Available Online at http://www.journalajst.com

ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN: 0976-3376

Asian Journal of Science and Technology
Vol. 5, Issue 1, pp. 094-097, January, 2014

RESEARCH ARTICLE

ABDOMINAL STRENGTH IN KOREAN AND AMERICAN POPULATIONS: THE DEVELOPMENT OF NORMS USING ABDOMINAL TEST AND EVALUATION SYSTEMS TOOL

***Jordan McKenzie Glenn, Barry Brown, Bae Yoon Jung and Robert Ferguson**

Department of Health, Human Performance, and Recreation, University of Arkansas, Fayetteville, Arkansas, USA

ARTICLE INFO

Article History:
Received 22nd October, 2013
Received in revised form
04th November, 2013
Accepted 29th December, 2013
Published online 25th January, 2014

Key words:
Absolute force,
Core-strengthening,
Representative,
ABTEST
Korean population.

ABSTRACT

Core-strengthening exercises have become an integral foundation of most training programs, however when developing normative data for core-strength it cannot be assumed that recommendations are appropriate for all populations. Therefore, the purpose of this study was to develop normative core strength data for the Korean population in comparison to established American norms as measured by the Abdominal Test and Evaluation Systems Tool (ABTEST). Core-strength data collected from American (males: n = 84, females: n = 94) and Korean (males: n = 196, females: n = 212) populations were used for initial comparisons and development of population norms. When using ABTEST for evaluation, subjects were placed with the knees and hips at 90-degree angles with a force transducer located directly over the xiphoid process. Force was measured using a secured, cushioned load cell and was expressed in kg. Absolute force, relative force (per unit body weight), and fatigue (force decline over a 10-second contraction) were evaluated between genders for both population groups using unpaired t-test. Normative data were developed by organizing outputs from American and Korean subjects into 10th, 25th, 50th, 75th, and 90th percentiles. When evaluating absolute strength, American males ($p < .001$) and females ($p = .003$) demonstrated significantly higher strength compared to gender and age matched Koreans. Similar significant differences ($p < .001$) were observed in males when evaluating relative strength, however, relative differences were not detected in females. Fatigue index demonstrated a reverse trend compared to absolute strength. Korean females demonstrated a 28% lower fatigue index than American females while Korean males show a 30% lower fatigue index than American males. When developing normative strength values for the Korean population, Korean males exhibited significantly lower scores at each percentile compared to their American, male counterparts. With the exception of the lowest percentile (10%), the same pattern existed for Korean females. Current data support the concept that analysis of different cultures is necessary to develop normative data for populations. Future research must not only evaluate different cultures, but also ensure that the evaluated subset is representative of the population.

INTRODUCTION

Core strength has been defined as "the muscular control required around the lumbar spine to maintain functional stability" (Akuthota and Nadler, 2004). When referring to strength from a perspective of force production, a more representative definition is described as the ability of the core musculature to produce force through muscle contractility and intra-abdominal pressure (Faries and Greenwood, 2007). Core strength has been documented as a critical factor for both general and sport related activities (Roetert, 2001; Hibbs, Thompson, French, Wrigley, and Spears, 2008). A lack of core strength can cause muscular overcompensation, predisposing individuals to injury (Jeffreys, 2002; Wilson, Dougherty, Ireland, and Davis, 2005). Core strength deficiencies have been documented as an important factor for occurrence of low-back injury during physical activity (Johnson, 1999; Nadler, Malanga, DePrince, Stitik, and Feinberg, 2000; Nadler, Malanga, Bartoli, Feinberg, Prybicien, and DePrince, 2002; Leetun, Ireland, Wilson, Ballantyne, and Davis, 2004). Proper development and maintenance of core strength can lead to an increase in maximal muscle force and efficiency (Lehman, 2006; Tse, McManus, and Masters, 2005). Because of these factors, core-strengthening exercises have become an integral foundation of almost all training programs (Kumar and Vasanthi, 2012). Due to the potential issues that can arise from a deficiency in core strength, proper evaluation and documentation of abdominal musculature is critical. The Abdominal Test and Evaluation Systems Tool (ABTEST) has undergone validation as an effective and accurate method of assessing core strength and previous literature has used ABTEST to compare abdominal strength in female athletes (Brown, Williams, and Hobbs, 1999) and as a predictive tool for assessing firefighting performance (Michaelides, Parpa, Henry, Thompson, and Brown, 2011). In

