Normative Data for the Functional Movement Screen in Middle-Aged Adults

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Abstract

Perry, FT and Koehle, MS. Normative data for the functional movement screen in middle-aged adults. *J Strength Cond Res* 27(2): 458–462, 2013—The functional movement screen (FMS) is an easily administered and noninvasive tool for identifying weaknesses and asymmetry during exercises and daily activity. The clinical utility of FMS is currently limited by its lack of normative reference values. This study aimed to fill this void by providing normative reference values for healthy, middle-aged adults. Furthermore, we hypothesized that FMS would be affected by other factors such as age, body mass index (BMI), exercise participation, and Balance Error Scoring System scores. Six hundred and twenty-two healthy adults were assessed based on their performance on the 7-Point FMS. A higher level of exercise participation was associated with higher FMS scores, whereas higher BMI and age were associated with lower FMS scores. There was a significant difference between individuals with high (>30) and moderate BMIs ($F[621] = 33.98$, $p < 0.0001$). The normative reference values presented can be used in clinical practice to identify abnormal scores across a broad age spectrum.

Key Words FMS, reference values

Introduction

Lifelong fitness and flexibility is an increasingly common goal in a growing segment of society. At present, fitness enthusiasts work diligently to increase their flexibility, power, strength, and endurance (13). Unfortunately, many of these individuals are inefficient in how they perform simple, fundamental exercises and, unbeknownst to them, are potentially causing as much harm as good in their long-term fitness goals. Solely incorporating traditional, single-plane exercises (such as bicep curls, leg press, bench press) into an exercise regime has, over time, shown a development of inequality and asymmetry throughout the body (1). Those individuals with such imbalances tend to develop incorrect movement patterns, and often train around preexisting problems or simply neglect training their weaknesses altogether (7). Over time, repetitive microtrauma because of overcompensation can lead to serious injury or chronic pain (8).

The Functional Movement Screen (FMS) is a means of identifying weak links and asymmetry in one's basic functional movements. The FMS is rapid, noninvasive, inexpensive, and easily administered (2). The screen consists of 7 different functional movements that assess the following: trunk and core strength and stability, neuromuscular coordination, asymmetry in movement, flexibility, acceleration, deceleration, and dynamic flexibility (11). The FMS measures the quality of the movement based on specific criteria that allow the evaluator to extrapolate a quantitative value for the movement on a scale of 0–3. Unlike other fitness assessments, the FMS emphasizes the efficiency of movement patterns rather than the quantity of repetitions performed or the amount of weight lifted (1). The FMS provides immediate feedback and is used as an assessment for a patient, client, or athlete that can subsequently be used to guide the training program.

The effectiveness of the FMS as a primary prevention tool for injury has been previously demonstrated in defined populations such as athletic populations and firefighters (8). Kiesel et al. (9) have used the FMS for various studies dealing with professional football players and found that those with scores <14 out of 21 had injury rates 11 times higher than those that scored >15. Furthermore, Kiesel et al. found that those with asymmetry in their FMS assessment recorded a 2.3 times greater risk of injury during a professional season (9). In 2007, research performed by Peate et al. studied the number of work-related injuries sustained by firefighters who were exercising to increase their FMS score vs. a control group (11). They found that the number of injuries decreased 42% and lost work time caused by injuries declined 62% during the 12-month period after the training program.

The FMS has proven to be a valid indicator of injury risk among elite athletes. Because of its marketability and user-friendly administration, it is clear why the FMS is increasing in popularity. However, few have investigated

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the implications and norms for the general population. The purpose of this study is to provide normative reference values for healthy, middle-aged adults and aims to identify the impact of certain variables on overall FMS scores. In this study, we aimed to determine normative values for community dwelling adults, and to test our hypothesis that age, body mass index (BMI), HPAPQ score, and Balance Error Scoring System (BESS) score would affect an individual's FMS score.

