359).

Endurance. The Holley Protocol for the IMHF endurance test on the Biodex resulted in no significant differences between trials (Table 4). The individuals also maintained their ranks, such that ICC was greater than 0.75. The HH trials had no significant differences between them ($p > 0.05$); the ranks were also maintained (average ICC = 0.866). A Wilcoxon Signed Ranks test showed no significant difference between the ranked scores of impulse from the IMHF and the ranked scores of dropped angle differences measured by the HH ($p > 0.05$). A Pearson Correlation did not show a significant relationship between the methods for measuring endurance ($p > 0.05$, correlation coefficient = 0.239).

Balance. No significant differences were reported between the balance trials for each subject ($p > 0.05$); however the ICC were only moderately acceptable (average ICC = 0.71). There were no significant relationships between balance scores and whether the subject thought about balance while dancing (Table 5).

SI joint imbalance. There were no significant relationships between sacrum imbalances and strength, endurance, balance, and flexibility measures ($p > 0.05$). Thirty-nine percent of the individuals failed at least one of the sacrum imbalance screenings.

Questionnaire. All dancers during the time of the current study were required to be enrolled in a dance class, the average amount of time spent per week dancing was reported to be 5.84 ± 4.44 hours (range = 1-18 hours per week). Four dancers, 13%, reported having experience in only one form of dance. About 87% of dancers reported having studied ballet, 71% reported experience in modern, contemporary or lyrical, 42% had taken gymnastics, and 64.5% reported other experience (data reported in Table 6). There were no current injuries, however, 29% reported past injuries from dancing. Only 74% of dancers understood what turnout meant. Balance was the variable most thought about while dancing (45%), while 55% of dancers wished to improve flexibility. All data gathered from the questionnaire can be seen in Table 1 and Table 6.

A partial correlation, controlling for age and experience of the dancer found significant correlations ($p < 0.05$) between measures of flexibility and balance, flexibility and endurance, strength and endurance, strength and balance, and balance and endurance (Table 7). There were no significant correlations between flexibility and strength ($p > 0.05$). There was not a significantly even split between preference for improving balance, strength, or flexibility (Chi-square = 6.645, $p = 0.036$). There was no significant relationship between years of experience and whether the dancer chose flexibility, balance, or strength to improve upon (Chi-square = 26.14, $p = 0.346$) as shown in Figure 1.

DISCUSSION

The primary purpose of the current study was to collect normative data on adolescent dancers and determine if there were any correlations between the measurements. The measurements were completed on the dancers' balance and flexibility, as well as strength and endurance of the hip flexors. Secondary objectives included determining the reliability and/or the validity of Holley Protocols for the individual assessments.

Flexibility. A MBSSR is a valid measurement for flexibility,[32] and the HVKT was determined valid compared to the MBSSR. The correlation between the MBSSR and the HVKT was moderate. The measurements for the MBSSR were visually inspected and rounded to the nearest half centimeter, while the angle was taken precisely, rounded to the nearest tenth, by a computer program locked onto the visually selected markers. There was also a smaller range between the MBSSR measurements (27.0 cm), while the range in angles for the HVKT was 78.17°. The HVKT was reasoned to be reliable due to the lack of difference between trials and the high ICC value. One trial would be sufficient for completing the HVKT; however, the test was not time consuming and the best of the 3 trials may be used. The HVKT is a more functional way to measure the dancer's flexibility, it mimics the GBD in dance classes.

Strength and Endurance. The Biodex dynamometer 4 has been a validated source for obtaining strength and endurance measurements.[27,35] Using the Holley Protocols on the Biodex were reliable forms of measurement for both strength and endurance. The dancer would never complete a GBD with their knee bent, nor would they with the angle of hip flexion less than 90°. Thus a more functional measure of measuring the dancer's hip flexion during the GBD is the Holley Protocol, and it should be considered in the future for obtaining these measurements on dancers.

Balance. The Biodex Balance System is a valid way for measuring balance.[25,26] Even though no significant differences were reported between the balance trials, the rankings of the individual varied across trials. Further studies should familiarize the dancer with the Biodex Balance System; although the positioning was functional for a dancer, they typically do not dance on an unstable platform.

SI joint imbalance. There were no significant comparisons to make of the few dancers that had a sacrum imbalance. Future studies may consider a prospective cohort study to determine if imbalances found during adolescence lead to impediments such as the inability to perform due to low back pain.

Questionnaire. The variety of responses from the questionnaire indicates many factors have an influence on adolescent dancers, such as their age, experience, types of classes they're taking, and knowledge. It was hypothesized that recreational dancers participate in multiple dance styles. Current study results confirmed this. The lack of significant equal distributions in the responses shows the absence of a pattern and leads to the possible conclusion that adolescent dancers are not uniform in their training. On one hand, dance teachers are not able to develop simplified instructions as each adolescent has a unique potential, but on the other hand, a lack of establishing instruction plays a role in the different information being passed along as well as the rate of change between training levels in dancers.

