

FITNESS

The Relationship Between Preservice Teachers' Health-Related Fitness and Movement Competency in Gymnastics

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Abstract

The current National Initial Standards for Physical Education Teacher Education state that preservice teachers should achieve and maintain a level of health-related fitness consistent with that expected of K–12 learners. However, little research has addressed the relevance of teacher fitness to effective physical education teaching. This study examined the relationship between teacher fitness and movement competence, based on the important role of motor competence in performing effective demonstrations of movement skills to learners. Preservice teachers ($N = 115$) were tested on their muscular strength/endurance, flexibility, body composition, and several gymnastics skills. Gymnastics performance was directly and significantly correlated with muscular strength/endurance after

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controlling for previous gymnastics experience. Regression analysis showed that curl-up scores predicted the most variance (7%) in gymnastics performance. Male participants meeting established fitness standards had significantly higher gymnastics scores than male participants not meeting the standards. This study suggests preservice programs should carefully consider assessing and developing candidates' fitness.

Physical education teacher education (PETE) programs accredited by the National Council on Accreditation for Teacher Education (NCATE) currently use the 2008 National Initial Physical Education Teacher Education Standards (National Association for Sport and Physical Education [NASPE], 2009) to define program goals and outcomes. Standard 2 (Skill-Based and Fitness-Based Competence) states, “Physical education teacher candidates are physically educated individuals with the knowledge and skills necessary to demonstrate competent movement performance and health-enhancing fitness as delineated in the NASPE K–12 standards” (NASPE, 2009). Although the previous edition of the standards also stresses movement competence, the expectation for candidate fitness is new. Specifically, candidates are now expected to “achieve and maintain a health-enhancing level of fitness throughout the program.”

For many physical educators, the rationale for candidate fitness may be philosophically intuitive. However, it is not well supported in the standards document (NASPE, 2009). An examination of the reference list underpinning Standard 2 reveals little in the way of an empirical or theoretical basis for expecting preservice physical education (PE) teachers to achieve and maintain a health-enhancing level of fitness. Moreover, when one looks beyond the standards document, the evidence is limited that PE teachers should be physically fit, at least from a pedagogical standpoint. One study found no difference in teacher–student interaction patterns between high-fit and low-fit high school PE teachers (Bischoff, Plowman, & Lindenman, 1988). Two other studies compared students’ test scores on material presented on videotape by an apparently fit (i.e., trim) versus unfit (i.e., overweight) teacher (Melville & Maddalozzo, 1988; Thomson, 1996). Although both studies found that students who watched the fit teacher had higher test scores, the results say more about why a teachers’ appearance might matter from a pedagogical perspective than they do about the importance of teachers’ fitness.

The present study aimed to further the existing research that addresses the pedagogical importance of teachers' fitness by examining the relationship between teachers' fitness and movement competence. Competently demonstrating movement skills is part of effective task presentation in PE teaching (Rink, 2003). An accurate model of the desired movement characteristics for performing a skill can facilitate learning the skill (Martens, Burwitz, & Zuckerman, 1976). This becomes particularly important in PE teaching when the intent is to explicitly communicate to learners what to do and how to do it and when the learner does not have a clear cognitive understanding of what they are trying to do (Rink, 2001).

Although evidence exists that movement competence predicts health-related fitness in young adults (Stodden, Langendorfer, & Roberton, 2009), no studies have examined whether fitness predicts movement competence. It seems logical that the ability to competently demonstrate certain movement skills would hinge on various components of the performer's health-related fitness. In the present study, fundamental gymnastics skills were selected based on this premise. We hypothesized that performance on basic balances, rolls, and smooth transitions as part of a gymnastics sequence would be directly related to the performers' muscular strength and flexibility and indirectly related to the performers' body composition when controlling for gymnastics experience. We further hypothesized that health-related fitness components would be significant predictors of movement competence.

Method

Participants and Setting

Participants ($N = 115$; age, $M = 21.60$; 45 males, 70 females) included preservice teachers majoring in PE ($n = 49$), elementary/early childhood education ($n = 62$), athletic training ($n = 2$), or other ($n = 2$). Participants identified their race/ethnicity as African American ($n = 14$), Caucasian ($n = 94$), Asian ($n = 1$), Hispanic ($n = 1$), or other ($n = 1$) and their year in school as Freshman ($n = 16$), Sophomore ($n = 56$), Junior ($n = 27$), Senior ($n = 11$), or Graduate Student ($n = 5$).

