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Fundamental Movement Skills Proficiency and Their Relationship with Measures of Functional Movement and Health-Related Physical Fitness in Welsh Adolescents

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ABSTRACT

The aims of this study were to determine the fundamental movement skill proficiency, functional movement competency and health-related physical fitness in a cohort of UK adolescents and to further examine if there were any relationships between these variables. In total, there were 178 participants aged between 11 and 13 years, 90 boys and 88 girls. Ordinal logistic regression analysis was used to investigate the relationship between FMS proficiency and functional movement competency and multi-factor ANOVA was used to explore the main effects of the FMS and the functional movements with health-related physical fitness responses. Overall, FMS proficiency and functional movement competency were classified as being low. In addition, positive relationships were found for several functional movements with specific FMS, and, for several functional movements and FMS with some measures of health-related physical fitness. In conclusion, further intervention of these variables is clearly warranted with this adolescent population in Wales (UK).

KEYWORDS

fundamental movement skills; functional movement; physical fitness; motor competency; adolescent youth

Introduction

Despite compelling evidence from the World Health Organization (WHO, 2018) that both the physical fitness and health status of children and adolescents are substantially enhanced by regular physical activity (PA), it is still unclear why some youths are more physically active than others (Jarvis et al., 2018). The WHO has reported a significant decline in PA as children advance from primary (for children aged 5–11 years) to secondary (for children aged 11–16 years) school. Further, Sandercock et al. (2015) suggested that PA levels have been reported to decline markedly after the age of 12 years in both frequency of PA engagement and actual participation time in sport. Indeed, the promotion of PA in youth continues to be a challenge, with limited success in increasing the proportion of children and adolescents who attain the recommended 60 min a day of moderate-to-vigorous PA (UK Chief Medical Officers, 2019). Faigenbaum et al. (2020) recently advocated that the generic recommendations to simply move more are not enough to activate this generation and instead suggested that an understanding of the multidimensional development of youth physical inactivity is needed to have the most significant impact on this population.

To this end, the development of fundamental movement skills (FMS) is consistently being touted as a key factor in promoting lifelong PA (Cohen et al., 2015) and they are frequently cited as the building blocks of more advanced, complex movements, which are necessary for participation in sports, games, and PA (Logan et al., 2018). FMS is common motor activities comprised a series of observable movement patterns, consisting of locomotor skills (e.g., run, vertical jump, side gallop and leap), manipulative skills (e.g., catch, overhand throw and kick) and stability skills (e.g., static and dynamic balance; Gallahue & Donnelly, 2003). Phillpott et al. (2020) suggested that greater levels of FMS performance have been associated with increased time in PA and sustained engagement in PA throughout childhood and adolescence. In contrast, Barnett et al. (2022) found that the overall evidence was indeterminate for the pathway from motor competence (i.e., FMS) to PA and suggested caution was needed when interpreting study findings and the potential bias toward associations. Despite this, Duncan et al. (2022) recommended that the development of motor competence (i.e., FMS) should be a fundamental priority with children and early adolescents as it represents a key enabler of their future PA.

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At present, the FMS proficiency of children and adolescents in the United Kingdom (UK) and Ireland has been reported as being low (Duncan et al., 2022). Several authors such as Bryant et al. (2016) and O'Brien et al. (2017) have also suggested that children are not mastering these FMS by their expected age-related developmental capability (i.e., mid to late childhood). Furthermore, O'Brien et al. (2016) suggested that it is reasonable to expect that children should be proficient in FMS by the time they transition to secondary school (11–12 years) and early adolescence. This is of importance as the physical education curriculum changes focus on entering secondary school in the UK (i.e., competency in basic movement patterns gives way to more complex levels of skill proficiency) for participation in various types of competitive sports and PA. Over the past decade, Duncan et al. (2022) suggested that most FMS studies conducted in the UK and Ireland have targeted children in mid to late childhood, with adolescents currently being an under-researched population. Of the limited studies conducted in the UK and Ireland with early adolescents (e.g., Lester et al., 2017; McGrane et al., 2018), Duncan et al. (2022) highlighted that many have demonstrated positive outcomes around the development of FMS proficiency and therefore it is never too late for adolescents to benefit from any further FMS research. Considering such evidence, investigating the FMS proficiency of those in early adolescent youth in Wales (UK) will be a primary aim of this study.

In addition to investigating FMS proficiency, it has been suggested by O'Brien et al. (2022) that in adolescent performers there is another indicator for actual movement skill proficiency that exists. These authors suggest that functional movement competency, which relates to the body's use of multi-plantar and multi-joint movements, specifically those activating the core musculature region are of importance. Hulteen et al. (2018) hypothesized in their conceptual model for PA across the lifespan that children and adolescent youth who possess higher levels of functional movement competency may also show higher levels of FMS proficiency as functional mobility and postural stability underpins performance in the basic observable patterns of running, hopping, jumping, and throwing. In addition, Hulteen et al. (2018) also suggested that developing functional movements that do not fit within the traditional definitions of FMS (e.g., squat, lunge and the push-up) could have the potential to support and promote participation in a greater range of PA.