****Corresponding author: Jordan McKenzie Glenn,***
Department of Health, Human Performance, and Recreation, University of Arkansas, Fayetteville, Arkansas, USA

order to individually apply the results from ABTEST, normative data must be established to enable proper interpretation and comparison. Normative scores for the American population have been developed in the general population of males and females as well as special populations (i.e., firefighters, athletes) on ABTEST, and five classification levels (from needs immediate attention to excellent category) have been developed based upon tendency for incurring low back pain and achieving desired levels of abdominal strength. However, these norms may be different in individuals of other ethnicities, cultures and countries. The purpose of this investigation was to establish norms for core strength in the Korean population and to compare both strength and fatigue in the core musculature of Korean and American male and female populations.

Methods

Selection of Subjects

A total of 586 subjects (males = 280, females = 306) participated in this study. Subject demographic data is presented in table 1. Age range of participants was from mid-20s to mid-50s. All Korean testing was done in E-Land Hospital, Seoul, Korea under trained physician supervision. This study was approved by the hospital ethics committee and before testing, all subjects signed an authorized informed consent. The data collected in the American population were obtained as part of multiple research projects. Each project was approved by the university institutional review board and all subjects signed an informed consent.

Inclusion Criteria

All subjects were pre-screened for low-back pain issues using the Oswestry low back pain disability questionnaire (Fairbank, Couper, Davies and O'brien 1980). Individuals found to have acute low-back pain did not qualify to participate in the evaluation. Subjects were advised not to engage in strenuous physical activity 24-hours prior to testing procedure.

Table 1. Participant demographic data distributed by gender and country

	N	Age (years) ± SD	Weight (kg)
Population combined total	586	38.74 ± 9.91	67.56 ± 15.08
American Male	84	28.19 ± 10.82*	85.56 ± 18.50*
American Female	94	30.55 ± 12.02*	65.76 ± 12.75*
Korean (Male)	196	43.89 ± 5.60	73.45 ± 12.75
Korean (Female)	212	41.80 ± 5.03	56.18 ± 7.77

*Indicates significant difference between genders for American participants compared to Korean participants

MATERIALS AND METHODS

When using ABTEST (Figure 1a) for evaluation, subjects were placed with the knees and hips at 90-degree angles respectively with a force transducer located directly over the xiphoid process (Figures 1b and 1c). Force was measured using a secured, cushioned, Sentran VB3 bending beam load cell (Ontario, CA) and was expressed in force units (kg) Outputs were then normalized based on subject weight. Maximal force outputs (kg) were also recorded for each trial. Subjects placed their hands on the acromion processes of opposing shoulders and were instructed not to remove the hands during the test. Placing the hands on opposing shoulders prevented swinging or rotational forces, which would alter momentum and ultimately, increase force production. During testing, subjects' feet were not secured to prevent hip flexors from contributing additive force production. Subjects were instructed to produce a maximal, isometric contraction against the force transducer for 10 seconds and maintain constant contraction throughout the evaluation. Prior to contraction, subjects were advised to take a normal inhalation and expire slowly in order to avoid the valsalva maneuver. Termination criteria for the test were as follows: (a) peaks detected in the graph due to pulsation on and off the transducer, (b) hands coming off the opposing acromion processes, (c) pain or extraordinary discomfort experienced by the subjects, (d) completion of full 10-second evaluation, or (e) subject voluntary cessation. A graphic display of the 10 second test was provided for each participant. Examples of acceptable and unacceptable outputs are depicted in Figures 4 and 5 respectively.