It was hypothesized that perhaps age or experience would play a role in determining which of the choices were selected in the questionnaire, but this was not the case. Researchers have clearly emphasized the impact a dancer's strength has on preventing injury.[16] A concern arises about the lack of significant correlations between strength and flexibility measurements and the dancer's questionnaire responses; however, more than half of the young dancers were concerned with improving flexibility. This could mean dancers are uninformed of the possible negative side effects associated with a lack of strength.

Practical Application. Missing technical classes and rehearsals because of injury is devastating. A Dancer's health and well-being ultimately determines whether the dancer is fit for performance. Although the study found limited correlations between measurements, participants received personalized results from the study and their rankings within the study. Hopefully this encourages awareness in the dancers. Increasing the education of the dancer may help to influence the dance instructors showing the potential for change in instruction.

Concluding this study, it is possible to gain reliable and valid results using the Holley Protocols for measures on the hip flexor including measurements of strength, flexibility, endurance, and balance. Thus these protocols are recommended to permit assessment of dancers using functional measurements of these variables.

Conflict of Interest. The author verifies that the testing completed in this study was done strictly out of interest for collecting data on an overlooked population. The author participates in a variety of dance related activities paid, or voluntary through the community and has worked with many of the dancers who participated in the study. The involvement of the author in dance would have only added credibility to the study design, it would not have interfered with the data collected as precautions were made to treat each dancer with the same instruction and accurate measurements.

Table 1. Descriptive data of the subjects

Description (N = 31)	Mean ± Std. Deviation
Age (yr)	12.5 ± 2.3
Height (cm)	154.4 ± 9.9
Weight (kg)	48.1 ± 15.7
Experience Dancing (yr)	8.2 ± 3.1
*Dance per Week (hr)	5.8 ± 4.4

The dancer received no further instruction on the questionnaire and was told to complete the question to the best of their ability. *Subjective to the current status of the dancer when they completed the questionnaire.

Table 2. Definition of Ranking System

Test	Measurement	Definition of High Rank
MBSSR	Flexibility - Reach (cm)	Furthest reach
HVKT	Flexibility - Angle of HF (°)	Largest Angle of HF
IMHF	Endurance - Impulse (N s)	Largest value
HH	Endurance - Angle of HF (°)	Smallest angle difference between hold and drop

MBSSR = Modified Back Saver Sit-and-Reach, HVKT = Holley Vertical Kick Test, HF = Hip Flexion IMHF = Isometric Hip Flexion Test, HH = Holley Hold Test.

Table 3. Descriptive data on subject's measurements

Test	Measurement	Description	Mean ± Std. Deviation
IKHF	Strength	Peak Torque (N m)	62.5 ± 18.6
IKHF	Strength	Angle of Peak Torque (°)	102.6 ± 15.8
IKHF	Strength	Torque at 90° (N m)	50.9 ± 17.1
IKHF	Strength	Average Torque (N m)	57.7 ± 17.2
IMHF	Endurance	Impulse (N s)	10.2 ± 3.2
IMHF	Endurance	Peak Torque at 90° (N m)	40.8 ± 12.8
HH	Endurance	Angle of drop difference (°)	61.6 ± 17.1
Balance	Balance	Balance	2.3 ± 0.9
MBSSR	Flexibility	Best reach past heel (cm)	23.6 ± 6.5
HVKT	Flexibility	Angle of HF (°)	107.9 ± 19.1

Table 4. Reliability estimates of strength, endurance, flexibility, and balance measurements.

Test	Measurement	Description	P value	Avg. ICC
IKHF	Strength	Peak Torque (N m)	0.66φ	0.963*
IKHF	Strength	Angle of Peak Torque (°)	0.20φ	0.359
IKHF	Strength	Torque at 90° (N m)	0.21φ	0.925*
IKHF	Strength	Average Torque (N m)	0.53φ	0.989*
IMHF	Endurance	Impulse (N s)	0.95φ	0.972*
IMHF	Endurance	Peak Torque at 90° (N m)	0.93φ	0.972*
Balance	Balance	Balance	0.84φ	0.72**
HVKT	Flexibility	Angle of HF (°)	0.90φ	0.983*
HH	Endurance	Angle of drop difference (°)	0.75φ	0.866*

IKHF = Isokinetic Hip Flexion Test, IMHF = Isometric Hip Flexion Test, HVKT = Holley Vertical Kick Test, HH = Holley Hold Test. φ There were no significant differences between the trials, $p > 0.05$. *The participants maintained their ranking well, ICC > 0.75. **The participants only moderately maintained their ranking.