To date, in the UK and Ireland, Lester et al. (2017) reported that a large proportion of adolescent youth are lacking functional movement competency and O'Brien et al. (2021) provided moderate evidence for possible associations between functional movement competency and FMS proficiency in Irish adolescents. Subsequently, O'Brien et al. (2021) has suggested that developing our understanding of both functional movement competency and FMS proficiency is critical toward the refinement of an appropriate measurement tool for holistic motor competency in adolescents. Thus, a secondary aim of this study will be to investigate participants' levels of functional movement competency and consider its relationship with their levels of FMS proficiency.

As previously highlighted, the cause of physical inactivity in youth is multidimensional. It has been suggested by Hulteen et al. (2018) that apart from the promotion of movement (i.e., FMS and functional movement) from a physical development perspective, the parallel and synergistic development of physical attributes (i.e., health-related fitness and weight status) play a critical role in the continued development of movement adroitness for PA across the lifespan. Most recently, Barnett et al. (2022) in a review of the literature found that health-related physical fitness (i.e., body composition, cardiorespiratory fitness and musculoskeletal strength) was a clear mediator in the relationship between FMS and PA. Similarly, both Molina-García et al., (2018) and Fitton-Davies et al. (2022) have reported that functional movement is positively associated with aspects of health-related fitness, namely cardiovascular fitness, muscular strength, and speed. Considering the importance of health-related physical fitness toward PA in the literature and its relationship with both FMS and functional movement, a further aim of this study will therefore be to investigate the relationship of several key measures of health-related physical fitness with the selected FMS and functional movements of the participants in this study.

Considering some of the points discussed in this introduction, the purpose of this study will therefore be to determine the FMS proficiency, functional movement competency and key aspects of health-related physical fitness in a cohort of Welsh adolescent youth and to further investigate if there are any relationships among these variables. In turn, it is hoped our findings will add to the literature with adolescent youth within the UK and Ireland and more specifically provide some additional evidence from Wales (UK).

Method

Participants and settings

Following the granting of ethical approval by the university's Human Research Ethics Committee, a total of three secondary schools, located in practical travel distance of the test venue, were invited to participate in the study. These schools were all within a single local authority in Wales, which is classified as having 71% of its area in the most deprived 50% of Wales (Welsh Government, 2019). Schools were briefed on the purpose of the study and issued with informed consent packs. Only those participants returning both signed parental consent and assent forms participated in the study. Subsequently, each school attended the test center at the university on separate dates and all data were collected in normal school operating hours during the summer school term. In total, 190 adolescents aged between 11 and 13 years attended the test center; 178 complete data sets were recorded comprising 90 boys (mean [M] age = 12.44 years, standard deviation [SD] = 0.41), and 88 girls (M age = 12.40 years, SD = 0.44). These participants were unintentionally exclusively Caucasian. Reasons for the missing data sets of 12 participants included their voluntary withdrawal from completing all or part of the assessment battery on the day of testing.

Instruments, measures, and procedure

Fundamental movement skills

FMS proficiency was assessed using selected process-oriented checklists taken from the Australian resource Get Skilled: Get Active (New South Wales Department of Education and Training, 2000), which has been deemed both valid and reliable for use with both children and adolescents (Okely & Booth, 2000). The resource includes checklists of skills from all categories of FMS (locomotor, manipulative and stability; Gallahue & Donnelly, 2003). In this study, eight individual FMS, including four locomotor skills (run, vertical jump, side gallop, leap), three manipulative skills (catch, overhand throw, kick) and one stability skill (static balance) were assessed. In addition, Get Skilled: Get Active was preferred to other measures of FMS (e.g., the Test of Gross Motor Development-2; Ulrich, 2000) as it includes a stability component of FMS assessment and is appropriate and culturally acceptable for use with children in this population (Jarvis et al., 2018).

The FMS assessments were video recorded (Sony Video Camera, Sony, UK) and analyzed using performance analysis software (Studio Code, NSW, Australia) in accordance with the Get Skilled: Get Active guidelines. The Get Skilled: Get Active process-oriented checklists and guidelines were used to determine the total number of components performed correctly for each skill. The total number of components performed correctly was summed to give a score for each skill (range 0–6). If children scored 0–4 on each skill, they were classified as having poor proficiency, if children displayed correct performance on all but one skill component (i.e., 5 out of 6) they were classified as having near mastery and if they demonstrated all skill components (i.e., 6 out of 6) they were classified as having achieved mastery for that skill (Booth et al., 1999). A combined mastery and near mastery category were created which has previously been validated by Van Beurden et al. (2002). This category has also been reported as "advanced skill proficiency" (Booth et al., 2005) and was subsequently used in this study. All test administrations and analyses were undertaken by the first and second authors, who were both experienced FMS practitioners. Prior to data scoring, inter- and intra-rater reliability analyses were performed on a randomly selected sample of the completed data sets and reliability was determined using linear weighted Kappa (Flesiss et al., 2003). Reliability for all FMS measures displayed a level of agreement that was good (Kw range =.73–.93) or above (Kw range =.61–.79), respectively, based on Altman's (1991) thresholds to describe reliability.