Methods

Experimental Approach to the Problem

In addition to developing normative reference values, this study investigated age, BMI, and values other fitness scores (HPAPQ and BESS) in an attempt to identify significant FMS predictors. The HPAPQ and BESS were used as variables based on their accessibility and their potential influence on FMS scores. Age was selected as a variable based on the notion that decreased muscle mass and biomechanical decrements would potentially lead to reduced scores on the movement screen (3,4). To determine normative reference values for FMS scores, 622 healthy adults were screened by level 1 FMS certified exercise physiologists. The HPAPQ and BESS were evaluated before the FMS at the same facility.

The BESS measures static balance characterized by postural sway and has been used in many studies to explore the effects of mild head injury on balance and stability. Because proper stability is one of the major components of the FMS, a relationship between BESS scores and FMS scores was investigated. The protocol for the BESS is described in Iverson et al. (6).

The Healthy Physical Activity Participation Questionnaire (HPAPQ) is a brief questionnaire that quantifies the frequency and intensity of one's physical activity. Consisting of 3 questions, it is administered at the beginning of the patients' overall fitness assessment, to estimate physical activity participation by self-report (14).

Subjects

The participants in this study were 622 urban-dwelling adults from 2 Canadian cities, Vancouver and Calgary. All the individuals were partaking in a preventative health screen at a multidisciplinary health care clinic and were fully aware of movement screen protocol and the inherent risks associated with the screen before testing. To contribute to the generalizability of the study, the subjects came from various athletic backgrounds and were tested throughout the year at various times during the day. The patients were tested in a euvolemic state and were typically fed 1–2 hours before their assessment. This study was reviewed and approved by the Clinical Research Ethics Board of the University of British Columbia and conformed to the Declaration of Helsinki and signed an informed consent document after having the risk and benefits of the study explained.

The mean age of the sample was 50.91 (SD = 10.80; range = 21–82). There were 395 men (63.5%) and 227 women (36.5%). The breakdown for the men is shown in Table 1, and the breakdown for the women is shown in Table 2. The mean age for the men was 52.1 (SD = 10.6), and the mean age for the women was 48.8 (SD = 10.8).

Procedures

The FMS was performed by certified exercise physiologists as a part of a preventative health screen at a multidisciplinary health care clinic. All exercise physiologists had completed their FMS level 1 Certification and had passed their FMS online certification test. Three pieces of equipment were used to evaluate each subject as per FMS protocol: a measuring device, a measuring stick and a hurdle. The screen was performed before any exercise and after a short familiarization of the protocol. The protocol for the 7-point FMS is fully described by Kiesel et al. (8). Each client was assessed on their performance on 7 different functional movements: squat, hurdle step, lunge, shoulder mobility, active straight leg raise, push-up, and rotary stability. After each movement, a score was given to the movement based on specific FMS criteria. A score of 3 indicates that the movement was completed both pain-free and without compensation. A score of 2 indicated that the movement was completed pain-free but with some level of compensation or aid, and a score of 1 indicated that the client could not perform the movement. A score of 0 was assigned to a movement that induced pain.

When FMS is performed, 5 of the 7 tests (hurdle step, shoulder mobility, active straight leg raise, push-up, and rotary stability) are scored independently on the right and left sides of the body. Because of the relationship between neuromuscular asymmetry and injury risk, the FMS scoring system highlights asymmetry and takes the lowest score of 2 as the overall score for that movement (1). For example, an active straight leg raise score of 3/3 on the left leg and 2/3 on the right gives an overall score of 2/3 on the active straight leg raise movement.

After the 7 different movements were evaluated, a cumulative score out of 21 was recorded. There were no complications or adverse events that occurred while collecting the data.

Table 1. Normative functional movement screen data for men, stratified by age.

Age	*N*	*M*	*SD*
20–39	53	14.79	2.76
40–49	102	14.85	2.58
50–54	68	14.03	2.29
55–59	72	13.64	2.68
60–64	50	12.98	2.67
65+	50	12.56	3.27

Table 2. Normative functional movement screen data for women, stratified by age.

Age	N	M	SD
20–39	44	15.43	2.44
40–49	66	15.17	2.93
50–54	34	14.59	2.88
55–59	44	13.66	2.63
60–64	27	12.89	3.23
65+	12	13.17	3.01

Table 4. FMS scores for all the participants, scores on the HPAPQ and BESS score.*

Measure	N	M	SD
7-Point FMS	622	14.1447	2.85477
HPAPQ	266	7.8045	2.89165
BESS score	116	12.84	10.240

*BESS = balance error scoring system; HPAPQ = Healthy Physical Activity Participation Questionnaire; FMS = functional movement screen.