Table 5. Independent T-test results: Overall balance scores compared to whether the dancer thought about balance most while dancing

	Mean ± Std. Dev.	Independent T-test Results	Mean Difference
Average Balance	2.3 ± 0.9	t(29) = -1.086, p = 0.29	-0.358
Thought about Other	2.2 ± 1.0		
Thought about Balance	2.5 ± 0.8		
Posterior/Anterior Balance	1.8 ± 0.9	t(29) = -.606, p = 0.363	-0.197
Thought about Other	1.8 ± 1.0		
Thought about Balance	2.0 ± 0.8		
Medial/Lateral Balance	1.0 ± 0.7	t(29) = -.804, p = 0.056	-0.201
Thought about Other	1.0 ± 0.5		
Thought about Balance	1.2 ± 0.9		

Balance scores are determined by how well the subject maintains their center of gravity, the larger the number, the more the subject deviated from their center.

Table 6. Frequency data of questionnaire response

Inquiry		**Yes**	**No**
Experience in…..			
Ballet		87%	13%
Modern, Contemporary, or Lyrical		71%	29%
Gymnastics		42%	58%
Other (Tap, Jazz, Hip Hop, Musical Theater, Figure Skating)		66%	35%
Previously Injured while dancing?		29%	71%
Familiar with what turnout means?		74%	26%
	Strength	**Flexibility**	**Balance**
What do you think about most while dancing?	32%	23%	45%
What would you like to improve?	26%	55%	19%

Table 7. Correlation of strength, flexibility and balance measures controlling for age and experience of the dancer via a partial correlation

		F 1	F 2	S 1	S 2	E 1	E 2	B 1	B 2	B 3
F 1	CC		.279	.178	.201	.294	-.366	.175	.385	-.335
	Sig.		.143	.357	.295	.122	.051	.363	.039	.075
F 2	CC	.279		-.073	-.193	-.046	-.432	-.006	.102	-.250
	Sig.	.143		.705	.317	.812	.019	.974	.599	.190
S 1	CC	.178	-.073		.911	.620	.334	.367	.270	.339
	Sig.	.357	.705		<.001	<.001	.077	.050	.156	.072
S 2	CC	.201	-.193	.911		.633	.423	.483	.383	.360
	Sig.	.295	.317	<.001		<.001	.022	.008	.040	.055
E 1	CC	.294	-.046	.620	.633		.100	.241	.208	.227
	Sig.	.122	.812	<.001	<.001		.604	.209	.278	.236
E 2	CC	-.366	-.432	.334	.423	.100		.515	.266	.643
	Sig.	.051	.019	.077	.022	.604		.004	.164	<.001
B 1	CC	.175	-.006	.367	.483	.241	.515		.876	.479
	Sig.	.363	.974	.050	.008	.209	.004		<.001	.009
B 2	CC	.385	.102	.270	.383	.208	.266	.876		.018
	Sig.	.039	.599	.156	.040	.278	.164	<.001		.928
B 3	CC	-.335	-.250	.339	.360	.227	.643	.479	.018	
	Sig.	.075	.190	.072	.055	.236	<.001	.009	.928	

*F 1 = MBSSR flexibility test, F 2 = HVKT flexibility test, S 1 = IKHT average peak torque strength measurement, S 2 = IKHT torque at 90° strength measurement, E 1 = IMHT impulse endurance measurement, E 2 = HH endurance test, B 1 = average balance score, B 2 = anterior/posterior balance score, B 3 = medial lateral balance score, CC = correlation coefficient, Sig. = significance value.