Functional movement screen

Functional movement competencies were assessed using the test procedures, instructions and scoring process taken from Cook et al.'s (2010) standardized version of the Functional Movement Screen. In this study, only three out of the seven Functional Movement Screen subtests were included for assessment. These included the subtests of the deep squat, inline lunge and trunk stability press-up. These specific subtests were included based on Hulteen et al.'s (2018) conceptual model for PA and their suggestion that these specific movements needed greater consideration as part of a broader assessment of movement competencies and the promotion of PA with adolescents. The selected subtests were administered and analyzed by both the first and second study authors who were both experienced functional movement-screening practitioners.

During data collection, each participant was given three attempts to perform the selected movement

subtests with the highest score of the three attempts retained. Each individual subtest on the Functional Movement Screen is coded on a scale of 0 to 3. A score of "3" is awarded for perfect execution of the movement (fully competent). A score of "2" is awarded if the subject can correctly complete the movement, but with the presence of compensatory movements (semi competent). A score of "1" is awarded if they demonstrated compensate or dysfunctional movement (non-competent). Participants who experienced pain during any portion of screening subtests received a score of zero and these data were removed from the data analysis. All individual Functional Movement Screen subtests were video recorded (Sony Video Camera, Sony, UK) and analyzed using performance analysis software (Studio Code, NSW, Australia). Inter- and intra-rater reliability was conducted by the first and second authors and was rated as being good or above based on Altman's (1991) thresholds.

Health-related physical fitness

Health-related physical fitness assessments were conducted with the High Priority battery from the Assessing Levels of Physical Activity and Fitness (ALPHA) Health-Related Fitness Test Battery for Children and Adolescents Test Manual (Ruiz et al., 2011). The battery includes assessments of body composition (weight, height, body mass index [BMI]), cardio-respiratory fitness (20 m multistage fitness test), and musculoskeletal strength (handgrip strength, standing long jump and the vertical jump). In addition, the study included a separate motor fitness measure the 20-m sprint, which has previously been reported to be a valid and reliable measure of speed in children (Morrow et al., 2005).

Statistical analysis

All study data were split by gender in accordance with previous practice (Malina et al., 2004) and a preliminary analysis confirmed that the boys and girls were statistically different ($p < .05$). Following FMS and functional movement group classification, an ordinal logistic regression analysis with FMS skills as predictors and BMI as a covariate was used to investigate the relationship between FMS proficiency and functional movement responses. Frequency tables revealed that the FMS skill of the overhand throw had very small frequencies for girls in the advanced FMS skill category for all three functional movement responses, thus overhand throw was not considered as a predictor when fitting the models for female participants.

Multi-factor ANOVA was then used to determine which of the advanced FMS proficiency profiles had a significant overall effect on each of the health-related physical fitness response variables. BMI was introduced as a covariate in the model not only to adjust the FMS proficiency profiles for its influence but also to explore its effect on the health-related physical fitness responses. The ANOVA models were considered separately for boys and girls. The main reason to consider BMI only as a covariate in the ANOVA models was that it demonstrated high positive correlations with Body Mass (0.873 boys, 0.889 girls) and with Stature (0.717 boys, 0.705 girls). Preliminary analysis revealed that not all dependent variables (health-related physical fitness scores, within each gender) fully satisfy the basic assumptions for ANOVA, especially in terms of normality of the data. In such circumstances, the alternative is to base the ANOVA on "transformed data" or use resampling methods such as the "permutation tests" (also known as "randomization tests"). In this study, the usual transformations (e.g., square root, log, etc.) neither provided satisfactory improvement for some of the response variables, nor provided a uniform transformation for the other responses. As a result, and to make all analyses uniform, permutation tests (with 2000 randomizations) were performed on the raw data. The resulting significance (p-values) of the various effects was very similar to those of the ANOVA using the raw data. Finally, multi-factor ANOVA (via permutation tests) was used to explore the main effects of the functional movements on the health-related physical fitness responses. Again, BMI was introduced as a covariate. All statistical analyses were performed using R Software version 4.1.0 (R CoreTeam (2021) Foundation for Statistical Computing, Vienna, Austria).

