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Development of a Standard Push-up Scale for College-Aged Females

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ABSTRACT

International Journal of Exercise Science 15(4): 820-833, 2022. The ACSM/CESP push-up test exemplifies the limiting nature of the gender binary in fitness. Males perform the standard push-up (from toes) while females perform the modified push-up (from knees), even if capable of multiple standard push-ups. Differences in upper body strength are used to justify the test protocol. Though the load difference between modified and standard positions is substantially less than the gender strength gap. Additionally, current fitness ratings are over 30 years old. The purpose of this study was to develop a new standard push-up rating scale for college-age females. Cis-female college students (n = 72) were recruited to perform maximal repetitions in the modified and standard positions. Health history and physical activity information was gathered prior to the test. Trained research assistants provided standardized warm-up, modelled correct form, and administered the tests. Order of the tests was randomized and there was at least 48 hours between test days. Mean push-ups in the standard position was 9 (8.87) and 17.5 (11.76) in the modified position. Participants who resistance train did significantly more repetitions of each. Linear regression was used to develop an equation to predict standard push-up repetitions from modified repetitions. The equation was applied to the current repetition ranges for each fitness category, and a new standard scale was developed. The new scale ratings are similar to the Revised Push-up but lower than the Fitnessgram® Healthy Zone. The modified or "girl" push-up contributes to gender stereotypes about muscular fitness. Providing females with the option to be graded on the standard push-up is a step to reducing gender bias in fitness. Future research is needed to validate this scale.

KEY WORDS: Push-up test, gender, fitness testing, stereotype

INTRODUCTION

All fitness tests use a binary gender format. Participants must designate either a male or female identity to determine their fitness level from charts or formulas. Most often the fitness categories are gender specific, so that males and females participate in the same activity, but their scoring is gender based. The ACSM/CESP push-up test (2), however, is doubly gendered. Both the position and the scoring are based on the binary gender. The format of the test restricts a cisgender participant to the modified or standard position, regardless of their current ability. Particularly for young physically active females, this requirement is belittling (26). Updating the current fitness categories would provide well trained females with the option to do the standard push-up as a test of muscular endurance.

The push-up is a dynamic closed kinetic chain exercise that targets the pectoralis major, minor, and triceps brachii muscles. The exercise is common in school, sport, and military fitness settings. And often is used to test shoulder girdle-strength and endurance (5). Several different test protocols have been developed. All seek the maximal number of repetitions that can be performed with good form. Variations include set time limits for the work segment (25, 20), multiple sets with designated rest periods (20), a required pace (24), or designate a gender specific position for the test (7). Both the ACSM and CESP regard gender specific positions as the only option for obtaining population-based fitness ratings (7, 2). The modified position (from knees) is used for females and the standard position (from toes) is used for male participants. Ratings for the modified push-up test were published by Pollock et al in 1978 (22). In 1993, the test was included in the 2nd edition of the ACSM Guidelines for Exercise Testing and Prescription (9). The normative standards (table 1) presented in that text were developed by the Canadian Association of Sport Sciences in 1987 (8) and are still used today despite an increase in resistance training among females (19).

Table 1. Push-up test fitness categories for 20–29-year-olds.

	Female	Male
Excellent	≥ 30	≥ 36
Very Good	21-29	29-35
Good	15-20	22-28
Fair	10-14	17-21
Poor	≤ 9	≤ 16

The gender differences in the push-up test are easily recognized due to the different body positions. So much so, that the modified push-up is commonly referred to as a "girl" push-up and thus re-enforces stereotypes about muscular fitness (28). Even the correct terminology implies that the standard push-up is the norm and that the modified position is inferior. It is important to note that not all published push-up tests require positioning differences for males and females. The Fitness Gram test battery used with children ages 5 to 17 has only the standard push-up as its upper body muscular endurance test (24). The revised push-up test also uses the standard position for college-aged adults (4, 5). Instead of holding the body off the floor in the down portion of the repetition, the revised push-up requires participants to bring their torso (chest to knees) to the ground and then push back up. Baumgartner and colleagues created the revised push-up to improve problems with interrater reliability (5, 14). A set of percentile norms for males and females was validated by Baumgartner et al in 2004 (4). Mozumdar et al (18) furthered those gender specific norms but found a greater number of females who could complete at least one repetition.