All data for the study were collected in a large indoor gymnasium with ample room for simultaneous testing of approximately 40 people on the fitness components or gymnastics skills described below.

Procedure and Instrumentation

Prior approval from the institutional review board for research with human subjects was obtained at the university where data were collected for this study. Participants were initially recruited using an electronic notice about the study sent to their university e-mail addresses, a flyer placed in their university mailboxes, and announcements made in class. A follow-up electronic notice was sent out about a week after the initial communication to maximize the sample. If interested in participating, students were instructed to sign up for prescheduled testing times. Fitness tests were scheduled at least 2 days apart from gymnastics tests to avoid participant exhaustion, and all data were collected within a 3-week timeframe to prevent changes in fitness from confounding study results.

Fitness testing. Participants were tested on three components of health-related fitness using established Fitnessgram[®] (Meredith & Welk, 2010) protocol. These components included muscular strength/endurance, flexibility, and body composition. The push-up and curl-up tests were used to test muscular strength/endurance, the back-saver sit-and-reach test was used to test flexibility, and a bioelectrical impedance analyzer was used to test body composition. Participants were tested using a station format, such that they rotated in small groups (no more than eight per group) from one test to the next. For motivational purposes, each participant was given a scorecard with the norm-referenced standards for males and females. However, to increase the potential for variability in scores, participants were asked to complete each test to exhaustion and do more than the standard if possible. Each station was fitted with at least two video cameras mounted on tripods so that all tests could be video recorded for later analysis.

Experienced PE teachers trained in Fitnessgram[®] (Meredith & Welk, 2010) testing protocol served as station monitors. Before each test, the station monitors demonstrated the correct form and checked for participant understanding. During each test, the station monitors observed for errors in form and, when necessary, prompted participants with verbal form cues (e.g., “back straight” for the push-up test) used during the demonstration. However, no participants were stopped during testing even if they exceeded the allowable number of errors, as scoring was conducted during video analysis (see Data Analysis section). Station monitors were also responsible for getting participants to say their names on video, making sure all cameras had working batteries, starting/stopping video recording

for each test, and operating any additional equipment (e.g., CD player for the push-up and curl-up tests) at their respective stations. In a given fitness testing session, participants completed all tests in approximately 45 min.

Gymnastics testing. Participants were tested on three gymnastics skills performed separately and a gymnastics sequence incorporating the skills. The skills included two balances and a roll. The first balance was a noninverted balance with weight on both elbows and one knee. The correct form included keeping the back straight and the free leg extended. The second balance was an inverted balance with weight on the upper back, shoulders, and arms. The correct form included extending the rest of their body upwards with legs together, such that the body shape looked like an upside down T when viewed from the side. The roll was an “egg roll.” The correct form included tightly tucking the body, hugging the knees, and rolling sideways. The sequence included the same three skills with the addition of a beginning and ending balance. The correct form for the beginning balance included keeping weight on the bottom, arms extended forward and legs extended upward and forward such that the body shape looked like a V when viewed from the side. The correct form for the ending balance included keeping the weight on both hands and on the ball of one foot and keeping both arms and legs straight with one leg extended upward such that the body shape looked like an upside down Y when viewed from the side. The skills and the sequence were selected because they were considered safe for all participants to try yet still required sufficient strength and flexibility, yielding varied levels of performance across participants.

The testing environment was set up with mats spaced several feet apart along two opposing ends of the gym. Each mat was large enough to afford three participants simultaneously performing any of the skills or one participant performing the sequence in one direction without running out of space. Video cameras mounted on tripods were placed in the center of the gym so that we could easily operate the cameras and record participants’ performances for later analysis. Participants were tested first on the noninverted balance, then on the roll, then on the inverted balance, and finally on the sequence. For each skill and the sequence, the testing procedure included a demonstration phase, a practice phase, and a testing phase. In the demonstration phase, participants were shown a video recorded demonstration of the skill/sequence. The video

was projected on a white wall in the gym so all participants could clearly see the demonstration. An experienced gymnast first showed a full demonstration of the skill/sequence at regular speed, then broke the skill/sequence into parts while summarizing performance criteria with verbal cues, then showed another full demonstration of the skill/sequence at regular speed, and finally reviewed the verbal cues. In the practice phase, participants practiced the demonstrated skill/sequence five times, then watched the video again, and then practiced two more times for skills and one more time for the sequence. A cue card with pictures of the skills and sequence was placed at each mat for participants to refer to at their leisure while practicing. The practice phase was included in this study to help ensure participants with little to no gymnastics experience would feel comfortable and safe performing the skills before they were tested. In the testing phase, participants performed each skill twice and the sequence once. Participants were told their best performance of the two for each skill would be used for the study.