Results

Descriptive statistics

FMS proficiency

The frequency distribution of FMS proficiency on each of the FMS is shown in Figure 1. In boys, none of the FMS achieved greater than 50% in advanced skill proficiency. The most proficient FMS was the skill of the kick (47%) followed closely by the side gallop (44%) and the poorest was that of the leap (19%). In girls, no FMS achieved greater than 45% for advanced skill proficiency. The most proficient FMS was that of the static balance (42%) followed closely by the side gallop (41%) whilst the FMS of

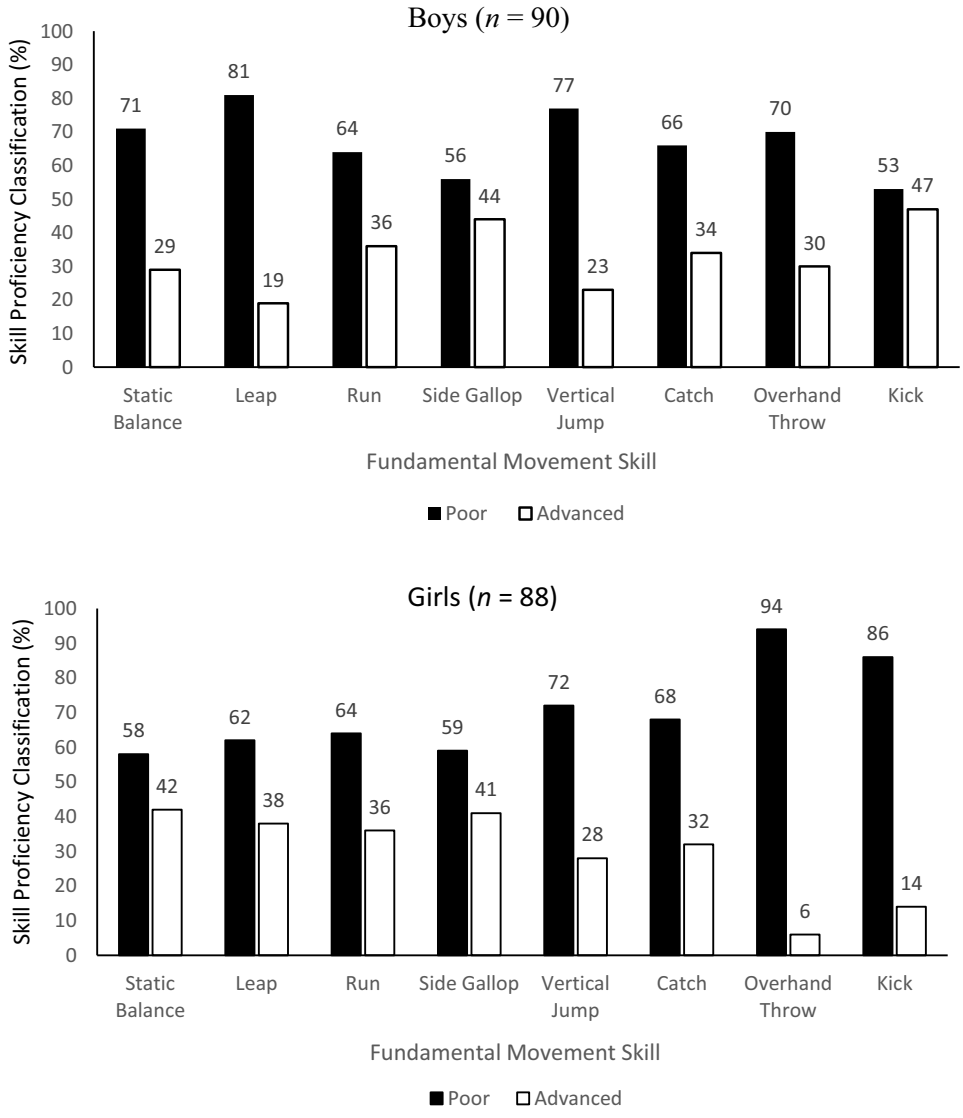

Figure 1. Frequency Distribution of Boys and Girls FMS Proficiency Classification Across Each FMS.

the overhand throw was the poorest with a very small proportion of the girls demonstrating advanced skill status (6%). In general, boys tended to perform better than girls in the manipulative skills of the catch, overhand throw, and the kick whilst girls demonstrated greater advanced FMS proficiency across the locomotor skills of the leap and vertical jump. Girls also demonstrated better performance across the stability skill category of the statics balance compared to boys.

Functional movement competency

Attainment of functional movement competencies is presented in Figure 2. In boys, approximately half of the participants were classified as being non-competent and a third of participants were classed as being semi competent across each of the functional movements (i.e., the squat, lunge and press-up). Of those who were fully competent, the functional movement of the squat showed the best performance (14%) whilst the movements of the press-up and the lunge were poorest, respectively. In girls, similar reporting to boys was evident with approximately half of the participants classified as being non-competent and just over a third classified as semi competent across each of the functional movements. Although low, girls' best performance was in the press-up with 10% of participants demonstrating full competency. This was followed by the functional movements of the squat and lunge with both values showing less than 10%.