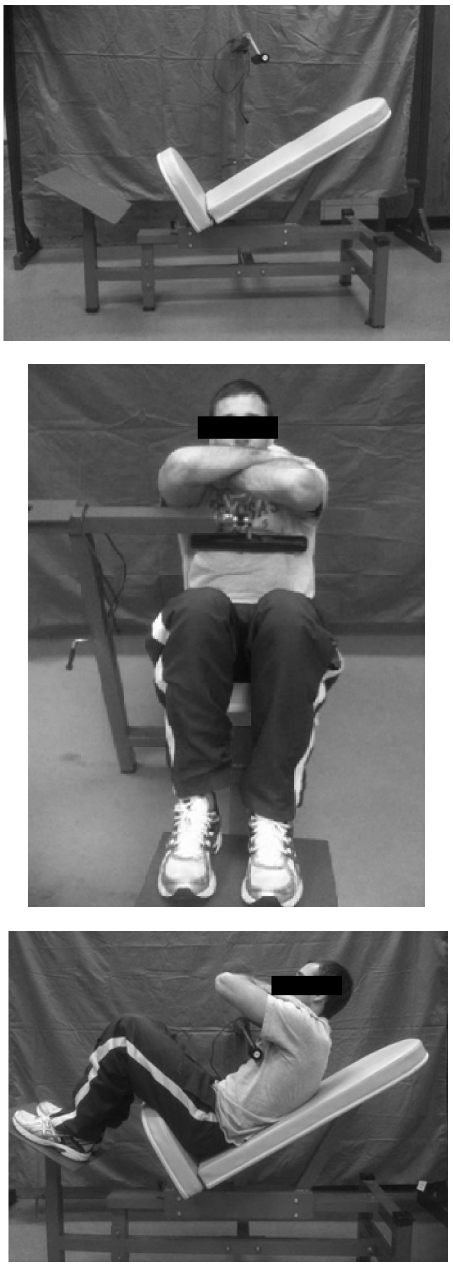

Figure 1. a) ABTEST modality, b) anterior view, and c) lateral view of proper technique

Table 2. ABTEST normative data for Korean and American participants

	10th Percentile (kg)	25th Percentile (kg)	50th Percentile (kg)	75th Percentile (kg)	90th Percentile (kg)
Combined Total	8.52	11.04	15.80	21.07	27.28
American (Male)	*14.97	*20.00	*25.68	*30.91	*37.98
Korean (Male)	12.66	15.84	19.15	22.25	27.02
American (Female)	5.90	9.00	#13.06	#17.84	#22.24
Korean (Female)	7.72	9.11	11.11	13.93	16.60

*Indicates significant difference in American males compared to Korean males. #Indicates significant difference in American females compared to Korean females.

Statistical Analyses

Differences between Korean and American populations for absolute and relative abdominal strength (kg) and fatigue index (expressed as the percentage reduction in abdominal strength over the 10 second testing time period) was assessed between Korean and US populations by gender and determined using an unpaired t-test. Since it was pre-determined there was a significant difference in body weight between both Korean and US populations by gender, abdominal strength was corrected for body weight and expressed as a relative score (max effort/kg) and an unpaired t-test was used to determine if significant differences existed between relative abdominal strength by gender. Normative classifications were then determined for the Korean population by gender and categorized into 5 percentile ranges (10th, 25th, 50th, 75th, 90th) and compared to those previously established for Americans. Significance for all analyses was set at $\alpha = .05$.