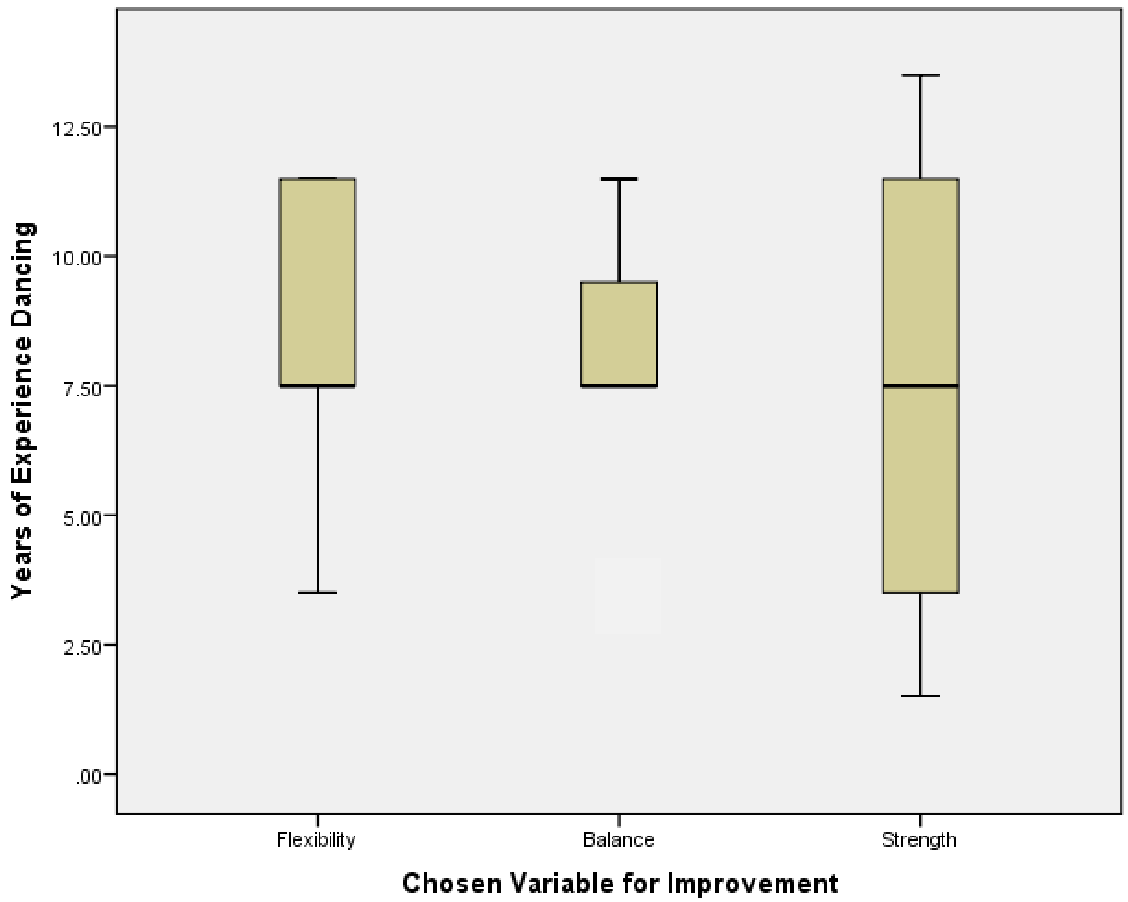

Figure 1. Mean and standard deviation for the choices of improvement compared relative to the experience of the dancer.

II. LITERATURE REVIEW

DANCE

Dance is widespread in recreation, competition, and entertainment. Over 500 styles of dance exist in the world. Each culture breeds its own form and manipulates others, while some sprout from music. For this reason, categorizing dance styles is challenging as many are a fusion of multiple types from different genres. Similarly, the definition of dance is vague; all-encompassing of rhythmic body movement with or without music.[14,15]

Popularity. In the United States (U.S.), it is common to see adolescent dancers participate in multiple styles of dance such as ballet, modern, tap, jazz, and hip hop. It is estimated that the U.S. has as many as 40,000 dance schools.[4] The National Health and Nutrition Examination Survey (NHANES) collects data in 2-year increments. Over the course of 2 cohorts, NHANES revealed data that adolescents ($n = 3,598$, Mean = 15.38 ± 0.08 years old) between the ages of 12 and 19 years old considered dance a form of physical activity. Of the group used in the survey, 21% of the students partook in dance.[3] The same survey data over an extended period of time ($n = 7,506$, 12-19 years of age) reported dance as the third most popular form of physical activity for female adolescents.[36]

Discipline. The precise movements required of dancers, uses refined physical skills that involve hours of technique classes and rehearsals. Adolescents may take private lessons, classes during school, or use dance as an extracurricular activity after school.[3] It is common for studios to hold classes until late in the evenings most week days. Typical technique classes range from 45 minutes to 2 hours in length. Class structure is usually broken down into a warmup, followed by technique training, exercises across the floor, and rehearsal. For example, a ballet class is usually divided into 3 sections; training (using a barre for support) for 60 seconds of activity followed by 30 seconds of rest (36% VO_2 max), moderate intensity center floor activity lasting 35 seconds followed by 85 seconds of rest (43% VO_2 max), and high intensity center floor work for 15 seconds followed by 75 seconds of rest (46% VO_2 max).[37]

Wyon and colleagues[38] determined that although technique classes are meant to better prepare the dancer for their performance, technique classes had significantly ($p < 0.01$) lower mean heart rates and mean oxygen consumption, less peak heart rates above 180 beats per minute, and lower percent of work time compared to performance. Rehearsals also had significantly ($p < 0.01$) lower mean heart rates, mean oxygen consumption and number of times peak heart rates were achieved compared to performance. The lack of sufficient aerobic and anaerobic training during technique classes and rehearsal may leave the dancer unprepared to handle the physical demands of performance and predispose them to fatigue. As in many other sports, fatigue leads to improper form, improper form may lead to poor alignment which can lead to injury which is detrimental to a dancer.