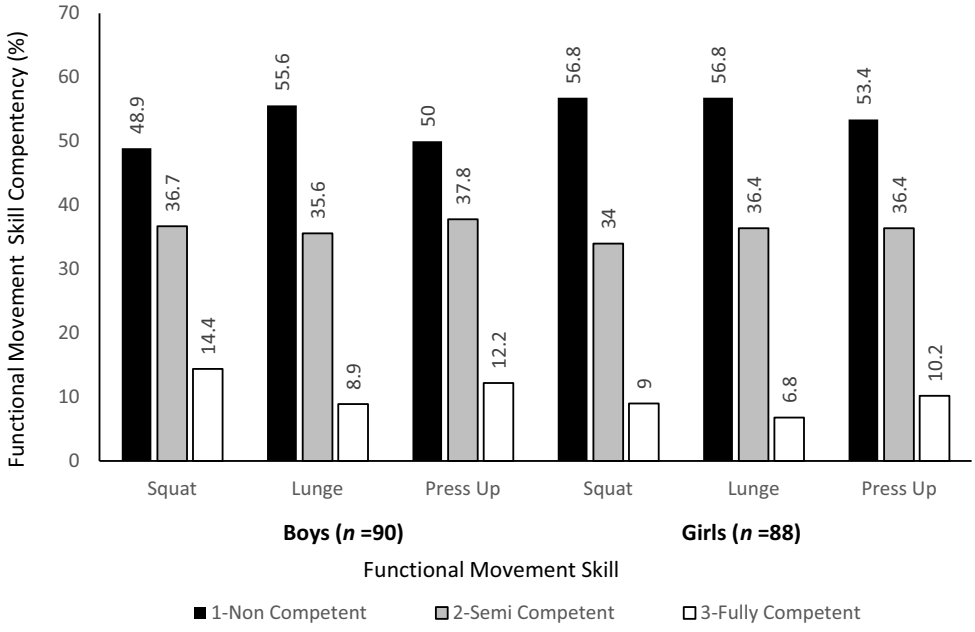

Figure 2. Percentage Frequency Distribution of Functional Movement Sub-Skills Competency by Gender.

Table 1. Means and Standard Deviations of Physical Characteristics and Health-Related Physical Fitness Measures for Boys and Girls.

Variable (units)	Boys (n = 90)	Girls (n = 88)
Age (years)	12.44 ± 0.41	12.40 ± 0.44
Stature (cm)	149.83 ± 8.13	152.00 ± 7.91
Body Mass (kg)	43.05 ± 10.63	46.11 ± 9.84
BMI ((kg m^2)	19.00 ± 3.54	20.08 ± 3.16
Broad Jump (cm)	154.71 ± 20.29	140.33 ± 21.77
Vertical Jump (cm)	26.96 ± 5.21	25.05 ± 5.10
Hand Grip (Kg)	20.05 ± 4.56	20.30 ± 4.24
Sprint Run (sec)	3.92 ± 0.31	4.18 ± 0.34
MSFT (Vo^2 max)	36.43 ± 8.27	32.07 ± 6.40

Health-related physical fitness characteristics

Participants' health-related physical fitness characteristics are summarized in Table 1. Girls demonstrated greater stature and mass than boys. Whilst boys demonstrated better performance across all health-related physical fitness measures apart from the upper body musculoskeletal strength variable of the hand grip where girls performed best.

Statistical findings

FMS proficiency and functional movement competency

Significant differences only between FMS proficiency and functional movement competency are presented in Table 2. In boys, the FMS of the run, vertical jump and the leap were highly significant ($p < .01$) predictors of functional movement competency with the squat. The odds ratio demonstrated that those with advanced FMS proficiency were likely to be between 5 and 6 times more likely to present a higher functional movement classification (semi or fully competent) than their poorly classified FMS counterparts. For the functional movement of the lunge again those boys demonstrating better FMS proficiency on the skills of the run and vertical jump along with the FMS of the static balance and the catch were highly significant ($p < .01$). Finally, all the FMS that were considered in this study were highly significant predictors ($p < .01$) of functional movement classification in the push-up with participants who demonstrated more advanced FMS proficiency over their poorly classified counterparts. BMI as a covariate did not present any significant findings with any of the functional movement competencies in boys. In girls, the FMS of the side gallop and the static balance were highly significant ($p < .01$) with the functional movement of

the squat. The estimated odds ratio showed that those with advanced FMS proficiency being between 4 and 6 times likely to score a higher functional movement category in the squat (i.e., semi or fully competent) compared to their poorly classified FMS counterparts, respectively. Similarly, with the functional movement of the lunge, the FMS of the side gallop and the static balance were highly significant in addition to the FMS of the leap ($p < .01$) with advanced FMS participants likely to be between 3 and 5 times likely to be more competent at the functional movement than their poorly classified counterparts. Finally, all the FMS considered in this study apart from the overhand throw were highly significant predictors ($p < .01$) of functional movement classification in the skill of the push-up. Again, and like the findings with boys, BMI as a covariate did not present any significant findings with any of the functional movements with girls.

FMS proficiency and health-related physical fitness

In boys, significant differences appeared for those who demonstrated advanced levels of FMS proficiency in the stability skill of the static balance and the lower body musculoskeletal strength variable of the vertical jump (f (1) = 4.828, $p = .03$). Other significant differences were noted for those who demonstrated advanced FMS proficiency in the locomotor skills of the run and the upper body musculoskeletal fitness measure of handgrip strength (f (1) = 4.790, $p = .03$) and the leap with the sprint run (f (1) = 4.220, $p = .04$). There were no other significant differences for those with advanced FMS and the associated measures of health-related physical fitness in boys, although the covariate BMI was significant with the physical fitness measures of the sprint run (f (1) = 9.035, $p < .01$) and the multistage fitness test (f (1) = 12.160, $p < .01$).