Biomechanical differences between males and females in the push-up have been well studied. Separate protocols to accommodate for strength differences between males and females appear to be supported. The shorter fulcrum arm in the modified push-up reduces the load (relative to body weight) and lessens the need for core muscles to stabilize as compared to the standard push-up. Prior research reports differences of 12-18% in load or ground reactive forces between the two positions. Gouvali et al (12) found that 66.4% of one's mass was moved in the standard position, while the load in the modified position was 52.9%. While measuring ground reaction forces, Ebben et al (10) found slightly lower loads relative to body weight; 64% for the standard push-up and 49% for the modified push-up. Peak ground reaction forces did not vary by gender or participant height but are reduced by 18% in the modified position (10). The range in load between the up and down position is greater for the modified push up position. Suprak et al (23) found loads increased from up to down by 8.24% in the modified but only by 5.88% in the standard. The difference is not gender related. Mier et al (16) found no difference in load by gender for the static up position, however a smaller range of motion was seen in the female participants.

The normative fitness ratings (table 1) reflect perceived gender differences in both strength and endurance. The modified position reduces the load and the lower repetition criteria decreases duration of contractions. Pollock et al (22) did not provide a rationale for the modified push-up. Maybe it was self-evident at the time that females would need an accommodation. Since the modified position only reduces load by 12-18% (10, 12), using the knee as the pivot point was likely convenience rather than an attempt to equate relative loads between males and females. The gap in upper body strength between males and females is thought to be much greater. A 45-63% difference in absolute strength in bicep curl, bench press and lat pull down exercises has been reported (16, 17, 15, 3). When considered in relative terms (divided by lean body mass or muscle volume) the range reduces significantly (15, 5). Data from Miller at el (17) and Bartolomei et al (3) show a difference of 30% in relative strength for isometric bicep curl and bench press exercises. Additional factors besides strength and endurance play a role in push-up performance. Meir et al (16) examined both push-up forms in males and females. Muscle activation in the pectoralis major and triceps are also reduced (12) in the modified position. This, as well as restricted shoulder range of motion due to breast tissue, has been noted as a possible explanation for why females produce fewer repetitions (16).

Despite the gender bias seen in the push-up test, it provides valuable information about the muscular fitness of the upper body. The test is simple and easy to conduct. However, for women who train using the standard push-up, reactions to the modified position for testing range from insult to discomfort (26). The purpose of this study is to develop a fitness rating scale for college-age females (18-24 years) on the standard push-up test. We hypothesize that standard push-up performance can be predicted from modified push-ups and that a new rating scale for the standard push-up can be established from this relationship.

METHODS

This cross-sectional study was conducted during the spring semester of 2021, during the Covid-19 pandemic. All state and local guidelines were followed including the wearing of face masks and physical distancing during data collection. The maximal number of repetitions performed in each position, standard and modified, was used to examine the strength of relationship between the two tests. Each test was performed on two different days. The goal of the study was to develop a fitness rating scale for the standard push-up for women ages 18-24.

Participants
Study participants (*n* = 72) were recruited using both active and passive methods. Requests for volunteers were posted on campus social media sites. A campus-wide email message was targeted to female students. Undergraduate research assistants solicited volunteers in-person at the student center, dining hall, and recreation center. Eligible students had to self-identify as cisgender females and be between 18-24 years old. No level of physical activity or exercise was required and no prior experience with the push up test was needed. 76 women initially enrolled. Volunteers completed an informed consent form and a brief health history questionnaire prior to testing. Participants were excluded if they had a muscle, joint or bone injury in the last 3 months or for whom medical clearance prior to physical activity was recommended. One participant was disqualified due to injury, another was excluded for age, and 2 withdrew from the study. The mean age was 20.38 years (*sd = 1.4*). Body mass index ranged from 17.43 to 51.49 (*m = 24.38, sd = 5.31*). Only 13% of the sample were inactive, while 35% engaged in enough physical activity to enhance health according to the International Physical Activity Questionnaire (IPAQ). Fifty-six percent of the sample reported some form of resistance training on their health history questionnaire. Few health concerns were reported. Participant characteristics are shown in table 2.