Injury Incidence. A dancer is susceptible to injury with inadequately trained energy systems. Toledo and colleagues[39] suggest numerous contributors to injury including, lack of warm-up, repetitive jumping, overuse, poor turnout, environmental hazards, reduced core strength, inflexibility, and hypermobility. The majority of these causes may be managed in order to prevent the injury from occurring in the first place.

Young dancers are more at risk as they strive for technical abilities they may have yet to learn properly and their bodies may not be physically ready to perform them.[40]

A brief review of the literature on dance injuries indicates the deficiency of research and issues with current methodologies. One of the more prevalent concerns is how to define an injury with relation to dance, as definitions by many authors are inconsistent. The Standard Measures Consensus Initiative (SMCI) of the International Association for Dance Medicine and Science (IADMS) formed to address topics such as these. The 3 primary purposes of the research group are to:

1. Establish uniform methodology for tests and measures used to assess dancer capacities and intrinsic and extrinsic risk factors for injury;
2. Establish common protocols for reporting injuries; and
3. Assist the dance medicine community in applying these recommendations through the use of all applicable technologies.[41]

While collecting current data, standard protocols may be followed, but historic studies may not have used similar definitions. Furthermore, the majority of data collected on injuries has been self-reported by the dancer and are usually based on recall. [41] This leaves room for interpretation of the injury by the dancer. The general consensus is to reference studies that only include injuries that resulted in time loss from dancing.

The reported range of injuries found in the research includes multiple genres, skill levels, and nationalities. An investigation of the literature showed dancer's injury rates between 43% and 97%.[5,11,18,42–50] Roberts and colleagues[9] completed an investigation using the U.S. National Electronic Injury Surveillance System to scan for dance related injuries over a 17 year timeline. Their findings indicated that the popularity of dance has grown overtime. Injuries also increased 37.2% during the course of the study period.[9] The national data also complemented multiple studies suggesting as dancers' aged, their likelihood of injury rose.[9,46,47] This may be due to the increased amount of time spent dancing which would then increase the potential for an injury.

The exposure of time spent in classes coupled with the intensity at which the dancer trains, increases with age. The ability to comprehend the necessary patterns for more technical movements also improves with age.[18,51,52] With increased time spent in the studio, dancers gain the aptitude for attempting advanced skills they may or may not be ready to attempt. Desire to accomplish challenging moves and achieve a specific dance role adds pressure to dance through the pain of an injury. Not surprisingly, dancers consider injury to be a natural, necessary occurrence.[53] If there is a possibility of missing a rehearsal and getting a less prestigious role, a common theme observed, as alluded to prior, is to "dance through" the pain.[54] Therefore, dancers are known to exhibit a high pain tolerance and are unable to distinguish pain associated with injury compared to that of performance.[55–57]

Each dance style emphasizes diversity in its artistic movements. Therefore, injuries vary with the individual dancers and style, but the most common injuries occur to the lower extremities. [5,9,43,45,47,48] Steinberg and colleagues[11] assessed injuries in female dancers (n = 1336, age range 8-16 years) who participated in mixed genres. A total of 569 students (42.6%) recorded 1051 injuries. The risk of obtaining a second injury was 1.73 times greater than the risk of incurring an initial injury. Knee injuries were most common in Steinberg's study followed by tendonitis in the ankle or foot joints and back injuries, 29.4%, 24.5% and 16.7%, respectively.[11] A 2 year evaluation on dance injuries screened during a summer intensive course in multiple dance genres reported the ankle (n = 54, 17%) the most common location of injury.[45] Moreover, Roberts et al. reported that the mechanism by which 44.8% of injuries to dancers (n = 75,992) occurred were caused by falling.[9] The evidence supports the conclusion that injuries are common in dancers.

DANCER

The physical and psychological demands placed on today's dancers include the physical stress the dancer undergoes in order to achieve the moves specified by the choreography and the pressures of obtaining the ideal aesthetic appearance.[16] Low body fat and low waist-to-hip and waist-to-thigh ratios are preferred by dancers.[51] The physical attributes used for dancing include cardiovascular endurance, neuromuscular coordination, flexibility, body composition, and muscular endurance, strength, and power.[14,18] Each dance style utilizes varied amounts of the aforementioned athletic components, although many non-professional dancers participate in multiple genres requiring multiple skills.[45,58]

Neuromuscular coordination includes finite motor control, which dancers acquire with practice. [37] Agility and balance occur sporadically among routines.[37] Sporadic moves allow dance to be identified as an intermittent type of exercise,[59] similar to tennis and soccer where rapid movements requiring muscular power are followed by moments requiring strength, precision, and skill.

