Movement by Age and Sex Using the Functional Movement Screen

M. P. Bonis[1], A. B. Welch[1] & B. L. Eason[1]

University of New Orleans, New Orleans, LA

J. M. Loftin[2]

University of Mississippi, University, MS

M. Sothern[3]

Louisiana State University Health Science Center

School of Public Health

New Orleans, LA

Abstract

Introduction: *The study compared movement patterns by age and by sex from the general population using the Functional Movement Screen (FMS).* ***Methods***: *Movement patterns were assessed using FMS of 526 subjects, 259 males, 267 females, (mean age ± SD = 27.4± 11.6 years). The IRB human subjects-approved study graded each subject for seven movement patterns on a scale from 0 to 3 where 0 indicated inability or pain when performing the movement and 3 indicated correct movement without any deficiencies. The subjects were divided into 3 age groups, 18-29, 30-49, >49 years.* ***Results***: *Kruskal-Wallis analysis indicated total functional movement performance significantly declined with age for the subjects,* $\chi^2(2) = 76.4$, $p < 0.05$. *Also, Mann-Whitney analysis indicated high threshold stability was significantly greater in males than in females,* $U(526) = 22{,}214$, $z = -7.64$, $p < 0.05$; *and significantly greater fundamental flexibility of heavy closed-chain leg activities in women than in men* ($U = 27{,}786.5$, $z = -4.23$, $p < 0.05$). ***Conclusions***: *Results demonstrated that the FMS can identify movement deficiencies by age, sex, or subpopulations and can be used in developing physical fitness/ rehab programs to address these specific group movement deficiencies. Continued collection of normative movement pattern data is recommended.*

Keywords: Movement, Mobility, Assessment, Performance

Introduction

The Functional Movement Screen (FMS) was introduced in 1997 as an easily administrable qualitative method to reduce the rate of injury and improve movement performance (6, 19). The procedure is designed to be used after a subject has successfully cleared a medical physical, but before beginning specific physical training. The FMS consists of 7 basic movements, 3 functional movements and 4 fundamental movements which collectively mimics total human movement. The subject performs all 7 movements. The purpose of the FMS is to determine if a subject has any movement deficiencies or symmetrical disparities. If a deficiency or disparity exists then the subject is at an increased risk of injury. Further, a deficiency or disparity also prevents the subject from maximizing physical performance. Each movement has a scoring range from 0 to 3 where a score of 3 reflects the subject's ability to do the movement correctly. A score of 2 represents the subject's ability to do the movement, but not perfectly; and a score of 1 is given if the subject attempts the move but is unable to do it. If during the movement attempt the subject experiences any pain, the subject stops the movement and is given a score of zero. The seven scores are added together so that a perfect subject score totals 21. If the subject scores a zero or a one in any or multiple movements then the subject is referred to a movement practitioner, such as an orthopedic surgeon, physical therapist, or athletic trainer to address the movement deficiency or symmetrical disparity.

The use of the Functional Movement Screen has become popular in the professional and elite ranks of athletes, such as in the NFL, the NFL combine, the NHL, Olympic and world class athletes and teams (2, 5, 8, 11, 12, 14, 17, 21, 22).

The military and first-responder organizations have also begun using the FMS on its new recruits to minimize the quantity and the degree of training injuries during "boot camp" (4,7,13,15,20). While there has been literature regarding the use of FMS on the general population in Canada (1), to date there is no current study using FMS to examine normative data in the general population of the U.S. The objective of this study is to examine FMS scores of adults within the U.S. by age and by sex.

Methods

The study consisted of a convenience sample of 526 subjects, 267 females and 259 males, ranging in age from 18 years old to 73 years old (mean age + S.D = 27.4 + 11.6 years) (See Table 1).The subjects were informed of the type of research being conducted. They provided written informed consent and agreed to perform the screens and to answer some basic physical data such as age, height, weight, hand dominance, and sex so that the cumulative results could be used in the study. The project was Institutional Review Board (IRB)-approved from the University of New Orleans.

The study was a Motor Learning project and the testers conducting the FMS were senior level undergraduate students in the Human Performance and Health Promotion Program at the University of New Orleans. The primary investigator (P.I.) of the project has a Level One FMS Certification. The participating student testers were Human Subjects certified and had at least five hours of FMS training which included inter-tester and intra-tester reliability training by the P.I. before beginning data collection (10, 18). Previous research indicated that FMS qualitative procedures were conducive to yielding reliable inter-tester and intra-tester data (9, 16).