In girls, significant differences were demonstrated for those with better FMS proficiency in the locomotor

Table 2. Significant Differences Only ($p < .05$) Using Ordinal Logistical Regression for Functional Movements with FMS skills as Predictors and BMI as a Covariate.

	Boys ($n = 90$)			
FMS	Estimate	*P*-Value	Odds Ratio	95% CI
Functional Movement – Squat				
Run	1.81	0.001	6.13	2.23–16.80
Vertical Jump	1.82	0.001	6.14	2.03–18.83
Leap	1.66	0.006	5.26	1.62–17.08
Functional Movement – Lunge				
Static Balance	3.05	0.001	21.19	5.04–89.14
Run	2.82	0.001	9.80	2.64–36.35
Vertical Jump	2.58	0.001	13.13	3.04–56.68
Catch	1.57	0.01	4.82	1.41–16.48
Functional Movement – Push -Up				
Static Balance	3.98	0.005	53.89	3.37–861.60
Run	4.89	0.001	132.71	7.20–2447.13
Vertical jump	4.99	0.001	146.92	7.04–3081.90
Side Gallop	4.29	0.001	72.96	6.42–828.05
Leap	5.17	0.001	176.69	9.73–3209.84
Catch	4.27	0.002	71.43	5.00–1019.56
Overhand Throw	3.92	0.005	50.42	3.18–800.55
Kick	4.17	0.002	64.45	4.76–873.31
	Girls ($n = 88$)			
FMS	Estimate	*P*-Value	Odds Ratio	95% CI
Functional Movement – Squat				
Static Balance	1.80	0.001	6.07	2.02–18.26
Side Gallop	1.54	0.005	4.67	1.61–13.59
Functional Movement – Lunge				
Static Balance	1.40	0.016	4.05	1.29–12.61
Side Gallop	1.62	0.003	5.10	1.72–15.14
Leap	1.13	0.04	3.09	1.03–9.25
Functional Movement – Push -Up				
Static Balance	2.92	0.002	18.47	2.89–117.94
Run	1.86	0.015	6.48	1.43–29.19
Vertical Jump	3.72	0.001	41.33	6.22–273.59
Side Gallop	2.61	0.002	13.56	2.57–71.67
Leap	2.76	0.004	15.91	2.46–102.75
Catch	2.79	0.002	16.23	2.84–92.55
Kick	2.83	0.012	17.07	1.84–158.07

Note. FMS = Fundamental movement skills; Significance value set at ($p < .05$).

skills of the vertical jump and the upper body musculoskeletal fitness measure of handgrip strength (f (1) = 4.421, $p = .04$) and the side gallop with the sprint run (f (1) = 4.380, $p = .04$). Further, the manipulative skill of the overhand throw was significant with both the lower body musculoskeletal fitness measure of the vertical jump (f (1) = 4.828, $p = .03$) and the sprint run (f (1) = 8.984, $p < .01$). There were no other significant differences for those with advanced FMS and the associated measures of health-related physical fitness in girls although like boys the covariate BMI has a significant effect on the measures of the sprint run (f (1) = 19.817, $p < .01$), and multistage fitness test (f (1) = 10.808, $p < .01$) and also the measure of lower body musculoskeletal strength via the vertical jump (f (1) = 13.136, $p < .01$) and upper body musculoskeletal strength and the hand grip (f (1) = 5.080, $p = .03$) in girls.

Functional movement competency and health related physical fitness

It was shown that significant differences were established in boys between the functional movement competency of the squat and the lower body musculoskeletal strength measures of the broad jump (f (2) = 5.443, $p < .01$) and the vertical jump (f (2) = 7.390, $p = .01$). Further, the lunge was also significant with the lower body musculoskeletal measure of the vertical jump (f (2) = 4.565, $p = .01$). No other significant effects were established between any of the functional movements and the health-related physical fitness measures in boys. However, the covariate of the BMI was significant with the health-related physical fitness measures of the hand grip, sprint run and the multistage fitness test ($p < .05$).

In girls, the only significant difference between the levels of functional movement competency and markers of health-related physical fitness was established with the press-up and the lower body musculoskeletal strength measure of the broad jump (f (2) = 4.897, $p = .04$). The covariate BMI was shown to have a significant effect on all the measured health-related physical fitness responses ($p < .05$) in girls.

Discussion

The purpose of this study was to gather data on Welsh adolescents' FMS, functional movement, as well as their health-related physical fitness, and to determine if there was any relationship between these variables. Overall, the baseline results identified varying levels of proficiency and competency across gender in the selected measures of FMS and functional movement. On closer examination of functional movement competency and FMS proficiency, it was evident in both genders that those who demonstrated higher levels of functional movement competency on the selected skills also presented enhanced levels of proficiency across several of the FMS. In addition, some variables of health-related physical fitness were also shown to be significant with several measures of FMS and functional movements in both boys and girls.