Athlete Profile. The energy utilization for dancers includes a capacity for both anaerobic and aerobic energy systems. Twitchett and colleagues[37] assessed the maximal oxygen uptake (VO_2max) in dancers compared with other physical activities. The

VO_2max for dancers averaged 49 ml/kg/min while other activities, such as running, rowing, soccer, gymnastics and squash, ranged from 55-77 ml/kg/min. Although most studies report various aerobic capacities for different dance styles and ages, the trend is to see dancers' capacities below other sports.[60–66]

Strength. In dance muscular strength requires a high degree of force, such as working with a partner, while muscular power can be seen in jumps and leaps where force is needed more quickly. Muscular endurance is appreciated where repeated muscular contractions take place in choreography and technique training.[14] Endurance trained athletes tend to have a higher percentage of slow twitch or type I muscle fibers; while power and strength reflect a ratio of muscle fiber types that are predominately fast twitch or type II.[16] Athletes have a tendency to have a composition characteristic of muscle fiber types for their sport. Dancers are more likely to have a greater ratio of type I fibers similar to endurance trained athletes.[67,68] Dancers that appear more muscular, inherently have a greater number of type II fibers.[16] This may be acceptable for modern dancers, but is generally undesirable for the classical ballet dancer.[16]

Flexibility. The ideal proportions along with greater flexibility allow the classical dancer to achieve the aesthetically pleasing body lines and versatile movements. Most pre-professional and elite dancers have a large range of motion throughout their joints.[15] Joint mobility is hereditary, however, with training a dancers full range of motion may be achieved.[15] Once the full potential of the joint has been reached, increasing the passive range of motion, even with training, is unlikely to occur.[69] Dancers with a naturally greater range of mobility may be preselected by their dance instructors to advance in a dance career.[15,69,70]

Balance. Balance has been used as a performance measure for dancers.[71] Dancers that advance in their career also perform at a higher standard. In order to coordinate movement with balance, as in dance, the sensory system passes information to the Golgi tendon organs to help control muscle contraction and relaxation.[71,72] Postural control of the dancer is highly dependent on balance. Improper balance during dance may result in a fall or unnecessary added stress on joints.[12,73]

ADOLESCENT

The age of adolescence is initialized with the physiological changes that occur with normal puberty. Each individual child will experience variable rates of change during their development and for different amounts of time. In females, the influx of estrogen with the onset of puberty and the adolescent growth spurt usually take place from ages 10 to 14 and can last up to 24 months.[13]

Age. The World Health Organization defines the age of adolescence between 10 and 19 years old.[24] When the individuals conduct is accepted as adult behavior, the identity of the individual changes from an adolescent to an adult.[23] In the US, all 18 year olds are accepted as adults.

Maturation. Adolescent girls mature at variable rates. During the menstrual cycle and with the onset of puberty there is an increase of estrogen which argumentatively affects the mechanical properties of ligaments.[13] The change in laxity of the ligaments is most likely due to the adolescent growth spurt that occurs during this age range.[74] A girl's growth spurt happens in different segments. The peak velocity for lower limb growth occurs before the torso growth.[75] Lower limb flexibility and strength decrease during the growth spurt in order to accommodate the rapid increases in height.[11–13,70] These changes increase the potential for lower limb injuries.[13]

THE ADOLESCENT DANCER

According to Steinberg and colleagues,[70] adolescents, dancers and non-dancers alike, are built similarly. Adolescent dancers look like any other adolescent as they progress through the years. Changes incorporated with the adolescent growth spurt include: increased height, length in appendages, and body mass.[13] With the nervous system stressed trying to keep up with the new muscular and skeletal changes, the dancer may experience variation in their ability to balance and coordinate their movement.[13] Many variables influence physiological changes of the adolescent and many others that impact a dancer. With the number of dance injuries reported to be growing in adolescents,[7,9,11,58] more research is warranted. Currently, data have been limited to professional and elite dancers where dancers are streamlined, or selected based on qualifying attributes and advanced along the same conditions. Data on adolescent dancers have been primarily injury related,[7,11,11,43,47–50,58] or dance specific.[5,42,45–50] As popularity of dance has increased for recreational sport,[36] the importance of gathering normative data on adolescent dancers is increasingly important. Relationships between measurements may account for the increases in injuries seen. If anything, the gathering of data on adolescent dancers will help to bring awareness to those whom participate.

III. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Summary. The Holley Protocol for measures of flexibility, strength, balance and endurance were found to be valid and reliable for measurements in relation to the hip flexors. These protocols, if used, could help to discern what factors should be stressed in dance classes in order to avoid injury as an adolescent; as previous research emphasizes the amount of injuries that adolescent dancers sustain each year.

The lack of research on the adolescent dancer invites speculation as to what variables play a role in the dancer's development. There were no patterns found between measurements of balance and the questionnaire response to whether the dancer thought about balance while dancing. No significant relationships were found between measures of strength, balance, endurance, and flexibility compared to sacrum imbalances. Significant relationships were found between measures of flexibility and balance, flexibility and endurance, strength and endurance, strength and balance, and balance and endurance, but not between flexibility and strength. There was no significant relationship between years of experience and whether the dancer chose flexibility, balance, or strength to improve upon.