Design

After receiving written informed consent the subjects were given a questionnaire to provide their age, date of birth, hand dominance, and sex. Their height was measured using a stadiometer and their weight was measured using a Tanita portable digital scale that was calibrated prior to measurements. The subjects were given instructions on how to perform the seven movements (See Figure 1) which consisted of the following:

(Fig 1.1 Squatting) - *The Deep Squat* is a functional movement pattern representing loading patterns on both legs.
(Fig 1.2 Stepping) - *The Hurdle Step* is a functional movement pattern representing loading patterns on a single leg stance.
(Fig 1.3 Lunging) -*The In-Line Lunge* is a functional movement pattern representing loading patterns in the lunge position.
(Fig 1.4 Reaching) -*The Shoulder Mobility Movement* represents fundamental mobility of both heavy overhead pushing and heavy arm pushing.
(Fig 1.5 Leg Rising) - *The Active Straight Leg Raise* represents fundamental mobility of heavy closed-chain loaded activities in running and polymeric activities.
(Fig 1.6 Push-up) - *The Trunk Stability Push-up* is a high threshold stabilization pattern representing heavy upper and lower body loads and vigorous plyometric activities; and
(Fig 1.7 Rotary Stability) - *The Rotary Stability Movement* is a sub-maximal stabilization pattern representing conventional core training resulting in high threshold core control.

The subjects could have up to 3 attempts to complete each movement where the scores ranged from zero to three. A score of three was given if done correctly. A score of two was given if done, but not totally correct. A score of one was given if the movement was attempted but the subjects were unable to do the movement or maintain their balance. Finally, if at any time during an attempt the subjects experienced any pain they were advised to immediately stop the attempt and a score of zero was given. For five of the screens except for the Deep Squat and the Trunk Stability Pushup, the movements were conducted on both the left and right extremities. The final score for these movements if different would be the lesser of the 2 scores. After completing the seven movements the final score for each movement was cumulatively summed for a total score, with a perfect score being a 21.The subjects were also advised that they could stop participation in the study at any time if they no longer wanted to participate.

Statistics

The IBM SPSS Version 23 program was used for statistical analysis. The subjects were divided into three age groups for comparative analysis.

The first group consisted of subjects from 18 - 29 years old (n = 406). The second group consisted of subjects from 30 - 49 years old (n = 68); and the third group consisted of subjects older than 49 years (n = 52).Spearman correlation, Mann-Whitney, Kruskal-Wallis, and Wilcox non-parametric analyses were conducted on the total data set as well as on each age group. (See Table 2)

Results

Spearman correlation analysis was used to determine associations among the variables. Overall, there were weak, negative associations between FMS total scores and the subjects' age ($\rho = -0.265$, n = 526) and BMI ($\rho = -0.187$, n = 522). Using non-parametric Mann-Whitney tests there were no significant differences by sex in regard to the total FMS score (U = 33,320.5, z = -0.725, $p > 0.05$); however, there were significant sex differences by specific movements. Mann-Whitney analysis revealed significantly greater high threshold trunk stability patterns (Push-up) in men compared to women (U = 22,214, z = -7.64, $p < 0.05$); and significantly greater fundamental flexibility of heavy closed-chain leg activities (Active Straight leg Raise) in women than in men (U = 27,786.5, z = -4.23, $p < 0.05$). (See Graphs 2 & 3)

Kruskall-Wallace analyses revealed significant decreases in the total FMS score [χ^2 (2) = 76.4, $p < 0.05$] and significant decreases in all 7 patterns as the subjects' age increased. Squat: [$\chi^2(2)$= 35.8, $p < 0.05$]; Hurdle:[$\chi^2(2)$= 26.1, $p < 0.05$]; Lunge:[$\chi^2(2)$= 55.2, $p < 0.05$]; Shoulder Mobility:[$\chi^2(2)$= 31.9, $p < 0.05$]; Active Straight Leg Raise:[$\chi^2(2)$= 17.3, $p < 0.05$]; Push-up: [$\chi^2(2)$= 31.7, $p < 0.05$]; and Rotary Stability:[$\chi^2(2)$= 38.9, $p < 0.05$]. (See Graph 3)

Wilcox analyses indicated significantly higher scores on the subjects' dominant side as compared to their non-dominant side for some of the specific movements: functional movement patterns(hurdle) z = -4.60, $p < 0.05$ and (lunge) z = -5.43, $p< 0.05$; fundamental mobility pattern (shoulder mobility) z = -5.74, $p < 0.05$; and sub-maximal stabilization pattern (rotary stabilization) z = -4.44, $p < 0.05$.

