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THE RELIABILITY OF THE UTAH SEATED MEDICINE BALL THROW AMONG ADOLESCENTS: BRIEF REPORT

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ABSTRACT

The seated medicine ball throw (SMBT) has been used to assess upper-body muscular power output among various populations. Recently investigators developed an initial normative data set for the SMBT among adolescents using a standardized protocol referred to as the Utah SMBT. The purpose of the current investigation is to report a detailed reliability analysis of the Utah SMBT among adolescents. Untrained male and female physical education students aged 12-15 years (n=113) performed three trials of the Utah SMBT field test during one session following a specific warm-up period. The distance the participants threw a 2 kg medicine ball (19.5 cm diameter) while seated against a wall with legs straight was recorded for each trial. The average participant age, height, and mass were as follows: females n=56 (13.5±1.0 yrs, 161.4±7.3 cm, 56.0±13.2 kgs); males n=55 (13.7±1.0 yrs, 170.7±9.2 cm, 63.7±18.7 kgs). The female's average distance (m) thrown for trials 1-3 were: 3.5±0.5, 3.5±0.5, 3.6±0.5, respectively. The male's average distance (m) thrown for trials 1-3 were: 4.6±0.8, 4.8±0.9, 4.8±0.9, respectively. The intra class reliability coefficients (ICCs) for the consecutive trial pairs ranged from ICC= 0.95-0.97. Within the parameters of this study the Utah SMBT Protocol provides a reliable assessment upper-body muscular power output among adolescent physical education students.

Keywords: *Upper-body muscular power, reliability, power assessment protocol, physical education, fitness testing, Utah SMBT Protocol.*

1. INTRODUCTION

The nature of the skills and techniques required for sports such as basketball, cheerleading, volleyball, tennis, and gymnastics require upper-body muscular power (Borms et al., 2018; Gillens et al., 2018; Salonia et al., 2004). A given sport may require an athlete to propel their body, limbs or an object through space, often requiring upper-body muscular power. When assessing readiness/aptitude for sport, muscular power is an essential consideration (Bechael et al., 2008). Part of the mission of physical educators is to prepare students for a lifetime of physical activity through sport participation, recreation and activities of daily living. Therefore, it is prudent for physical educators to assess and track upper-body muscular power to assess the success of the physical education curriculum and the preparation students for a life time of physical activity including sport participation.

The Seated Medicine Ball Throw (SMBT) has been used to assess upper-body muscular power output due to its ease of use in a field setting. The SMBT is a non-complex movement (Beckham et al., 2019; Harris et al., 2011) that has been used successfully by a number of populations including children, athletes, healthy adults, and older adults (Beckham et al., 2019A; Beckham et al., 2019B; Cronin et al., 2004; Davis et al., 2008; Harris et al.,

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2011; Sato et al., 2018; Stockbrugger et al., 2003; Vossen et al., 2000). The SMBT is relatively simple to score as it is the horizontal linear distance that the medicine ball is thrown. Adopting the use of the SMBT within a physical education curriculum for the purpose of assessing and tracking upper-body muscular power development appears to be an advantageous opportunity.

Prior research (Beckham et al., 2019) has suggested that SMBT studies lack consistency in methodology with regards to conducting the SMBT. With that said, researchers recently developed the Utah SMBT protocol for the purpose of standardization and the development of normative data sets for adolescent physical education students (Biggar et al., 2021). Prior to implementing a field test there should be an extensive investigation of the associated reliability of the assessment. As such, the purpose of this report is to provide potential clinicians and researchers with an extensive analysis of the reliability of the Utah SMBT Test.

2. METHODS AND MATERIALS

2.1 Participants

Researchers in Northern Utah (United States) recruited adolescent students from physical education classes in a single public school by issuing a public announcement in their classes. Researchers obtained permission to conduct the study by a University IRB committee (IRB Approval #24-032020b) prior to recruiting the students. Informed consent/parental assent was obtained prior to any data collection. Inclusion criteria required participants to be between 12 and 15 years of age, free of injury or disease, and considered untrained. Participation was voluntary, and participants were able to withdraw at any time without penalty. Before the engaging the study, researchers discussed procedures, possible risks, benefits, and confidentiality with the volunteers. The current study is a continuation of the Biggar et al. (2021) investigation.

