Fundamental movement skills - How do primary school children perform? The 'Move it Groove it' program in rural Australia

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Child Fundamental Movement Skills (FMS) underpin active lifestyles yet little is known of their distribution and mastery.

'Move it Groove it' project rated proficiency of primary school children (n=1045, 18 schools) in skills of balance, throw, catch, sprint, hop, kick, side gallop and jump. Rating categories were 'mastery', 'near mastery' or 'poor' (ie mastered all, all but one, or less of the five to six components of an FMS).

Less than half of all child tests were rated at mastery (21.3%) or near mastery (25.7%) level. In grade three, 75.4% of children achieved mastery or near mastery (MNM) in static balance but less than half did so for any other FMS. In grade four, 59.0% achieved MNM in the side gallop and 56.0% in the catch but less than half did so for any other FMS.

Although the highest percent mastery for both genders was for the balance, the skills best performed thereafter by boys (throw and kick) rated poorest for girls. Conversely the hop and side gallop which rated, after balance, as the skills best mastered by girls, were among the more poorly performed skills for boys.

The low prevalence of FMS mastery found in this survey suggests that there may be great potential to improve fundamental movement skills of primary aged children in many parts of rural Australia. Even if the aim were for children to achieve near mastery levels, the improvement could be substantial in every skill category. Where appropriate, gender differences in mastery might easily be addressed by tailored physical education programs and modification of social and physical environments.

Introduction

It has long been argued that common physical activities which may be performed, enjoyed, or enhance health in later life are underpinned by competence in various basic motor skills (Butcher & Eaton, 1989; Corbin, 1980; De Oreo & Keogh, 1980; Evans & Roberts, 1987; Harter, 1981; Haubenstricker & Seefeldt, 1986; Ulrich, 1987). For example mastery of the basic overarm throw leads to mastery of the serve in volleyball and tennis, the overhead clear in badminton, the smash in tennis and badminton, the shoulder pass in netball and basketball, the baseball pitch and the javelin throw (Thomas, 1997; Wickstrom, 1983). This understanding has led to a systematic approach to child physical activity (PA) based on the concept of Fundamental Movement (or Motor) Skills (FMS).

It now appears that improved performance of FMS among children is positively correlated with participation in organised sport (Okely, 1999;

Raudsepp & Paasuke, 1995). Failure to master a basic set of these skills may therefore prove to be a barrier to participation in physical activities and to achieving adult PA levels recommended for maintenance of good health.

New education policies and training manuals increasingly reflect this viewpoint. These policies and manuals, which are part of broader integrated initiatives targeting levels of PA among school children, have FMS as a key component (Department of Education Victoria, 1996; Department of Education Western Australia, 2000). In NSW, The Department of Education and Training has now made FMS a priority area and has developed a teaching resource to this end (Department of Education and Training NSW, 2000).

The efficacy of such initiatives is unclear. Although some good descriptive data concerning child FMS performance is now emerging there has been no measure, in Australia, of change in mastery associated with a school-based intervention (Booth et al., 1997; Booth et al., 1999).

We are seeking to redress this situation through the multi-strategic 'Move it Groove it' intervention, which aims to increase PA in primary school children. The aim of this part of the baseline study was to describe the proportion of grades three and four children from 18 schools in rural NSW who achieved FMS mastery.

Method

Setting and sample

The Northern Rivers Area covers 24,555 sq km of far north coast New South Wales extending from Grafton north to the Queensland border and west to the Great Dividing Range. Its 257,617 residents live in a range of settings from farms to small rural villages to a few large inland and coastal urban centres. Children 0-14 years represent 22% of the total population.

Sample size was calculated for FMS mastery prevalence of 50%, (for the most conservative estimate), detection of a 10% difference between groups with one-tailed α of 5%, power of 80% and then applying a design effect inflation factor of 1.5 to compensate for the clustering effect of intra school student similarities (Booth et al., 1997). The required sample size was 458 per gender or per school grade (three or four).

The required 18 schools were randomly selected from a list of 39 primary schools (of a total 118 within the Northern Rivers Area of NSW) that had agreed to be on the selection list. Selection was stratified by school size (large if >42 year three plus year four students, else small). Large schools are mostly in urban centres (with populations > 2000) and small schools are in smaller rural villages. The study sample was all grade three and four children in the 18 schools whose informed parents did not refuse their participation (there were no refusals) and who were able to attempt all components of each FMS (participation rates >85%).