Age Group: 18-29 Years

Using Group 1 data (subjects' age 18-29 years) Mann-Whitney tests showed no significant differences by sex in regard to the total FMS score (U = 19,609, z = -0.914, $p > 0.05$); however, there were significant sex differences by specific movements. Group 1 results revealed significantly greater high threshold trunk stability patterns (Push-up) in men compared to women (U = 13,332, z = -6.88, $p < 0.05$); and significantly greater fundamental flexibility of heavy closed-chain leg activities (Active Straight leg Raise) in women than in men (U = 17,202, z = -3.21, $p < 0.05$).

Group 1 Wilcox analyses results indicated significantly higher scores on the subjects' dominant side as compared to their non-dominant side for some of the specific movements: functional movement patterns(hurdle) z = -4.51, $p < 0.05$ and (lunge) z = -5.39, $p< 0.05$; fundamental mobility pattern (shoulder mobility) z = -5.60, $p < 0.05$; and sub-maximal stabilization pattern (rotary stabilization) z = -4.33, $p < 0.05$.

Age Group: 30-49 Years

Using Group 2 data (subjects' age 30-49 years) Mann-Whitney tests showed no significant differences by sex in regard to the total FMS score (U = 479.5, z = -1.21, $p > 0.05$); however, there were significant sex differences by specific movements. Group 2 results revealed significantly greater high scores in men compared to women in regard to the threshold trunk stability pattern (Push-up: U = 297.5, z = -3.49, $p < 0.05$), and the functional movement pattern (Lunge: U = 402.5, z = -2.30, $p < 0.05$).

Group 2 Wilcox analyses results indicated no significantly different scores between the subjects' dominant side and their respective non-dominant side.

Age Group: Over 49 Years

Using Group 3 data (subjects' age over 49 years) Mann-Whitney tests showed no significant differences by sex in regard to the total FMS score (U = 314, z = -0.36, $p > 0.05$); however, there were significant sex differences in one specific movement. Group 3 results revealed significantly greater scores in men compared to women in regard to the threshold trunk stability pattern (Push-up: U = 210.5, z = -2.35, $p < 0.05$). Group 3 Wilcox analyses results indicated no significantly different scores between the subjects' dominant side and their respective non-dominant side in regard to the hurdle, lunge, shoulder mobility, active straight leg rise, and rotary stability movements.

Discussion

Study results indicated that the overall quality of movement declines significantly with age independent of sex. Males demonstrated significantly better trunk stabilization and plyometric activities than women, while women displayed significantly better hip flexibility than men. The 18-29 year old age group indicated symmetrical movement disparities with the dominant side scores being significantly greater in hurdling, lunging, reaching, and rotary stabilization movements.

The findings demonstrate that the Functional Movement Screen (FMS) can be utilized to identify functional group movement deficiencies by subgroups, age or sex instead of using it only as an individual movement screen. The FMS can be a powerful resource in promoting public health in the general population. Examination of normative data can pinpoint general areas of movement deficiencies by occupational, athletic, or recreational subpopulations, age, and/or sex. Public health professionals in conjunction with movement practitioners can use this information to design physical activity programs to specifically focus on improving specific group movement deficiencies. Over time the risk of movement problems in these targeted groups will be reduced and movement patterns will be improved with the implementation of these programs.

The FMS corrective strategy algorithm is to address mobility, motor control/ stability, and functional deficiencies in that order. Identify scores in the zero and one range and symmetrical disparities (Leg, MOB, Rot, Lunge, and Hurdle patterns) from the raw data scores. Mobility patterns (Leg and MOB) should be reviewed first in that order; next motor control or stability patterns (Rot and Push-up) in that order; and finally the functional patterns(Lunge, Hurdle, and Squat) in that order. Address the first deficiency from the corrective algorithm then retest to target the next deficient pattern, if any. The purpose of re-testing after correcting the first deficiency is that sometimes the initial corrective action may also correct other lower prioritized movement deficiencies. For example, in the current study corrective action to improve the non-dominant shoulder movement should first be addressed for both groups 1 and 2. For Group 3 the first corrective action should address correcting deficiencies in both shoulders. After corrective action is applied from 4-8 weeks re-test and re-prioritize (3).

There are limitations to the current research. 407 participants (77%) from the total sample of 526 subjects were group 1 members (18-29 year old age group). Therefore the total FMS mean values should be positively biased toward the higher-scoring group 1 results. However with the increasing popularity of FMS usage the data base will increase and the larger data set will become more normalized. As the normative data base increases further distinctions of movement deficiencies between age and sex will improve. Further, there was more than one tester collecting data; however, previous research (9, 10, 16, and 18) has indicated that three or more hours of scoring training reduced the possibility of discrepancies and improved the intra-rater and inter-rater scoring reliability. The testers of the current research underwent at least 10 hours of scoring training.