The current study indicates that adolescent dancers are not uniform in their recreational dance practices. Although there were patterns between some measurements, predicting certain outcomes is unreasonable for adolescent dancers as there are many factors to consider.

Recommendations. The information gained during the completion of this study provides insight to potential future studies. Imminent studies on adolescent dancers should consider a prospective cohort study to determine what factors influence the individual's strength, balance, and flexibility over time. A follow-up could be completed to determine whether participating in the study increased the awareness of the importance of strength. Future studies may want to include the adolescent dancer's status of maturation and their growth rate. The questionnaires could also be extended to include the instructor's answers to determine how influential they are.

Optimistically, after sending the dancers their individual scores for rankings and the measurements taken, their personal awareness of where they stand may promote their self-confidence, or provide the motivation they need to continue growing in their dance practice. The dancers, at minimum, will gain information on their strength and how improving that may prevent future injury in dance. With a high rate of injury in adolescent dancers, instructors may be looking for protocols to follow in order to determine training techniques with individual dancers, hopefully the Holley Protocols can be useful.

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APPENDIX A

Human Subject Research Review Committee Approval

Memorandum

TO: Alexandra Holley
School of Health and Human Performance

CC: Randall Jensen
School of Health and Human Performance

DATE: September 18, 2015

FROM: Brian Cherry, Ph.D.
Assistant Provost/IRB Administrator

SUBJECT: IRB Proposal HS15-684
IRB Approval Dates: 9/18/2015-9/18/2016**
Proposed Project Dates: 9/26/2015-10/15/2015
"Assesing and Reporting Normative Data and Correlations in Adolescent Non-Professional dancers"

The Institutional Review Board (IRB) has reviewed your proposal and has given it final approval. To maintain permission from the Federal government to use human subjects in research, certain reporting processes are required.

A. You must include the statement "Approved by IRB: Project # HS15-684" on all research materials you distribute, as well as on any correspondence concerning this project.

B. If a subject suffers an injury during research, or if there is an incident of non-compliance with IRB policies and procedures, you must take immediate action to assist the subject and notify the IRB chair (dereande@nmu.edu) and NMU's IRB administrator (bcherry@nmu.edu) within 48 hours. Additionally, you must complete an Unanticipated Problem or Adverse Event Form for Research Involving Human Subjects

C. Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding. Informed consent must continue throughout the project via a dialogue between the researcher and research participant.

D. If you find that modifications of methods or procedures are necessary, you must submit a Project Modification Form for Research Involving Human Subjects before collecting data.

E. **If you complete your project within 12 months from the date of your approval notification, you must submit a Project Completion Form for Research Involving Human Subjects. If you do not complete your project within 12 months from the date of your approval notification, you must submit a Project Renewal Form for Research Involving Human Subjects. You may apply for a one-year project renewal up to four times.

NOTE: Failure to submit a Project Completion Form or Project Renewal Form within 12 months from the date of your approval notification will result in a suspension of Human Subjects Research privileges for all investigators listed on the application until the form is submitted and approved.

All forms can be found at the NMU Grants and Research website: http://www.nmu.edu/grantsandresearch/node/102

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Amanda Wigand

Graduate Assistant

Grants and Contracts Office

Northern Michigan University

906-227-2437

APPENDIX B

Parent's Permission Form

INFORMED CONSENT FOR PARTICIPATION IN DANCER'S ASSESSMENT RESEARCH STUDY

Northern Michigan University | Exercise Science Laboratory | Dancer's Assessment | Parent's Permission |

September 17, 2015

Dear Dancer's Parent,

As a dancer, your child has been invited to be a part of a research study. The purpose of the study is to analyze the relationships between strength, flexibility and balance in adolescent dancers. At the end of the study the child will receive their own personal results and explanations for their measurements.

Procedures

This study will take place over two weekends. Approximately 40 people will take part in this study at Northern Michigan University. At most the process should take around two hours to complete. If you agree to have your child participate, please let me know by returning the Child's Assent form to the Second Skin Shop on Washington Street. An attempt will be made to reach everyone by phone or email before October 3rd. At this time, we will schedule an appointment for the completion of the questionnaire and lab measurements. The appointment will be completed within two hours and include the following.

1. Completion of a questionnaire
2. Measurements, including height, leg length, and weight
3. Warm-up of leg swings while watching an instructional video
4. Two flexibility measurements, one of which will be videotaped to ensure accurate measurements
5. Three measurements of the sacrum (child will bend forward in three different positions)
6. A strength test
7. Two muscular endurance tests (holding a position for a certain amount of time)
8. Two balance tests

Voluntary Participation

The participation in this study is 100% voluntary. The child can be withdrawn from the research study at any time without penalty.