Skills and their measurement

Testing took place from March to May 1999. Eight core skills (Table 1) of a possible 11 FMS were assessed including: static balance, sprint run, vertical jump, kick, hop, catch, overhand throw and side gallop. These were selected because they are recognised as vital to development of higher skills (eg overarm throw for the overhead smash in tennis, for the volleyball or tennis serve, or for the baseball or javelin throw) and should ideally be mastered by children in

Skill	Description	Number of Components Scored	School Grade Tested	% at 'poor' level Boys	Girls
Static Balance	Stand and balance on one leg	5	3	25.8	22.8
Sprint run	Run as fast as possible between two points 20 metres apart	6	3	52.2	66.2
Vertical Jump	Jump up vertically as high as possible from knees-bent standing position	6	3 4	67.2 67.2	58.8 56.6
Kick	Run up to and kick a 20cm play ground ball as far as possible with top of foot	6	3 4	45.0 38.0	80.4 74.6
Hop	Hop between two points 15m apart	5	3 4	63.5 52.9	55.9 52.7
Catch	Catch a soft ball thrown underarm from 3-5 metres distance to 2 metres high	6	3 4	49.2 42.6	65.8 46.8
Overhand Throw	Throw a soft ball overarm as far as possible	6	4	36.6	77.6
Side Gallop	Gallop sideways between two points 15m apart	5	4	50.0	32.5

Table 1: FMS tested and potential gains for a planned intervention, in terms of % of children who might be shifted from their current 'poor' level to 'near mastery' or 'mastery'

grades three and four (Booth et al., 1997). The specific grades in which each FMS was tested (grade three only, both three and four, or four only, Table 1) were based on general developmental patterns (Booth et al., 1997). Other skills were considered but determined outside the scope or budget of the 'Move it Groove it' project.

Each FMS was broken down, and assessed in terms of 5 or 6 components considered essential to mastery of that skill (Table 1) (Booth et al., 1997). This breakdown of skills into components affords their measurement a level of objectivity beyond that of a single overall score and provides a good foundation for measuring change over time. Observational methodology was based on a written protocol in accordance with methods of the draft NSW Department of Education and Training resource on FMS that has since been finalised (Department of Education and Training NSW, 2000). This was derived from the earlier NSW Schools Fitness and Physical Activity Survey protocols (Booth et al., 1997) and the Department of Education of Victoria: 'Fundamental Motor Skills: A Manual for Classroom Teachers'. For example in assessing the Sprint Run (called the Run in earlier protocols) testers checked if: 1. the child landed on the ball of the foot, 2. the non-support knee was bent at least 90 degrees in recovery, 3. the thigh to the high knee was parallel to the ground, 4. the head and trunk were stable and eyes were looking forward, 5. the elbows were bent at 90 degrees and 6. the arms were driven forward and back in opposition to the legs.

Groups of children were taken to each testing station in turn where a trained tester demonstrated the FMS, asked each child to perform them five times and rated each component of FMS as present or absent. This was done without the

tester providing any verbal feedback. A component was deemed as present if the child performed it on at least four of the five trials (Holland, 1986).

Testers and training

The 10 testers were trained student observers from the School of Exercise Science and Human Movement at the regional University. Training was done using established protocols by an experienced tester from the NSW School Fitness and Physical Activity Survey (Booth et al., 1997) and the NSW Department of Education and Training State FMS Demonstration Project (Booth et al., 1999). Training included repetitive rating, by each prospective tester, of children performing each FMS on a video. A panel of experts had previously rated every component of each videoed FMS performance. Students were only conferred 'tester' status when they could reliably (>85% correct) score each component of each FMS in line with that of the expert panel. Inter rater reliability was subsequently determined during field observation periods in schools. This was done by pairs of observers, simultaneously scoring the mastery level of the same child attempting the same FMS. Each observer pair did so for three children for each of the 8 skills and each observer was checked in this manner against two other observers.