Protocol
A standard health history form inquired about any current and prior medical conditions that could limit exercise. In particular, the health history questionnaire asked for signs and symptoms of cardiovascular disease, diabetes, kidney disease, respiratory disease, musculoskeletal injury, and smoking history. An open-ended question asked participants to list their current physical activities. Additionally, participants were asked, but not required to, provide their age, height, weight, and year in college on the form. Information from the health history questionnaire was used to determine if a participant could engage in physical activity without medical clearance according to the ACSM pre-activity screening guidelines (1). Participants were excluded from the study if they did not meet the conditions for "no medical clearance necessary" or had sustained a muscle, bone, or joint injury within the last 3 months.

Participants' current level of physical activity was estimated using the short form of the International Physical Activity Questionnaire (IPAQ). This 7-item survey quantifies energy expenditure from physical activity per week and categorizes physical activity volume as low, moderate, or high (13). Following the questionnaires, participants were randomly assigned to perform either the modified or standard push-up. The protocol outlined in the 10th edition of the ACSM Guidelines for Exercise Testing & Programming (2018) was used (1). Both positions have been found to be a valid measure of upper body muscular endurance (21, 27). Errors in form such as arched back, elevated hips and lack of elbow flexion have been reported to weaken this test's reliability (5, 14). Trained undergraduate researchers instructed participants on the proper execution of the push-up.

Table 2. Participant characteristics, *n* = 72.

		Count	Portion of Sample
Age	18	7	0.1
	19	16	0.22
	20	12	0.17
	21	22	0.31
	22	12	0.17
	23	1	0.01
	24	2	0.03
Year in School	first-year	16	0.22
	sophomore	10	0.14
	junior	27	0.38
	senior	18	0.25
	graduate student	1	0.01
BMI Category	normal	41	0.62
	obese	7	0.11
	overweight	13	0.2
	underweight	5	0.08
PA Level	low	9	0.13
	moderate	38	0.53
	high	25	0.35
Resistance Trains	yes	40	0.56
	no	32	0.44
Health Concerns	none	57	0.79
	asthma	9	0.13
	arthritis	1	0.01
	dizziness	2	0.03
	kidney disease	1	0.01
	quit smoking	3	0.04

Data were collected by undergraduate researchers and occurred in the college's fitness facility. Participants attended two sessions a minimum of 48 hours apart to allow for complete recovery. Questionnaires were completed in a private setting; however, the warm-up and push-up tests were conducted in open view of other patrons. On day 1, the informed consent, health screening, and IPAQ were administered prior to conducting either the modified or standard push-up test. On day 2, the remaining push-up test was completed. The order of push-up tests was randomized to reduce performance bias. An electronic coin flip determined the day 1 test position; heads modified, tails standard.

Prior to the push-up test each day, participants were led through a 5-minute dynamic warm-up. The warm-up began with a fast pace walk on an indoor track or in an open gymnasium. Next, a series of active movements targeting the pectoral, deltoid, and trapezius muscles was completed. The exercises increased in intensity from non-weight to light resistance band and finally to partial body weight. The specific warm-up exercises are listed in table 3. Correct form was modelled and verbally cued by the research assistants. Verbal instructions were provided for the key elements of proper form; no pausing at the top, elbows bend to 90°, chest should nearly touch floor, and shoulders, hips and knees should be in alignment. The modified position was performed with knees on a ½ inch foam mat. Participant could cross the lower leg at the ankle or leave uncrossed. In the standard position, the toes were the pivot point with knees straight and feet together. No mat was used. The depth of the movement was the same for both; 2 inches from floor or nearly touching with chest and the elbow flexed to at least 90° in the down segment.

Table 3. Participant warm-up.

3 mins fast paced walking	
Dynamic Movements	
Arm circles – 5 forward/ 5 backwards	Bodyweight Resistance Movements
10 Overhead Press to Lat Pulldown	10 Wall Push-ups followed by
10 Arm Claps – horizontal abduct-adduction	10 Standing Int/Ext Rot at 45°
Band Resistance Movements – light resistance	10 Bent Y Rows
10 Standing Band Pulls	Wall Pec Stretch
10 Scapular Retractions, neutral grip	Hold 20 sec, 2x – both Right and Left

Participants were asked to perform as many full repetitions as possible. During the test, participants were given one corrective cue per flaw. If the participant could not fix their form on the next repetition, the test was stopped. The total number of well executed repetitions was recorded.