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. The study demonstrated that Functional Movement Screening can be used to discriminate group movement deficiencies in the general population. It can be a valuable public health resource in determining what types of physical activities are required to reduce the risk of movement injuries and to improve movement quality by both sex and by age. In order for the movement analysis to yield valid movement analyses the general normative data base must be large enough to reflect the correct movement characteristics of the population by age and by sex. It is recommended that additional studies continue as the overall data base increases.

Acknowledgements

This study had no funding sources. No companies, manufacturers, or outside organizations provided technical or equipment support. There were no conflicts of interest regarding the current study. The authors have not and will not benefit from any company or manufacturer from these findings. The results of the study are presented clearly, honestly, without fabrication, falsification, or inappropriate data manipulation; further, the results of the study do not constitute endorsement by the ACSM.

The contributions of the senior level undergraduate students in the Human Performance and Health Promotion Program at the University of New Orleans are acknowledged for assistance in collecting the study data.

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Figure 1: Functional Movement Screen

Table 1: Physical Characteristics

N	Group	Male	Female	Age (yrs)*	Weight (kg)*	Height (m)*	BMI*
526	-	259	267	27.4 ± 11.6	73.3 ± 16.3	1.7 ± 0.10	24.9 ± 4.29
407	1	197	210	21.9 ± 2.70	71.4 ± 14.9	1.7 + 0.10	24.2 + 3.70
68	2	34	34	38.3 ± 6.30	79.5 ± 19.8	1.7 + 0.10	27.1 + 5.30
51	3	28	23	56.6 ± 5.70	79.8 ± 18.4	1.7 + 0.10	27.5 + 5.19

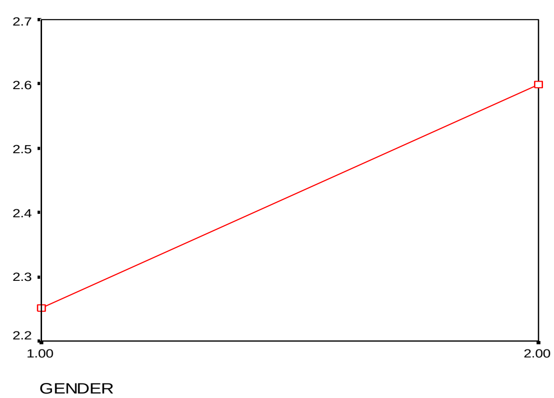
*mean ± standard deviation

Table 2 –FMS Scores

Group	Squat*	Hurdle*	Lunge*	MOB*	Leg*	Pushup*	Rotary*	Total*
Total	2.2±0.8	2.5±0.7	2.2±0.8	2.0±0.8	2.4±1.5	2.2±0.9	1.9±0.8	15.5±3.5
1	2.3±0.7	2.6±0.6	2.4±0.7	2.1±0.8	2.5±1.7	2.4±0.8	2.0±0.7	16.2±4.1
2	2.1±0.9	2.1±0.9	2.0±0.8	1.9±0.8	2.1±0.8	2.0±1.0	1.8±0.9	13.9±3.9
3	1.5±0.9	2.2±0.8	1.5±0.9	1.4±0.8	2.1±0.9	1.6±1.1	1.3±0.9	11.5±3.5

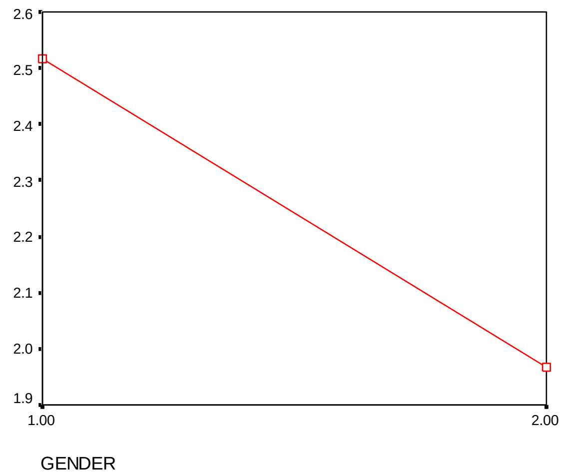
*mean ± standard deviation

Graph 1– Significant Gender Differences of Hip Mobility (Leg)



*1.0 – Male, 2.0 – Female

Graph 2 - Significant Gender Differences of Trunk Stability (Push-up)



*1.0 – Male, 2.0 - Female

Graph 3 – Decreasing Mean Total Scores by Age Group