2.2 Instruments and Apparatus

The Utah SMBT test was conducted with a 19.5 cm diameter 2 kg medicine ball along with a measuring tape and gymnastic chalk. The medicine ball was a rubber "Champion Sports" brand ball (Figure 1). The measuring tape was labeled with metric increments of centimeters. A Detecto 437 eye-level physician's scale was used to collect the participants' body mass in kilograms. A separate measuring tape collected body height in centimeters. A description of the assessment of height and weight is provided in detail elsewhere (Biggar et al., 2021).

Figure 1: Example of the Champion medicine ball (2 kgs mass, 19.5 cm diameter)

2.3 Procedures

The participants completed all testing during their regular physical education class period. Researchers spent an additional school day giving information to potential participants and handing out informed assent packets. In total, the study required two days to complete.

As previously discussed (Biggar et al., 2021): "data collection for this study occurred during the COVID-19 pandemic. Due to the pandemic, researchers took additional measures to ensure the safety of participants and researchers. In order to protect both researchers and participants from possibly contracting the virus, the school district required researchers to place increased restraints on data collection. Commonly touched surfaces, such as the medicine ball, had to be sanitized between every use. All participants were required to wear masks during the data collection, and participants were kept six feet apart at all times".

On the day of testing, the researcher read instructions to students and demonstrated the assessment. After recording height, weight, gender, and age, subjects participated in a warmup protocol.

2.4 Warmup Protocol

The warmup protocol included multidirectional shoulder movements similar to those used in the Borms et al. investigation (2018). The warmup protocol also included a jog in place for 30 seconds, thirty jumping jacks, ten body weight push-ups, ten T-Y-I shoulder motions, and ten chest-passes with a basketball.

2.5 Seated Medicine Ball Throw

The following is as described in Biggar et al. (2021). The SMBT was conducted no longer than three minutes following the warmup protocol. To accomplish this, participants performed the warmup protocol and the SMBT in groups of five. After the researcher gave instructions on the warmup and SMBT protocols, participants performed the SMBT one at a time, in no particular order. Participants started by sitting at a 90° angle against a designated wall with their legs straight out and their head resting on the wall. Participants started by holding a 2 kg medicine ball against their chest.

After receiving a verbal signal from the researcher, participants pushed the medicine ball in a chest-pass motion as forcefully as possible without their back or their head leaving the wall. In order to better identify the impact site of the ball, researchers lightly dusted medicine balls with gymnast chalk, which provided a mark on the floor where the ball initially made contact after the throw. A measuring tape was placed on the ground starting at the spot where the medicine ball rested and extended outward away from the participant. The measuring tape recorded distance in increments of tenths of a meter, measuring began at the start position of the ball (2 cm from the pelvis of the person performing the SMBT) and ended at the first point of contact between the ball and the floor. The distance thrown was then recorded by hand using a data collection sheet and later transferred into a MS Excel spread sheet. Each participant had three attempts to throw the medicine ball as far as possible with a two-minute break between each attempt. From the demonstration to the final attempt, the entire testing procedure took no longer than 45 minutes.

The current testing protocol is similar to those used in prior studies (Borms et al., 2018; Harris et al., 2011; Margin et al., 2016). However due to, the unique standardization of the current procedures and the participant population, we refer to the current study methods as the "Utah SMBT Protocol" (Biggar et al., 2021).

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2.5 Statistical Analysis

The SMBT trials were examined between sequential trials with: Δ mean between trials, interclass reliability coefficients (*r*), intraclass reliability coefficients (ICCs), typical error expressed as a CV%, and the standard error of measurement (SEm). Scatter plots were constructed to examine linearity between the sequential trial scores. Bland-Altman plots were used to determine error uniformity and limits of agreement (LOA) between the trial scores. Data were tabulated in an MS Excel spreadsheet where demographic and basic statistics were calculated. The Excel spreadsheet was peer reviewed for accuracy as suggested by AlTarawneh and Thorne (2017). The reliability statistics were calculated in an MS Excel spreadsheet provided by Hopkins (2013).

3. RESULTS

A total of 111 adolescent female (n=56) and male (n=55) completed the study without complications. The age, height, and mass of the participants can be found in table 1. The SMBT average trial scores are presented in table 2. The SMBT trial scores for the female and male participants were combined for the purpose of statistical analysis.