Day 2 testing occurred between 48 hours and 7 days after the initial test. Participants were asked if they were experiencing muscle pain/soreness or illness that would prevent them from performing their best. Any affirmative response was followed by probing questions. Information on location of soreness and type of illness was noted in the participant's file. Twelve sessions (17%) were postponed due to soreness. Make-ups were completed within 3 days. The day 2 push-up test followed the same warm-up as day 1. At the conclusion, participants were asked if they would like to receive the results of the study.

Statistical Analysis

Raw data were entered into a spreadsheet. The IPAQ scoring guidelines were applied resulting in a continuous variable for energy expenditure (MET mins/week) and the classification of each participant as low, moderate, or highly active (13). The relationship between and MET mins/week and push-up repetitions was assessed with Pearson correlations. Grouping variables were added (PA level, resistance training, health concerns, and day 1 push-up position) prior to moving the data to SPSS version 27. Means and standard deviations were calculated for each push-up position by group. Data were visually examined via scatterplots and histograms using R version 4.0.5. Three outliers were identified but not removed as they were still possible test results.

The goal of producing a valid rating scale for the standard push-up for college-aged females required four steps. First, a Pearson correlation was used to determine the strength and direction of the relationship between push-up positions. Next, linear regression was used to check that modified push-ups were a significant predictor of standard push-ups and to develop a prediction formula. Then, the prediction formula was applied to the current cut-points of the modified push-up ratings to form a new rating scale for standard push-ups. Lastly, our sample's distribution of standard push-ups was compared to the new rating scale. The hope was that there would be high agreement between the quintile cut points and the new scale's five ratings.

A paired t-test determined the position from which the highest number of repetitions was completed. Independent t-tests checked for performance differences between the categorical groups established by the protocol; day 1 position, participation in resistance training and the presence of health concerns. A one-way ANOVA was used for the PA level groups; low, moderate, and high.

RESULTS

72 participants completed both push-up tests. Table 4 provides the means and standard deviations for all continuous variables. Eight participants could not complete one standard push-up, but 7 performed more than 20 repetitions. The number of modified repetitions was significantly higher than the standard repetitions (t = -11.44, p < .001).

Table 4. Sample means and standard deviations, n = 72.

	Standard Reps	Modified Reps	METS mins/week	BMI	Age
Mean	9	17.51	3769.67	24.38	20.38
Std. Deviation	8.87	11.76	3378.87	5.31	1.43

Table 5 shows push-up repetitions by PA level, BMI category, and self-reported resistance training. Participants who reported resistance training performed significantly better in both test positions. This group's mean standard reps were 12 (*sd* 10.37) versus the 5.8 (*sd* 4.33) completed by the non-resistance training participants (t = 3.51, p = .001). Mean modified reps differed by a similar margin from 20 (*sd* 13.76) to 14 (*sd* 7.79, t = 2.05, p = .02). No significant differences between PA or BMI groups were found in either modified or standard push-ups repetitions.

Table 5. Mean push-ups by categorical groups.

		Standard Reps	Modified Reps
PA Level	low	4.11 (2.85)	10 (3.61)
	moderate	6.24 (7.18)	14.74 (9.74)
	high	14.96(9.63)	24.44 (13.24)
BMI Category	underweight	9.8 (11.52)	18.20 (12.15)
	normal	11.51 (9.46)	20.51 (13.17)
	overweight	5.54 (6.5)	12.92 (6.28)
	obese	3.57 (5.38)	12 (10.15)
Resistance Trains			
	yes	12.05 (10.37) ‡	20 (13.76)*
	no	5.88 (4.23)	14.41 (7.79)

‡ $p = 0.001$ * $p = 0.02$

A strong linear relationship exists between max repetitions in the modified and standard positions ($r = 0.85$, $p < .001$), with a high coefficient of determination ($r^2 = 0.72$). See figure 1.