Data and analysis

Observations were coded and entered into an EpiInfo database (World Health Organisation, 1996). They were checked, cleaned and analysed using the SAS statistical package (SAS Institute Inc., 1987). Distributions of percentage 'mastery' and 'near mastery' were calculated for each FMS and presented by gender and school grade. 'Mastery' was defined as correct performance of all components of a skill. 'Near mastery' was defined as correct performance of all components but one. Any poorer performance was coded 'Poor'. Category comparisons were by 95% confidence interval calculated according to Gardiner and Altman (Gardiner & Altman, 1989) and chi square test.

Results

The 1045 children who took part in the FMS survey consisted of 515 from grade three and 530 from grade four. The mean kappa coefficient for paired observations of testers in the field was 0.61 representing fair to good agreement (Fleiss, 1981). The gender distribution of tested children was 53% boys and 47% girls in both grades.

Overall 47.0% of tests on all children for all FMS returned a score of mastery (21.3%) or near mastery (25.7%). By far the best performed FMS was the static balance, with 43.2% of children achieving mastery and 32.2% achieving near mastery. This was followed by the side gallop where 29.0% achieved mastery and 30.0% achieved near mastery. The poorest performance was for the jump and sprint where only 14.5% and 16.6% respectively achieved mastery and 23.5% and 23.7% achieved near mastery.

FMS profiles of boys and girls differed substantially (Figure 1). This is highlighted by a consideration of the percent of children who either mastered or near mastered each FMS (MNM). Although balance was the skill best performed by both boys and girls (MNM values of 75.4% and 77.1% respectively with no significant difference between genders; χ^2=0.78, df=1, p=0.377), the skills best performed thereafter by boys (throw 62.6% and kick

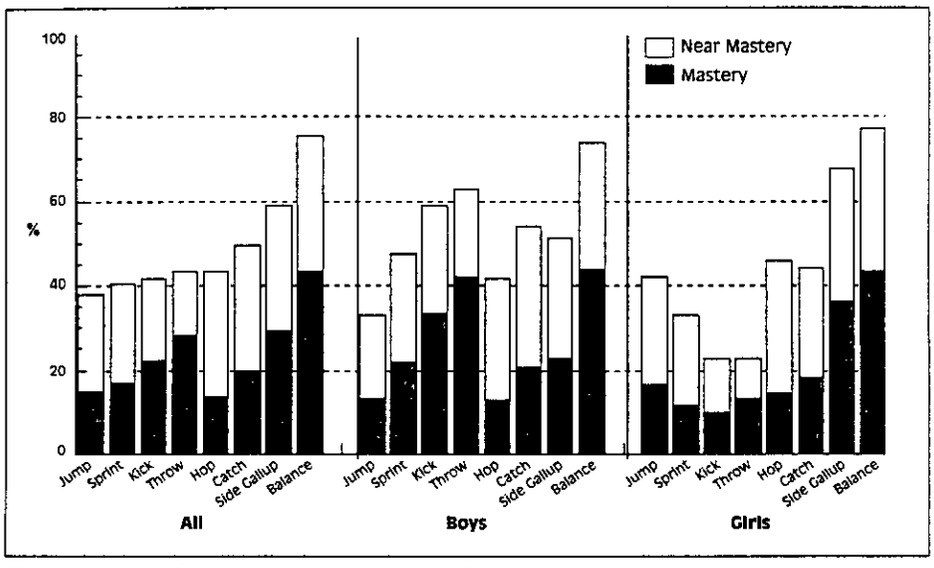

Figure 1: Ranked fundamental movement skills for boys and girls based on percentage achieving Near Mastery and Mastery (n=1039, boys=540, girls=499).

59.1%) rated poorest for girls (throw 22.7% and kick 22.8%). Conversely the hop and side gallop which rated, after balance, as the skills best performed by girls (67.7% and 45.7%) were among the more poorly performed skills for boys (51.2% and 41.5%). Except for the hop, these differences between genders were significant (χ^2_{throw}=84.84, p<0.001, χ^2_{kick}=134.53, p<0.001, $\chi^2_{side\ gallop}$=14.60, p=<0.001).

FMS profiles by school grade provided further insight into the distribution of skills. Of the two skills tested only in grade three (because they should, in theory, be mastered in grade two (NSW Department of Education & Training, 2000)), MNM for the balance was 75.4%. For the sprint run however, MNM was 40.3%. For all other skills tested among grade three children (catch, hop, kick and vertical jump), fewer than half of the children (42.7%) achieved MNM. In grade four no FMS had a MNM level greater than 60% and MNM for the throw and side gallop were only 43.3% and 59.0% respectively.