On closer inspection in this study, the FMS proficiency levels for both boys and girls across the range of skills selected were low (based on similar reporting of FMS proficiency in adolescent youth) and are not dissimilar to the overall levels demonstrated in other UK and Ireland studies with adolescent youth of similar age (Lester et al., 2017; O'Brien et al., 2016; Philpott et al., 2020). The low prevalence of FMS proficiency demonstrated is worrying given the importance placed on FMS in enhancing PA and promoting health. Moreover, the lack of FMS proficiency in this age group is concerning given that the development of these skills is seen as a precursor to the learning and mature performance of more complex levels of skill proficiency (sport specific) in the early years of secondary school physical education programs.

In addition, to identifying overall levels of FMS proficiency, it is also mindful to recognize FMS differentials that exist between genders. In this study, although low, it was shown that boys demonstrated better FMS proficiency across the object-control skills compared to girls and vice versa that girls demonstrated better FMS proficiency across the locomotor skills than boys. These findings support previous research in gender differentials across FMS by Hardy et al., (2013) among others, although wider research suggests that the gender divide is not as clear with locomotor skills compared to that of the object-control skills (Barnett et al., 2010). It has been suggested by Hardy et al. (2013) that low FMS proficiency among girls across object control skills may indicate that either the underlying pedagogy of these skills was not successful or the typical activities associated with the development of such skills does not resonate well with girls. Of particular concern in our study is the extremely poor performance of girls in the object control skills of the kick and overhand throw. In recent years, Bevan et al. (2021) suggested that there has been an increased focus of attention by sporting National Governing Bodies in promoting levels of participation to girls in traditional sports (e.g., cricket, football and rugby) which involve many of these object-control skills (e.g., kick and overhand throw). In Wales, this has resulted in a positive increase in participation figures among young girls (Sport Wales, 2018). Therefore, it would seem important that we should look to build upon this foundation and ensure that practitioners

(i.e., teachers and coaches) are able to develop and promote these types of FMS with young adolescent girls to enhance and continue their participation in these traditional sports both in the school environment and in community sport. Furthermore, as our study findings indicate, it is also important to recognize that both boys and girls in late childhood and early adolescence still need a greater exposure to a full range of FMS to enhance their levels of FMS proficiency.

Whilst research related to FMS has been and continues to be an important focus of children's and adolescent youths' PA, a more contemporary viewpoint as expressed in the introduction by Hulteen et al. (2018) and O'Brien et al. (2021) suggested that there is a growing need to investigate the levels of functional movement alongside FMS within the motor development domain. In a subsequent investigation of functional movement competency in this study, it was shown that approximately, 50% of both boys and girls were classified as being non-competent in the skills of the squat, lunge and press-up. It is plausible that at this age (i.e., 11–13 years old) the participants of the study are at the onset of or different stages of maturation. O'Brien et al. (2022) suggested that due to the substantial physical and hormonal changes at this age, they could consequently lack the bodily competence and coordination to negotiate the demands for the functional movement assessment. Fitton-Davies et al. (2022) further highlighted that the effect of maturation on adolescent youth seems to be overlooked in many functional movement studies. However, Walker et al. (2019) in a review of methods to determine maturity status highlighted that at present, there was no clear consensus about the most reliable and effective method to adopt in field-based studies, and Fransen et al. (2021) suggest that researchers need to carefully consider their shortcomings before use. Despite this, Fitton-Davies et al. (2022) advocate that it still needs to be given greater consideration in any future research with this specific adolescent population.

On closer investigation of the relationship between functional movement competency and FMS proficiency in this study, it was evident that a significant association existed in both genders for those who presented a higher classification of functional movements with those who demonstrated advanced levels of FMS proficiency. This was most evident with the functional movement of the push-up being significant with all FMS in both genders (i.e., the locomotor, manipulative and stability skills). Whilst the functional movements of the lunge and squat were significant associations with some of the locomotor and stability FMS but none of the manipulative FMS in both genders. These findings on the individual functional movement subtests are of interest as Fitton Davies et al. (2022) highlights the press-up test on the Functional Movement Screen is aimed at assessing tri-plantar and sagittal stability, which can be seen as key in the execution of several locomotor, manipulative and stability FMS. In addition, both the squat and lunge are proposed to examine essential foot positions, which are also key in the execution of locomotor FMS.

To date, the number of studies in the UK and Ireland looking at these motor competency relationships with adolescent youth is limited, although most recently, O'Brien et al. (2021) found moderate evidence for an association between overall functional movement competency scores and locomotor and stability FMS proficiency in an Irish cohort. O'Brien et al. (2021) further suggested that the associations between overall functional movement competency and locomotor and stability FMS are a result of FMS skills demanding greater thoracic mobility and activation of the core muscular regions. Whilst, Chen et al. (2016) suggested that having higher proficiency in the functional movement exercises of the squat, in-line lunge and shoulder mobility may account for the biomechanics required to perform locomotor skills (e.g., run, vertical jump, lunge, etc.) sufficiently.