Following gymnastics testing, participants completed a questionnaire asking for demographic and biographic information. Demographic information included age, gender, race/ethnicity, academic major, and year in school. Biographic information focused on previous gymnastics experience including competitive experience, recreational experience, and past/current enrollment in university gymnastics courses.

Data Analysis

Four of the fitness testing monitors reviewed the video recorded fitness tests and scored participants following the Fitnessgram® (Meredith & Welk, 2010) scoring protocol in teams of two to increase scoring accuracy. Because each monitor was trained in using the protocol, they disagreed only a few times about participant performance. When a disagreement occurred, the scorers discussed their perspectives until consensus was reached. Two of the researchers, one of whom is an experienced gymnast, reviewed the video recorded gymnastics performances and scored participants using a modified version of the South Carolina Physical Education Assessment Program (2007) protocol for middle school gymnastics. Participants were assessed using a four-level rubric on their ability to demonstrate stillness in the balances (i.e., held for 3 s), good extensions, accurate performance on skill-specific cues

(e.g., “straight back” for the noninverted balance), and smooth transitions between skills during the sequence. Scoring ranged from 0 (*did not demonstrate the desired performance characteristic*) to 3 (*highest level of performance*). The scores for each performance characteristic were averaged to calculate a final score for each participant. The two researchers worked together to review, discuss, and score participants until the need for cross-checking was almost not necessary. Agreement between scorers was assessed by randomly selecting and independently rescoring 10% of the sample (12 participants). They disagreed on only one out of 44 scores (92% agreement).

The Statistical Package for the Social Sciences (IBM SPSS Statistics, Version 19) was used to perform all data analyses. Descriptive statistics including means and standard deviations were calculated for all fitness and gymnastics scores broken down by gender and academic major. Partial correlations controlling for gymnastics experience were performed to examine relationships between fitness scores and gymnastics scores. A stepwise multiple regression was performed to determine the most parsimonious set of predictors for explaining variance in participants’ final scores on the gymnastics sequence. Predictor variables entered into the model included the questionnaire items assessing previous gymnastics experience and all fitness scores. Mann-Whitney U tests were also performed to examine differences in gymnastics scores between participants who met and did not meet the Fitnessgram® Healthy Fitness Zone (HFZ) standards (Meredith & Welk, 2010; Welk, De Saint-Maurice Maduro, Laurson, & Brown, 2011).

Results

Descriptive statistics are presented in Table 1. Fitness results are presented in relation to the HFZ standards for individuals aged 17 or older. Mean scores for male and female participants met the HFZ standards for all tests. Male participants scored higher on the push-up and curl-up tests, and females scored higher on the back-saver sit-and-reach test. PE majors had the highest mean score for push-ups and curl-ups and a lower mean body composition compared to participants from other academic majors, and elementary/early childhood majors had the highest mean score on the back-saver sit-and-reach.

Table 1*Descriptive Statistics for Fitness and Gymnastics Scores Broken Down by Gender and Academic Major*

	Fitness Scores											
	Push-Ups			Curl-Ups			Sit-and-Reach			Body Composition		
	<i>M</i>	<i>SD</i>	HFZ	<i>M</i>	<i>SD</i>	HFZ	<i>M</i>	<i>SD</i>	HFZ	<i>M</i>	<i>SD</i>	HFZ
Males (<i>n</i> = 45)	22.0	10.62	>18	48.0	23.41	>24	9.18	6.41	8	16.02	7.32	7-22.2
Females (<i>n</i> = 70)	8.24	7.40	>7	34.53	23.74	>18	14.74	5.04	12	23.04	6.67	16.5-31.3
Physical Education (<i>n</i> = 49)	20.37	11.12		48.94	24.26		9.46	6.37		16.72	7.30	
Elementary/ Early Childhood Education (<i>n</i> = 62)	8.06	7.84		33.23	22.83		15.11	4.72		23.13	6.84	
Athletic Training (<i>n</i> = 2)	15.5	6.36		21.0	12.73		5.50	7.78		23.55	13.65	
Other (<i>n</i> = 2)	19.0	1.41		38.5	16.26		17.0	4.95		16.55	1.34	

Table 1 (cont.)