Statistical Analyses

All data were analyzed using PASW 18 (IBM, NY, USA). Means and *SD*s were first calculated for FMS scores, age, height, weight, HPAPQ score, BMI, and BESS score (Tables 3 and 4). Partial correlations were conducted for FMS scores and each of the variables. Linear regression was then conducted to evaluate the predictive value of BMI, BESS, height, weight, and age on FMS scores in which all assumptions were met. Lastly, analysis of variance (ANOVA) was used to analyze differences in FMS scores for men and women and between individuals with high and low BMIs.

Results

Regression analyses were performed to determine which variables may impact FMS scores. The FMS scores were regressed on age, physical activity level (as represented by the HPAPQ), and BMI. Each of the variables was found to contribute significant predictive value to the equation, and the full model explained a significant portion of variance in FMS scores ($R^2 = 0.24$, $F[2, 622] = 27.16$, $p < 0.0001$). Age and BMI were found to be negatively associated with FMS, demonstrating that younger participants with lower BMIs achieved higher FMS scores, whereas higher HPAPQ scores, indicating higher levels of physical activity, predicted higher FMS scores. The BESS was not shown to affect FMS scores. The regression values for the 3 significant predictor variables can be found in Table 5.

Because the potential associations between the variables, the FMS scores were partially correlated between, BMI, age, and HPAPQ scores to ensure independent significance. Because the BESS was only evaluated for 116 participants, it was evaluated first as a bivariate correlation. No significant association was found ($r = 0.071$, $p = 0.50$), so partial correlations were not conducted. To control for the inflated alpha level resulting from multiple comparisons, significance was set at $p < 0.001$. The FMS scores were correlated with physical activity, controlling first for BMI ($r = 0.25$, $p < 0.0001$) and second for age ($r = 0.32$, $p < 0.0001$). This relationship demonstrates a significant positive association between physical activity level and FMS score that is not moderated by age or BMI. FMS scores were also correlated with BMI, even when controlled for age ($r = -0.20$, $p < 0.0001$), and physical activity ($r = -0.29$, $p < 0.0001$). Age, controlled for BMI, was also related to FMS ($r = -0.29$, $p < 0.0001$).

To evaluate differences between high and low BMIs, an ANOVA was conducted as body index scores were split into 2 groups. A score of 30 was designated as the cutoff point because it represents a clinical indicator of obesity. The first group included all the participants that had a BMI of ≥30 (13% of participants). All the participants with a BMI <30 (87% of participants) comprised the other group. The

Table 3. Descriptive statistics for all variables.*

Descriptive statistic	N	M	SD
Age	622	50.9132	10.80655
Height (cm)	621	174.1277	9.46090
Weight (kg)	621	79.5739	16.76429
Body mass index	621	26.0220	3.88330

*Height and weight were measured in centimeters and kilograms, respectively.

Table 5. Regression values for age, HPAPQ scores, and BMI on FMS scores.*

Variable	Standarized β	t(622)	p
Age (y)	−0.27	−4.368	<0.0001
HPAPQ	0.26	4.687	<0.0001
BMI	−0.24	−4.368	<0.0001

*BMI = body mass index; HPAPQ = Healthy Physical Activity Participation Questionnaire; FMS = functional movement screen.

ANOVAs were used to analyze potential differences in FMS scores between the 2 groups. There was a significant difference between FMS scores in high BMI and low BMI participants ($F[621] = 33.98$, $p < 0.0001$). Post hoc comparisons using Tukey honestly significant difference test revealed that individuals with low BMIs achieved higher FMS scores ($M = 14.39$, $SD = 2.76$) than participants with high BMIs ($M = 12.45$, $SD = 2.91$).