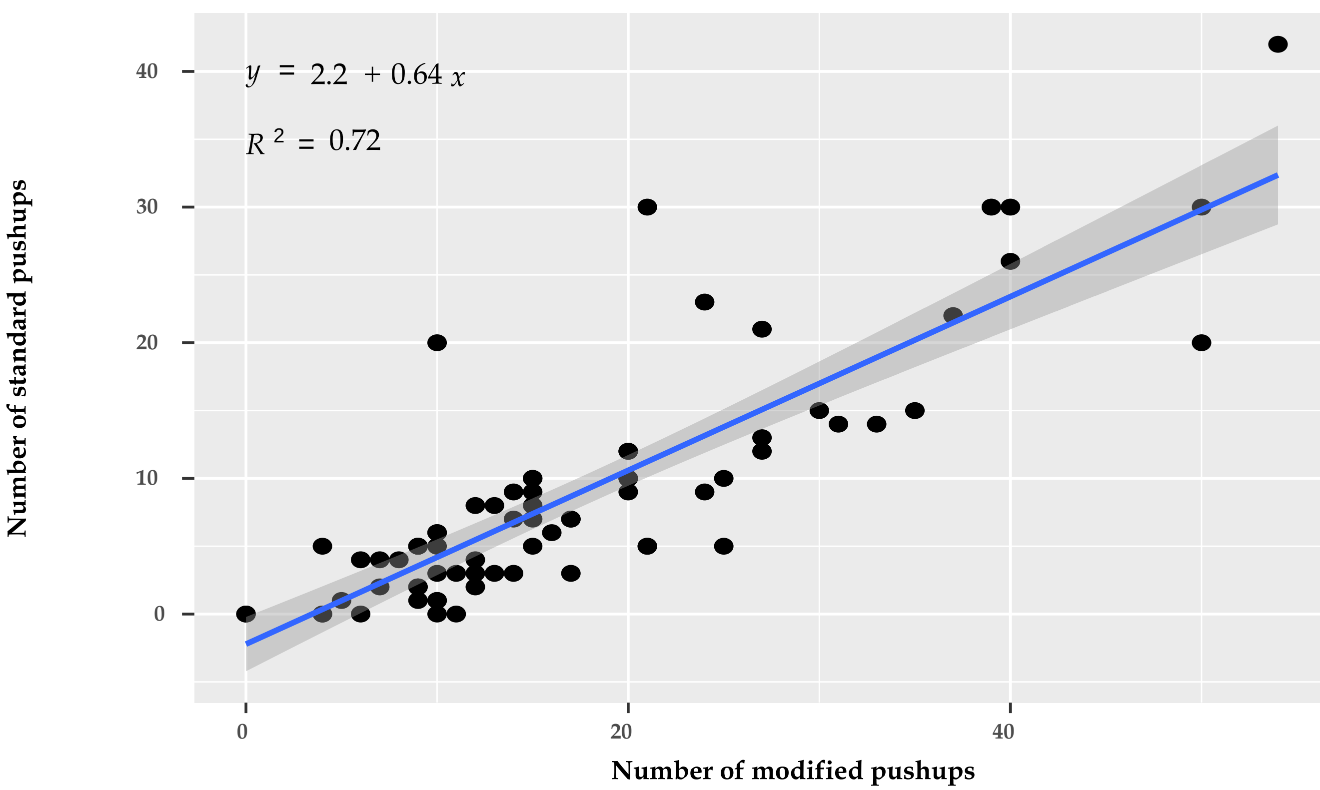

Figure 1. The correlation between modified and standard push-up repetitions was strong. The blue line and shadow illustrate the best fit.

Volumes of PA (MET mins/week) was weakly associated with standard push-up repetitions (r = .31, p = .001) and modified push-ups repetitions (r = .24, p =.04). Figure 2 shows that the relationship between modified and standard repetitions was slightly stronger in participants who reported resistance training (r = .86, p = .00) than those who didn't (r = .82, p = .00).