Tables 2-3 show the reliability statistics between sequential SMBT trials (Δ means, *r*, ICC, %CV, and SEm). Figure 2 is a scatter plot of the SMBT trial 2 and 3 scores, suggesting a linear relationship between the test-retest scores. A similar scatter plot for the SMBT trial 1 and 2 scores appeared nearly the same. Figure 3 is a Bland-Altman plot of SMBT trial 2 and 3 scores including limits of agreement (LOA). The Bland-Altman plot did not exhibit evidence of non-uniform error or bias. A similar Bland-Altman plot for the SMBT trial 1 and 2 scores appeared nearly the same.

Table 1: Demographics (mean±sd)

N	Age (years)	Height (cm)	Mass (kg)
Combined n=111	13.6±1.0	166.0±9.5	59.8±16.6
Female n=56	13.5±1.0	161.4±7.3	56.0±13.2
Male n=55	13.7±1.0	170.7±9.2	63.7±18.7

Table 2: Seated medicine ball throw distance trial scores

N	Trial 1	Trial 2	Trial 3
Combined n=111	4.0±0.9	4.1±1.0	4.2±0.9
Female n=56	3.5±0.5	3.5±0.5	3.6±0.5
Male n=55	4.6±0.8	4.8±0.9	4.8±0.9

Table 3: Seated medicine ball throw distance trial 1 and 2 statistics

Statistic		Upper Limit	Lower Limit
Δ means (m)	0.12±0.30	0.16	0.07
r	0.95	0.96	0.93
ICC	0.95	0.96	0.93
Typical Error (CV%)*	5.5	6.2	4.9
SE_m	0.21	0.24	0.19

90% Confidence UL-upper limit, LL-lower limit. *Typical error expressed as a CV% based on Log-transformed data. SEm- standard error of the measure. *r*- Pearson correlation coefficient. ICC- Intraclass correlation coefficient. m- meters.

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Table 4: Seated medicine ball throw distance trial 2 and 3 statistics

Statistic		Upper Limit	Lower Limit
Δ means (m)	0.07±0.22	0.11	0.04
r	0.97	0.98	0.96
ICC	0.97	0.98	0.96
Typical Error (CV%)*	4.2	4.7	3.7
SE_m	0.16	0.18	0.14

90% Confidence UL-upper limit, LL-lower limit. *Typical error expressed as a CV% based on Log-transformed data. SEm- standard error of the measure. r- Pearson correlation coefficient. ICC- Intraclass correlation coefficient. m- meters.