RESULTS

Demographically, the age of Koreans was significantly greater compared to American participants. The body weight of Koreans was significantly less for both genders (17%) compared to American participants. It was considered appropriate to compare cross cultural and international data using both relative and absolute values because of the lower body weight among Korean participants. Data analysis revealed no effect of age on either absolute or relative maximum abdominal strength scores, or fatigue index ($r < 0.2$). Figure 2 presents the absolute and relative scores for maximal abdominal strength (kg). When evaluating absolute strength, American males ($p < .001$) and females ($p = .003$) demonstrated significantly higher strength compared to males and females of Korean descent. The same significant results ($p < .001$) were observed for males when evaluating relative strength; however, these differences were not detected between American and Korean females after correcting for body weight. Fatigue index, expressed as the percentage loss in absolute strength over a 10 second period, demonstrated a reverse trend compared to absolute strength. Korean females demonstrate a 28% lower fatigue index than American females while Korean males show a 30% lower fatigue index than American males. Finally, Korean males exhibited significantly lower scores at each percentile compared to their American, male counterparts (Table 2). With the exception of the lowest percentile (10th percentile), the same pattern also existed for Korean females. The differences between percentiles become increasingly pronounced at higher percentiles. The greatest differences between ethnicities exist in the 75th and 90th percentiles.

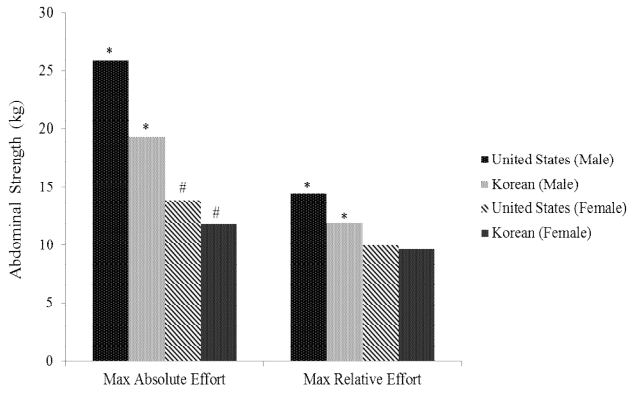

Figure 2. Abdominal strength scores distributed by gender and country. *Indicates a significant difference between American and Korean males. #Indicates a significant difference between American and Korean Females

DISCUSSION

The purpose of this investigation was to develop normative core strength data for the Korean population in comparison to established American norms. American males exhibited increased abdominal strength from both absolute and relative viewpoints when compared to their Korean counterparts while females only presented significant differences in absolute strength. The significant differences in absolute and relative abdominal strength values between both populations cannot be ascribed to technique as the apparatuses used in each location were identical and technicians were trained and certified using matching protocol in both countries. The difference in stature accounts for a narrowing of the differences but even relative abdominal strength values are significantly lower in the Korean male population. Lifestyle and the use of core musculature in everyday activities and the emphasis in the American culture of developing core strength as part of typical training routines may account for the significantly higher values in the American population (Kibler, Press, and Sciascia, 2006). The recent emphasis in Korean culture to promote high levels of fitness among females may explain the narrowing of abdominal strength differences between American and Korean females (Shin, Hur, Pender, Jang, and Kim, 2006). It is important to apply population specific norms when comparing the effects of intervention programs and discussing the role of core strength as it affects activities of daily living and the potential for low back pain and related medical issues (Vasseljen, Unsgaard-Tondel, Westab, and Mork, 2012). The population measured at the Korean hospital may reflect lower scores than the general Korean population. Therefore, it is recommended that a wide scale assessment program be initiated in a variety of Korean populations including young adults to verify the current results.

Conclusion

Current data advocate the concept that activity levels and values toward fitness in different cultures may cause differences in fitness profiles that influence normative data for individual populations, and that normative data from one cohort may not necessarily be applicable to a general

population. Future research must not only evaluate different cultures, but also ensure that the subset of a particular population is representative of the community as a while. This particular investigation evaluated individuals within the confines of a Korean hospital and cannot necessarily be attributed to the entire Korean population.

REFERENCES

Akuthota, V., & Nadler, S.F. 2004. Core strengthening. *Archives of Physical Medicine and Rehabilitation, 85*, 86-92.