Previously, Okada et al. (2011) have suggested that functional movements need to be considered more closely on a continuum alongside FMS as PE teachers and sports coaches tend to neglect these skills in favor of more traditional movements such as running, catching, throwing or kicking, which are more traditionally recognized in sporting activities. More recently, there have been calls in the UK by the Department of Education (2019) to empower schools to deliver and assess motor competency more effectively as part of a well-balanced PE program to enhance levels of PA for future health. The present study suggests that there is a need to embrace the development of functional movement alongside the traditional FMS within the PE curricular in schools. It supports the previous works in this area by Philpott et al. (2020) and O'Brien et al. (2021) who suggested that the implementation of both functional movement and FMS strategies has the potential to capture the wide variety of adolescent movements within PE and using more contemporary assessment pedagogy in practice could see the augmentation of students' physical movement skillsets. In turn, this may prove to be more stimulating for those in early adolescents as they build a greater awareness and understanding around the importance of developing these

movements and skill sets for participation in a greater variety of PA opportunities.

A further aim of this study was to examine the relationship between both FMS proficiency and functional movement competency with several measures of health-related physical fitness. Our findings revealed that the health-related fitness measures of upper body and lower body musculoskeletal strength in both genders and the sprint run in boys were significant with several of the FMS and for those showing advanced levels of proficiency. With regard to the functional movements, the health-related fitness measure of lower body musculoskeletal strength was significant with those demonstrating better competency on the functional movements of the squat and the lunge in boys whilst in girls' lower body musculoskeletal strength was significant with the functional movement of the press-up. The study findings therefore support the findings of previous works by Jarvis et al. (2018) and Fitton Davies et al. (2022) in that musculoskeletal fitness may have an important role to play in the development of FMS and the functional movements of early adolescent youth, although the specific direction of these relationships is still to be determined. It has been suggested by Stodden et al. (2013) that a certain level of force production and force attenuation is needed to proficiently perform many ballistic FMS (e.g., throwing, kicking, striking, jumping, running and leaping). In addition, Grainger et al. (2020) recently highlighted that short-duration interventions to enhance musculoskeletal fitness in adolescent children have presented a positive impact on their functional movement ability with a specific focus of attention on exercises requiring the extension and flexion of the hip, knee and ankle joints and lunging exercises requiring co-ordinated separation of the limbs considered key.

Currently, the levels of muscular fitness appear to be declining in children and adolescents living in the United Kingdom (Sandercock & Cohen, 2019), and this may be having a detrimental impact on the development of both children and adolescent youths motor competency. In addition, Faigenbaum et al. (2020) highlight that without integrative exercise interventions, which target neuromuscular deficits early in life, contemporary youth may be unable to overcome an acquired strength deficit and they may never catch up to their more active peers who possess average or better levels of musculoskeletal fitness. Therefore, Granger et al. (2020) has suggested that integrating fundamental and functional movements with age-appropriate musculoskeletal strength training could provide an ideal stimulus for children and early adolescent youth, but the development of such an intervention requires appropriate pilot and feasibility studies in the first instance.

It is also important to note that BMI was significant with several measures of health-related physical fitness and the FMS and functional movement in both boys and girls in this study. In the literature, weight status has been shown to consistently impact both FMS and functional movement performances in childhood, early adolescence and in late athletically determined adolescent populations (O'Brien et al. 2022). Although the relationship appears robust, the directionality of this relationship is unclear and further investigation is still needed.

The present study holds several limitations and needs to be acknowledged. Firstly, the design of this study meant that the direction of the association between FMS, functional movements and health-related fitness variables could not be determined, therefore findings must be observed with caution. In addition, maturational status was not considered as part of this study. The authors acknowledge that maturational status is extremely valuable in the assessment of various health outcomes in adolescence with the hormonal changes associated with puberty having an impact on the measures undertaken and needs greater consideration in any subsequent investigation. Further, caution needs to be exercised when interpreting the functional movement competency results, as only three of the seven subtests in Cook et al.'s (2010) Functional Movement Screen were included for analyses and therefore impacts on the construct validity. Finally, as the convenience sample of participants in this baseline study was confined to schools near the test center it presented a limited sample size, and therefore, needs to be interpreted with caution as it may not be wholly representative of the geographical region or the wider population in Wales.

In summary, the low levels of performance identified across both the movement domains in this study and their direct relationship with each other suggests that we should perhaps be looking to broaden the classification of movement skill assessment and present developmentally appropriate activities and teaching strategies that would enhance deficiencies in early adolescent youth. In addition, the relationship of FMS and functional movement with specific health-related fitness outcomes suggests they also have a critical role to play in the continued development of movement skills for PA. Further intervention is clearly warranted in, around these domains, and with this population in Wales.

Disclosure statement

No potential conflict of interest was reported by the authors.

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