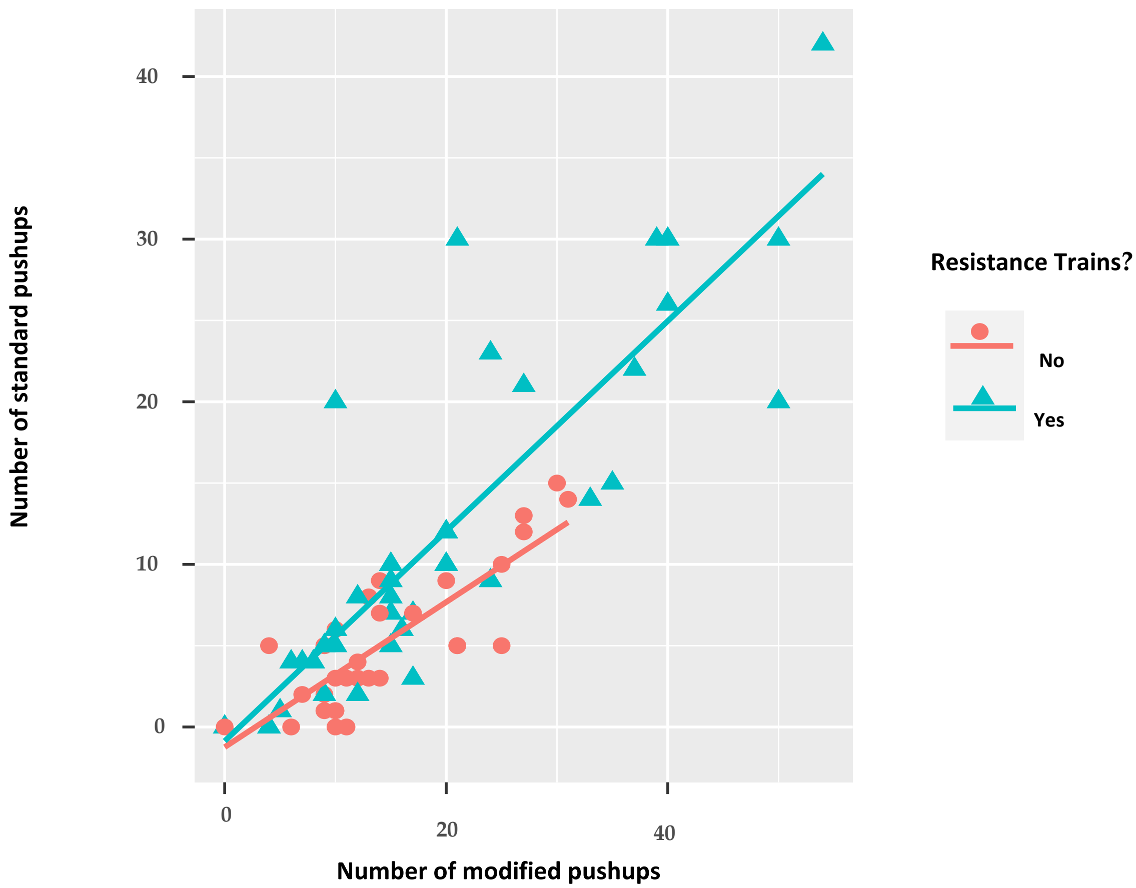

Figure 2. Participants who resistance trained showed a stronger correlation between the standard and modified repetitions.

Performance in the modified push-up was a significant predictor of max reps in the standard push-up, and vice versa. Linear regression analysis produced the following equation for predicting standard push-ups from modified; $Y = -2.217 + 0.64\ x\ modified\ reps$. See table 6 for the new standard push-up ratings scale. The predicted scale was developed by applying the formula to the current cut points for the five rating categories in modified push-up (2). The rounded scale shifted the thresholds for each category so that there was no overlap or gaps between the fitness ratings. Figure 3 shows the distribution of the standard push-up repetitions with the quintiles.