Confidentially

We will keep the information your child provides confidential; however, federal regulatory agencies and the Northern Michigan University Institutional Review Board (a committee that reviews and approves research studies) may inspect and copy records pertaining to this research. The measurements and questionnaires will be completed with an identification number linked to the child. If we write a report about this study we will do so in such a way that the child cannot be identified. The videotaping used during the flexibility test will only be seen by the researcher, Alex, and will only be used for data collection purposes.

Risks

During this study, the same risks will be involved as in a dance class. A possibility exists that the dancer may experience bodily injury including, but not limited to, injuries to the muscles, ligaments, tendons, and joints. Every effort will be made to minimize these occurrences by proper warm-up and spotting during the balance tests.

Costs

There is no cost associated with being in this research study I only require that your child shows up on time. At the conclusion of the study, if requested, I will send the results of your child's measurements and what they mean; there is no payment for being in this research study.

Questions

If you have any further questions regarding yours or your child's rights during research project you may contact Dr. Brian Cherry of the Human Subjects Research Review Committee of Northern Michigan University (906-227-2300) bcherry@nmu.edu. Any questions you have regarding the nature of this research project will be answered by the principal researcher who can be contacted as follows: Alexandrea Holley (989-619-6160) aholley@nmu.edu or by the advisor, Dr. Randall Jensen at rajensen@nmu.edu.

Thank you very much for your consideration. Please return the child's assent form indicating your permission and their willingness to participate in this study. The contact information you provide will be the information used to contact you.

I have read the "Informed Consent: Parent's Permission," The nature, risks, demands, and benefits of the project have been explained to me and I agree to let my child participate if they would like to.

Parent's Signature____

Date____________________

Acknowledgement that your child will be videotaped for the purpose of data collection:_____ (Initials)

Best way to contact you:

Phone:____

Email:____

Please return this form the Second Skin Shop on Washington Street.

Thank you,

Alexandrea Holley
Graduate Student, Exercise Science
School of Health and Human Performance
Northern Michigan University

Approved by the Northern Michigan University Institutional Review Board (HS15-684)

APPENDIX C

Child’s Assent Form

INFORMED CONSENT FOR PARTICIPATION IN DANCER’S ASSESSMENT RESEARCH STUDY

Northern Michigan University | Exercise Science Laboratory | Dancer’s Assessment | Child’s Assent Form |

Dear Dancer,

I am asking you to be in a research project. My name is, Alex Holley, a graduate student at Northern Michigan University. I am doing this project to learn more about you as a dancer.

I will be at the Exercise Laboratory in the Physical Education and Instructional Facility (PEIF) the first two weeks of October. First, I will be asking you some questions and taking some physical measurements like your height and weight. Second, I’ll ask you to do some leg swings to warm up while I play an instructional video for you. The video will show you how I will also be taking the other measurements. I will be testing your balance, seeing how strong your leg is, and also checking how flexible you are. The process should not take longer than two hours.

Because we will be looking at flexibility, please wear the same type of clothing you would for a dance class so you can move easily. I also need to see your knees so make sure you have on tights or shorts, any type of dance shoe, or barefoot will work.

When my research is completed I will be able to give you the results of your measurements and explain what they mean.

You don’t have to be in this study. It is OK if you don’t want to do it. If you decide to be in the study, you can stop at any time. You do not have to answer any questions.

If you have questions, you can ask me at any time. My number is 989-619-6160. You can also email me at aholley@nmu.edu with further questions.

Thank you,

Alex Holley

Please put a check next to <u>one</u> sentence. Then sign the form.

I want to be in this study. ______ I do not want to be in this study. ______

Dancer’s Printed Name:_________________________ Dancer’s Signature:_______________________

Approved by the Northern Michigan University Institutional Review Board (HS15-684)

APPENDIX D

Questionnaire

DANCER'S ASSESSMENT RESEARCH STUDY

Northern Michigan University | Exercise Science Laboratory | Dancer's Assessment | Questionnaire |

Please answer the questions to the best of your knowledge. Circle the best answer.

1. **How old are you?**

   10 11 12 13 14 15 16 17

2. **How many years of dance classes have you taken?**

   0-1 1-2 3-4 5-6 7-8 9-10 11-12 13-14 15+ years

3. **Which is your better leg?** Right Left

4. **What do you think about most when dancing? Circle <u>one</u> choice.**

   Muscle Strength Flexibility Balance

5. **What styles of dance have you studied? Circle all that apply.**

   Ballet Jazz Tap Modern Lyrical Contemporary

   Gymnastics Figure Skating Hip Hop Musical Theater

6. **Have you ever injured yourself dancing?** Yes No
7. **Do you know what turnout means?** Yes No
8. **What is something you would like to improve? Circle <u>one</u> choice.**

   Flexibility Balance Muscle Strength

9. **What type of class or classes are you taking now? How many hours a week do you dance?**

Approved by the Northern Michigan University Institutional Review Board (HS15-684)