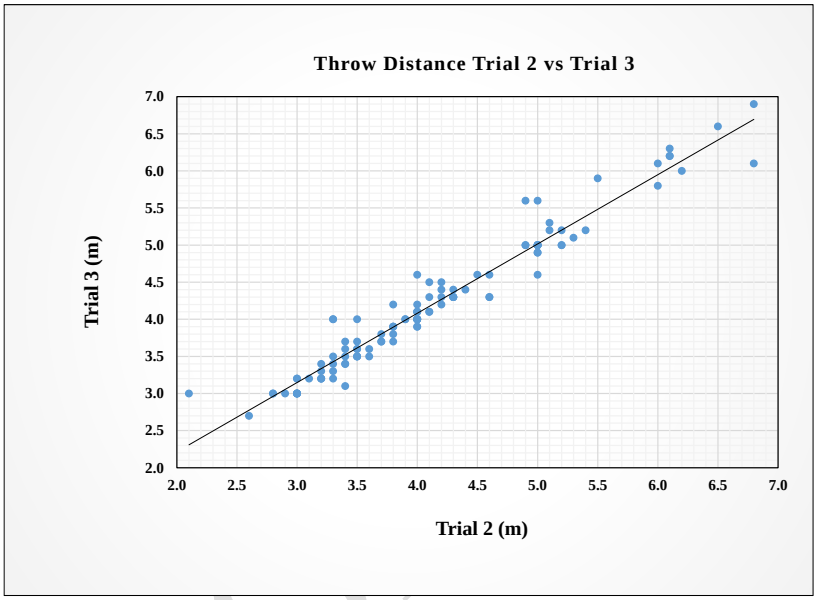

Figure 2: Scatter plot of trial 2 and 3 Utah SMBT

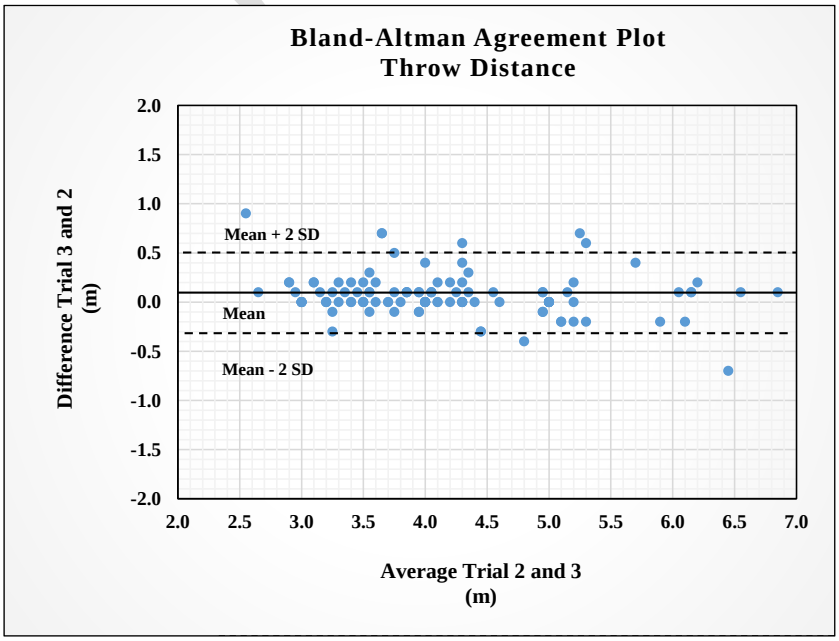

Figure 3: Bland-Altman plot of trial 2 and 3 Utah SMBT. Limits of agreement are the mean±2 SD in the differences in trial scores

4. DISCUSSION

The purpose of this study was to determine the reliability of the Utah SMBT protocol among adolescent physical education students. The various reliability statistics indicated high reliability between the sequential trials of the SMBT. With that said, the best reliability was observed between trials 2 and 3.

Tables 3-4 tabulate the reliability statistics with 90% confidence limits (UL, LL) for the sequential SMBT trials 1-2 and 2-3. The interclass reliability coefficients (r or PCC) ranged from 0.95-0.97, which are consider as high (Safrit & Wood, 1995). The intraclass reliability coefficients (ICC) ranged from 0.95-0.97, which are considered as excellent reliability (Koo & Li, 2016). The standard error of measurement (SEm) ranged from 0.16-0.21 m which was similar to that reported by Beckham et al. (2019) of SEm=0.12-0.16 m and Harris et al. (2011) of SEm=19.1 cm and 14.8 cm. As suggested by Hopkins (2013), the data were log-transformed to identify typical error and no bias or non-uniform error was detected.

The ICCs of the SMBT sequential trials scores were very similar to those reported by: Beckham et al. (2019) for college age students ICC=0.97-0.99; Harris et al. (2011) among ageing adults ICC=0.97; Gillespie et al. (1987) reported ICCs=0.95-0.97 in active college males; Lyttle et al. (1996) for regionally competitive athletes an ICC=0.93. Collectively, these study results support the premise that the SMBT is a reliable measure of upper body muscular power across a host of populations.

5. CONCLUSION

The results of the current study suggest that a preferred/better reliability was observed between the SMBT trials 2 and 3 which infers that the addition of a couple of practice trials may enhance the consistency of subsequent scores. With that said, the male trial 2 and 3 scores had the equivalent mean and standard deviation. As such, it is recommended that the average of trials 2 and 3 serve as a student's score. A limitation in a prior investigation suggests that there is bias between raters when scoring the SMBT for distance (Borrie et al., 1998). We believe a strength of the Utah SMBT protocol is the manner in which the throw distance was measured. Dusting the SMB with chalk left an objective datum of the location of landing as opposed to a rater's subjective visual acuity of the landing point of a SMBT.
Within the parameters of this study the Utah SMBT has exhibited high to excellent test-retest reliability among adolescent physical education students. The Utah SMBT protocol provides physical educators an easy to use, inexpensive, standardized field test to assess and track upper-body muscular power among adolescent physical education students.

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