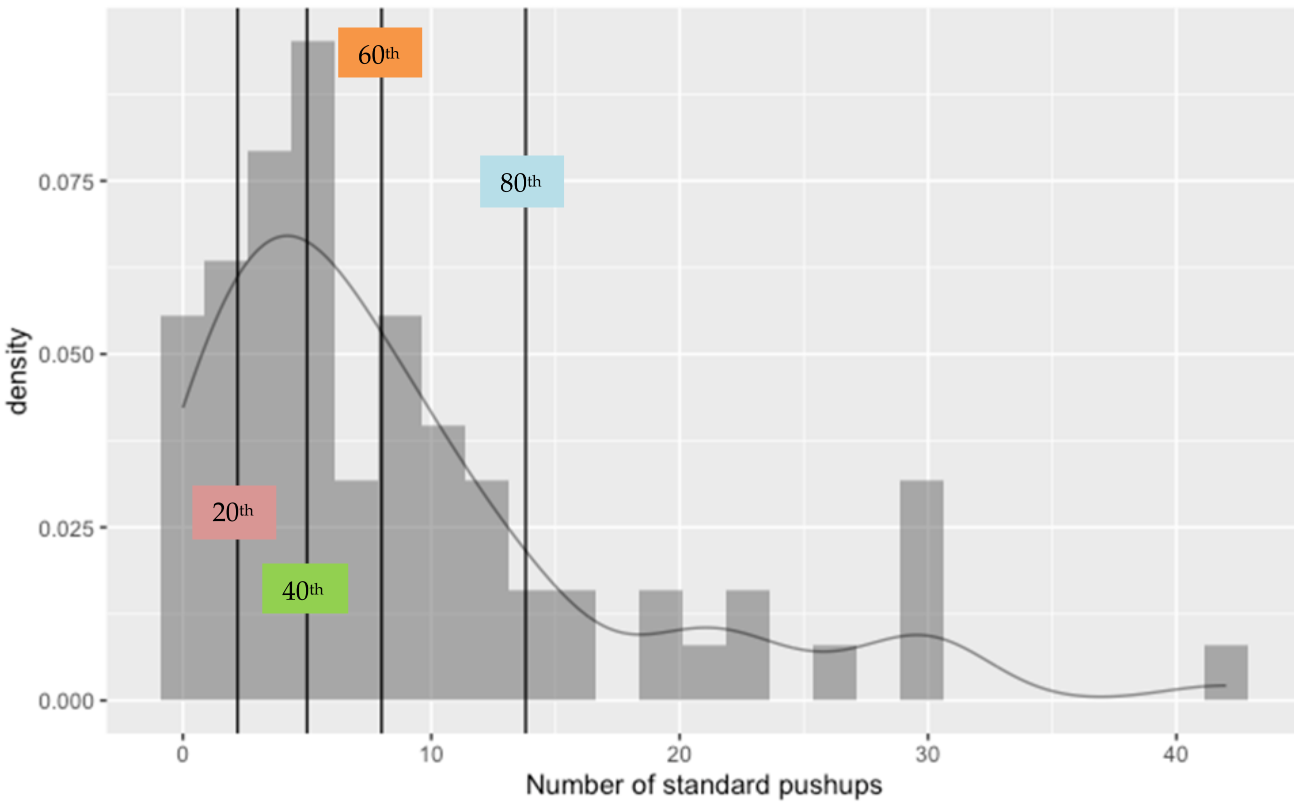

Figure 3. The initial cut points for the 5 fitness categories are show above. They were adjusted to account for participants who produced more than 20 repetitions.

Eight participants (11.1%) had standard reps greater than 20 enhancing the positive skew (1.6) displayed in the histogram. Therefore, the best alignment of the quintiles to the rounded scale occurs when the quintiles are shifted down one category (table 6). In this sample, the threshold for the predicted excellent category occurs at the 85.5 percentile.

Table 6. Predicted scale for standard push-up.

	Predicted Scale Standard Push-up	Predicted Scale (rounded)	Existing Modified Push-up Scale	Quintile Distribution (percentile)
Excellent	16.983	18	30	18.52 (85.5th)
Very Good	11.223-16.343	12-17	21-29	13.8 (80th)
Good	7.383-10.583	8-11	15-20	8 (60th)
Fair	4.183-6.743	5-7	10-14	5 (40th)
Needs Improvement	3.543	4	9	2.20 (20th)

DISCUSSION

Gender has long been an element of fitness testing. Distinctions in test protocols and grading standards are meant to balance observed physiological differences between females and males. However, they have not been updated to reflect current fitness practice. More and more, female athletes and women who resistance train use the standard push up. It seems reasonable that there should be a normative rating scale to provide them the option of testing from the standard position.