	Gymnastics Scores									
	Still Balances		Full Extensions		Skill-Specific Cues		Smooth Transitions		Final Score on Sequence	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Males (<i>n</i> = 45)	2.76	.61	2.31	.85	2.76	.53	2.93	.25	2.69	.39
Females (<i>n</i> = 70)	2.54	.72	2.86	.43	2.63	.52	2.80	.44	2.71	.32
Physical Education (<i>n</i> = 49)	2.80	.58	2.45	.82	2.80	.50	2.94	.24	2.75	.37
Elementary/ Early Childhood Education (<i>n</i> = 62)	2.53	.72	2.81	.47	2.56	.53	2.79	.45	2.67	.32
Athletic Training (<i>n</i> = 2)	1.5	.71	2.0	1.41	3.0	.0	3.0	.0	2.38	.53
Other (<i>n</i> = 2)	2.5	.71	3.0	.0	3.0	.0	2.5	.71	2.75	.35

Note. *M* = Mean; *SD* = Standard Deviation; HFZ = Healthy Fitness Zone (Fitnessgram®). Gymnastics performances were scored 0–3 (0 = the performance characteristic was absent, 3 = highest level of performance).

For gymnastics performances, male participants performed slightly better on average than female participants on all performance characteristics except extensions, on which females performed sufficiently better than males to result in a higher mean final score for the sequence. PE majors had the highest mean score for still balances, and elementary/early childhood majors had the highest mean score for full extensions. Athletic training majors and “other” majors shared the highest mean score for skill-specific cues, and athletic training majors had the highest mean score for smooth transitions (though there were only two participants from each of these majors). PE majors and other majors shared the highest mean final score on the sequence.

Partial correlations controlling for participants’ gymnastics experience are presented in Table 2. As hypothesized, final scores for the gymnastics sequence were directly and significantly correlated with scores for curl-ups and push-ups (i.e., muscular strength/endurance). However, final scores for the sequence were not significantly correlated with scores for the back-saver sit-and-reach (i.e., flexibility) or body composition. The stepwise regression showed that the best set of predictors (in order of most to least important) for the final score on the gymnastics sequence was curl-ups, competitive gymnastics experience, past or current enrollment in an educational gymnastics course, and recreational gymnastics experience, $F(4, 110) = 6.28, p < 0.001$. Contrary to what we hypothesized, other components of health-related fitness did not enter the models as significant predictors. The adjusted R^2 values showed that curl-ups accounted for 7% of the variance in the final score on the sequence, and competitive gymnastics experience explained an additional 5% of the variance, past/current enrollment in educational gymnastics explained an additional 4% of the variance, and recreational gymnastics explained an additional 3% of the variance. The beta values showed that for every unit increase in the score for curl-ups, the score for the final gymnastics sequence increased 25% ($p = .008$).

The Mann-Whitney U tests showed statistically significant differences on the scores for extensions ($M = 2.51, M = 1.78, p = .005$) and the final scores for the gymnastics sequence ($M = 2.78, M = 2.53, p = .013$) between male participants who met ($n = 35$) and did not meet ($n = 9$) the HFZ standard for push-ups, respectively. Also, statistically significant differences were found on the scores for still balances ($M = 2.88, M = 2.25, p = .037$) and extensions

($M = 2.45$, $M = 1.50$, $p = .042$) between male participants who met ($n = 40$) and did not meet ($n = 4$) the HFZ standard for curl-ups, respectively. Finally, a statistically significant difference was found on the scores for skill-specific cues ($M = 2.88$, $M = 2.46$, $p = .007$) between male participants who met ($n = 32$) and did not meet ($n = 13$) the HFZ standard for body composition, respectively. No statistically significant differences were found on gymnastics scores between female participants who met and did not meet the HFZ standards.