Brown, B., Williams, B., & Hobbs, J. 1999. A new protocol to evaluate abdominal strength in women. *American Journal of Health Studies, 15*(2), 91-93.

Fairbank, J., Couper, J., Davies, J., & O'brien, J. 1980. The oswestry low back pain disability questionnaire. *Physiotherapy, 66*(8), 271-273.

Faries, M. D., & Greenwood, M. 2007. Core training: Stabilizing the confusion. *Strength & Conditioning Journal, 29*(2), 10-25.

Hibbs, A. E., Thompson, K. G., French, D., Wrigley, A., & Spears, I. 2008. Optimizing performance by improving core stability and core strength. *Sports Medicine, 38*(12), 995-1008.

Jeffreys, I. 2002. Developing a progressive core stability program. *Strength & Conditioning Journal, 24*(5), 65-66.

Johnson, H. 1999. Stressful motion: Golfers at high risk for low back pain. *Sports Med Update, 14*, 4-5.

Kibler, W. B., Press, J., & Sciascia, A. 2006. The role of core stability in athletic function. *Sports Medicine, 36*(3), 189-198.

Kumar, A. S., & Vasanthi, G. 2012. Effect of swiss ball and crunches on muscular strength and abdominal strength. *Asian Journal of Science and Technology, 2*(01), 89-92.

Leetun, D. T., Ireland, M. L., Willson, J. D., Ballantyne, B. T., & Davis, I. M. 2004. Core stability measures as risk factors for lower extremity injury in athletes. *Medicine & Science in Sports & Exercise, 36*(6), 926-934.

Lehman, G. J. 2006. Resistance training for performance and injury prevention in golf. *The Journal of the Canadian Chiropractic Association, 50*(1), 27-42.

Michaelides, M. A., Parpa, K. M., Henry, L. J., Thompson, G. B., & Brown, B. S. 2011. Assessment of physical fitness aspects and their relationship to firefighters' job abilities. *The Journal of Strength & Conditioning Research, 25*(4), 956-965.

Nadler, S. F., Malanga, G. A., Bartoli, L. A., Feinberg, J. H., Prybicien, M., & DePrince, M. 2002. Hip muscle imbalance and low back pain in athletes: Influence of core strengthening. *Medicine & Science in Sports & Exercise, 34*(1), 9-16.

Nadler, S. F., Malanga, G. A., DePrince, M., Stitik, T. P., & Feinberg, J. H. 2000. The relationship between lower extremity injury, low back pain, and hip muscle strength in male and female collegiate athletes. *Clinical Journal of Sport Medicine, 10*(2), 89-97.

Roetert, P. 2001. 3D balance and core stability. *High-Performance Sports Conditioning: Modern Training for Ultimate Athletic Development. Champaign (IL): Human Kinetics,*

Shin, Y. H., Hur, H. K., Pender, N. J., Jang, H. J., & Kim, M. 2006. Exercise self-efficacy, exercise benefits and barriers, and commitment to a plan for exercise among Korean women with osteoporosis and osteoarthritis. *International Journal of Nursing Studies, 43*(1), 3-10.

Tse, M. A., McManus, A. M., & Masters, R. S. 2005. Development and validation of a core endurance intervention program: Implications for performance in college-age rowers. *The Journal of Strength & Conditioning Research, 19*(3), 547-552.

Vasseljen, O., Unsgaard-Tøndel, M., Westad, C., & Mork, P. J. 2012. Effect of core stability exercises on feed-forward activation of deep abdominal muscles in chronic low back pain: A randomized controlled trial. *Spine, 37*(13), 1101-1108.

Willson, J. D., Dougherty, C. P., Ireland, M. L., & Davis, I. M. 2005. Core stability and its relationship to lower extremity function and injury. *Journal of the American Academy of Orthopaedic Surgeons, 13*(5), 316-325.

****