Discussion

The FMS is a rapid, noninvasive, inexpensive and easily administered method of quantifying a series of basic physical movements. As more research on the physical elite continues to prove the effectiveness and reliability of FMS as an injury prevention tool (10), interest in the FMS for other populations continues to grow. This study provides the first normative data for the FMS scores in a general population of middle-aged adults. Furthermore, we confirmed our hypothesis that age, BMI, and HPAPQ scores were significantly correlated with FMS scores, but BESS scores did not show a significant relationship.

Aging is associated with physiologic declines in muscle mass and biomechanical factors such as a decrease in balance and joint flexibility (3,4). Furthermore, degenerative joint disease is associated with a decrease in joint range of motion and could play a prominent role in FMS scores (12). Accordingly, in this study, age was significantly related to FMS scores. On average, FMS scores were highest within the 20–39 age group ($M = 15.08$) and lowest for those who were age ≥ 65 ($M = 12.68$). When gender norms were examined, women aged between 20 and 39 years showed the highest average scores ($M = 15.43$).

The BMI is one of the common means to assess the risk of developing health problems related to being overweight or underweight. The BMI categories range from underweight (BMI < 18.5), to normal weight (BMI 18.6–24.9), to overweight (BMI 25–29.9) to obese (BMI ≥ 30). Gates et al. (5) studied different BMIs and the physical limitations associated with obese scores. Obesity was found to not only limit movement for an individual but also to produce an increase in musculoskeletal or joint-related pain while producing movement. Not surprisingly, this study showed that BMI was negatively correlated with FMS scores. As well, those with BMIs > 30 showed significantly lower scores on the FMS than those with lower BMIs.

A significant correlation was also found between participants' level of physical activity (HPAPQ score) and their respective FMS scores. Further analysis demonstrated that age, BMI, and physical activity level independently affected FMS scores. However, although these 3 factors did affect FMS scores, a regression demonstrated that age, BMI, and HPAPQ scores only explained 24% of the variance. In summary, these variables significantly affect FMS scores, but there are numerous other variables that could contribute to ones overall FMS score (8).

The FMS is versatile enough for use with both men and women. There is only one difference between the FMS protocol for men and women: an adjusted hand placement during the core push-up assessment for the women's assessment. The movements are based on one's ability to elicit a functional movement rather than recruitment muscles to produce force, and this enables men and women to perform reasonably equally (11). In this study, the mean scores for women and men were 14.5 ($SD = 2.80$) and 14.0 ($SD = 2.80$), respectively.

The data in this study represent normative reference values for the FMS. However, those who intend to use these values must consider the limitations of the normative data. The participants in the study had the screen performed as part of a multidisciplinary preventive health assessment. The participants would have paid for the program themselves, or had the assessment fee paid by their employers. Therefore, this sample likely represents a population with frequent access health facilities. In this study, we present descriptive data only for total 7-point FMS score. In the future, with a larger sample size, it would be beneficial to break down the FMS score into each of the subtests and present normative data for each, which would illuminate which parts of the FMS are affected most by variables such as age, fitness, and body composition.

This study provides the normative FMS data for a large sample size across a broad age spectrum. This study has identified that FMS score appears to be related to age, BMI, and participation in physical activity.

Practical Applications

The decline of physical activity with age conflicts with public health goals for aging adults. Strategies to counteract the decline in physical activity within the aging population need to be developed. The FMS aims to impact 2 important factors that influence fitness: (a) it strives to increase movement efficiency and (b) it strives to decrease injury potential. Thus, identifying an individual's weaknesses and asymmetries and then training to improve in these areas could play a key role in enabling lifelong habitual physical activity and movement. Examples of mediums to use the screen aside from clinics and gymnasia include: the geriatric community to assess and promote functional mobility with age, with recreational athletes as an injury prevention tool or within the workplace to decrease the number of work-related acute and overuse injuries.

The practicality of the FMS is that it is simple, relatively and can be administered in all kinds of facilities. Further, the FMS is done individually and supervised by an evaluator who must interact with the client, which inherently incorporates both an education and motivational component (10).

To date, FMS data has primarily focused on the elite athletes. This study provides the first normative FMS data for a large sample size across a broad age and athletic spectrum. These data can be used in a clinical population to better identify abnormal overall scores at various ages.

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