Table 2

Partial Correlations Controlling for Gymnastics Experience

	1.	2.	3.	4.	5.	6.	7.	8.
Fitness								
1. Push-Ups	1.0							
2. Curl-Ups	.47***	1.0						
3. Sit-and-Reach	-.08	.17	1.0					
4. Body Composition	-.45***	-.21*	.42***	1.0				
Gymnastics								
5. Still Balances	.18	.19*	.02	.01	1.0			
6. Full Extensions	.01	.08	.18	.10	.18	1.0		
7. Skill-Specific Cues	.26**	.19*	.04	-.13	.12	.19*	1.0	
8. Smooth Transitions	.06	.08	.02	.00	.01	-.02	.01	1.0
9. Final Score on Sequence	.21*	.24*	.12	.00	.65***	.67***	.59***	.32***

* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

Discussion

Given the expectation for preservice PE teachers to achieve and maintain health-enhancing levels of physical fitness (NASPE, 2009), the aim of this study was to build on the limited research literature addressing the question of whether a pedagogical basis for such an expectation exists. That is, what contribution does teacher fitness make to effective PE teaching? Prior research has not examined the intuitive presupposition that a teacher's fitness can underpin his or her movement competency, which is necessary for providing accurate demonstrations of movement skills. The results of this study suggest muscular strength, especially core (abdominal) strength, could be an important factor in a teacher's ability to competently demonstrate certain fundamental skills in educational gymnastics.

The scores for the push-up and curl-up tests significantly correlated with the final score for the gymnastics sequence when controlling for gymnastics experience. Push-ups and curl-ups were directly associated with performance on skill-specific cues, and curl-ups were also directly associated with holding still balances. These results seem logical because competently performing the balances selected for this study requires a requisite level of core strength and/or arm strength to support body weight and muscular endurance to maintain stillness. However, scores on the back-saver sit-and-reach and body composition were not significantly correlated with the final score for the sequence. These results are unexpected because it seems that increased flexibility would give the performer an advantage in fully extending limbs during balances and smoothly transitioning between skills, whereas higher levels of body fat would give the performer a disadvantage in trying to hold still during balances. The relatively high mean score across participants for smooth transitions (2.87) suggests the difficulty level of the transitions may not have been high enough to challenge participants' flexibility. Testing participants on more gymnastics skills with varying levels of difficulty might help to better explain the relationship between gymnastics performance and different health-related fitness components.

The regression analysis revealed a statistically significant model with the score on the curl-ups test as the strongest predictor of competency on the gymnastics sequence, followed by three different gymnastics experiences (competitive gymnastics, enrollment in an educational gymnastics course, and recreational gymnastics). Although curl-ups explained only a small amount of the variance in gymnastics performance (7%), this is the first study to suggest that a teacher's health-related fitness could impact the quality of an important pedagogical skill, namely, the demonstration. Research shows that effective PE teachers tend to perform full and accurate demonstrations for their students. Holding preservice teachers accountable for their health-related fitness—particularly their core strength and endurance—could help PETE programs prepare more effective PE teachers.

The Mann-Whitney U tests showed that the Fitnessgram® HFZ standards for push-ups, curl-ups (Meredith & Welk, 2010), and body composition (Welk et al., 2011) were useful in discriminating male, but not female, participants' skill competency in gymnastics. These results suggest it could be appropriate for preservice programs to

use the current HFZ standards for these tests as benchmarks for assessing male candidates' fitness, at least when the goal is to help ensure candidates are able to provide effective demonstrations of gymnastics skills. However, programs might need to set more stringent fitness standards for female candidates to establish a meaningful link between fitness expectations and effective teaching.

This study has several limitations. The small sample size in this study limits the generalizability of the findings. Additionally, this study was designed under the assumption that accurate demonstrations are an important aspect of effectively teaching educational gymnastics (i.e., balances and rolls). Future research should test this assumption using student outcome data, such as performance on a gymnastics skill immediately following the teacher's demonstration, collected from intact PE classes. Other suggestions for building on this study are to examine the relationship between fitness and movement skills from other content areas (e.g., educational games) and to examine the relationship between endurance (cardiovascular and muscular) and a range of pedagogical skills across a full day of teaching, as a lack of physical stamina could compromise teachers' ability to sustain their best level of performance.

In conclusion, this study provides initial evidence that preservice teachers' health-related fitness is related to their movement competency, thereby strengthening the empirical and pedagogically relevant basis supporting Standard 2 of NASPE's (2008) Initial Physical Education Teacher Education Standards. Graduating competent movers has been heralded as an important focus of preservice programs (Siedentop, 2002; Zeigler, 2003) in PE partly because movement competency functions to increase demonstration accuracy when presenting skills to learners. Accurate demonstrations in educational gymnastics might be particularly important in PE teaching given the foundational role gymnastics skills play in preparing children to be successful in many physical activities. Although this study offers only a glimpse into the relationship between teachers' fitness and pedagogical skill, the results suggest preservice programs carefully think about assessing candidates' fitness and helping candidates improve their fitness as a means to increase their teaching effectiveness.

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