Our sample included all levels of physical activity seen in college-age females. The majority, however, were moderately to highly active and 56% of them reported engaging in resistance training. Maximal repetitions for the standard push-up ranged from 0-42 and from 0-54 in the modified. Push-up ability was weakly related to volume of physical activity, but no significant differences were found by activity group. Participants who reported doing resistance training as part of their current physical activity did complete significantly more repetitions in each position than those not engaged in resistance training. Nationally, 46% of 18–24-year-olds participate in muscle strengthening activities at least twice a week (19). Our sample outpaced this rate, though it is unclear from our questionnaires if they met the 2 times a week criterion or not. Participation in resistance training among females is raising. In 2011, just 24.5% of females in the Behavioral Risk Factor Surveillance System (BRFSS) reported regular muscle strengthening. The 2019 report shows an increase of 7% (19). Greater prevalence of resistance training among females is another reason to revise the current testing procedures and rating scales.

The strong correlation between the two positions allowed for a reasonable prediction of the standard reps. The formula; $Y = -2.217 + 0.64\ x\ modified\ reps$ was applied to the current range for each fitness category. The standard repetitions are roughly half of the modified repetitions in each category. The quintile distribution is skewed towards higher performance levels. The Fitnessgram® Healthy Zone has an even higher criterion. For example, females aged 17 years are expected to do between 18-35 push-ups in the standard position. The percentiles for the Revised Push-up (standard position, body touches floor) published by Baumgartner et al (4) in 2004 are less demanding than our predicted scale. While Revised Push-up percentiles from 2010, developed by Mozumdar et al (18) are more in line with our results (table 7). The 80th, 60th, and 40th cut points from the Mozumdar study fit within our very good, good, and fair ratings.

Table 7. Predicted scale with percentiles compared to revised push-up tests.

	Predicted Scale	Mozumdar et al 2010	Baumgartner et al 2005
Excellent (85-86th)	18	16	12
Very Good (80th)	12-17	15	10
Good (60th)	8-11	10	6
Fair (40th)	5-7	7	2
Needs Improvement (20th)	3	4	0

The maximum repetitions seen in the Revised Push-up studies (4, 5, 18) and in the present study illustrate the muscular fitness improvements are occurring in college-age females. In 2002, Baumgartner et al (5) noted that numerous zero scores were a challenge to criterion scoring and favored percentiles. Over the last 25 years, upper body strength and endurance has improved to the point that criterion categories for the standard push-up for females can be determined.

The new scale provides a useful tool for categorizing muscular endurance in normative terms. It can be used in school, sport, and fitness settings.
The protocol we used for the modified push-up placed a ½ inch foam mat only under the knees, creating a slight decline from the knees to the hand position. This was done to standardize the hand position for all participants regardless of height. The 36-inch mats available us required taller participants to put hands on the floor. As a result of lowering the hands, the modified push-up test may have been slightly harder than intended. No mat at all was used for the standard push-up. In hindsight, the same ½ inch mat should have been put under the feet for the standard push-up. This would have maintained a slight decline position for both tests. We believe the impact of this error to the prediction equation to be minimal.

The modified push-up is rooted in gender stereotypes and no longer reflects the abilities of young physically active females. In fact, the current test position and fitness ratings may reduce expectations and limit the development of self-efficacy. Zan and Ping (28) found that female students had lower expectations about their performance of resistance exercise than male students. These expectancy beliefs were stronger predictors of performance than interest in resistance training or beliefs about the importance of the exercise (28). Qualitative research supports this as well, a group of athletic females saw the lower standards for females as restrictive (26). If the standard push up becomes an exercise that women regularly have access to and can routinely receive a rating for, this could elevate expectations for muscular fitness and encourage more females to try the standard position. At the very least, the new scale provides females the option to select which push-up position they prefer.

This study is a small step to decreasing the gender bias in fitness culture. Additional research is needed to validate the new standard scale. Future studies should test the consistently of the fitness rating across both test positions as well as compare the standard push-up to the YMCA Bench Press test in female populations. An even greater step would be to develop a push-up test that is non-binary to be inclusive of all gender identities.

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