The cross sectional comparison of each FMS across grades three and four provided insight into the current rate of development as children progressed from one grade to the next (Figure 2). Although grade four children achieved higher MNM levels for each of the four FMSs tested in both grades (jump, kick, hop, catch) the actual differences were small (<6%) except for the catch, which was 12% higher in grade four, (χ^2=16.95, df=1, p<0.001). However, even in the catch the overall MNM at grade four was only 55.5%.

Cross-sectional comparisons of mastery levels by grade were performed separately for boys and girls to gain a still finer understanding of FMS development. For boys, the least development was evident in the jump. This skill was the least mastered skill in grade three (MNM=32.9%) and there was

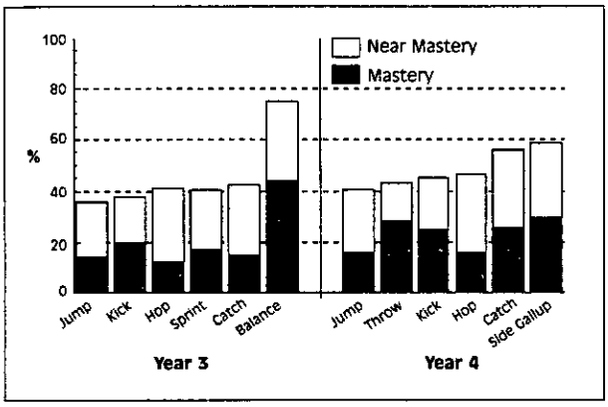

Figure 2: Ranked fundamental movement skills for grade 3 and 4 children based on percentage achieving Near Mastery and Mastery (n=1045, grade3=515, grade4=530).

virtually no difference between grades three and four (0.1%, χ^2=0.001, df=1, p=0.976). The greatest development was evident in the kick with a 7.0% difference from an initial 55.0% (χ^2=2.526, df=1, p=0.112). For girls, the least development was in the hop with a 3.2% increase from 44.0% (χ^2=0.489, df=1, p=0.485) and the greatest difference was a 19.0% improvement for the catch (χ^2=18.014, df=1; p=0.001).

By focussing on the percentage of children who are unable to either master or near master each skill, Table 1 highlights FMS deficiencies which provide the greatest opportunities for improvement by gender and grade. Prime targets among girls are the 80.4% in grade three and 74.6% in grade four who displayed poor kicking performance and the 77.6% in grade four who displayed poor throwing skills. Among boys, the two thirds of grades three and four who displayed poor jumping skills offer the greatest potential.

Discussion

The MIGI results provide important insights into the development and distribution of FMS, implications for future efforts to improve FMS among children, a new benchmark for rural schools at least in the NSW Northern Rivers Area and a baseline for the MIGI intervention.

The scoring protocol adopted by MIGI is currently being disseminated for routine testing in NSW schools (Department of Education and Training NSW, 2000). Unfortunately it differs from that used in earlier published studies especially in terms of FMS component definition and number. When comparisons are made with grade four children in the 1997 NSW Fitness and Physical Activity Survey, similar aged children in MIGI generally showed higher levels of MNM (Booth et al., 1997; Booth et al., 1999). Specifically, for the eight possible grade four comparisons (ie both genders for run, jump, catch and kick) MIGI found higher MNM for the girls' and boys' catch, throw and kick and lower MNM for the run and for the boys' jump. The direction of these differences was the same regardless of whether comparisons were with rural or urban cohorts of the NSW survey. However, because of the above mentioned

differences in methodology, any comparison should be viewed with caution. While the NSW survey itself revealed some interesting rural urban variations, none was statistically significant and until more testing is done with the newer protocol our results do not clarify this issue.

Limitations of the MIGI study stemmed chiefly from the differing objectives of the three organisations involved, the competing demands of other evaluation components and under resourcing in comparison with the ideal. Further, it would have been more accurate to have two observers score every child for each FMS for, although inter rater reliability was high when tested, there may have been variation at other times. From a research viewpoint it would have been fruitful to survey each FMS in both grade three and grade four but limited funds demanded a minimalist approach based on the requirements of comprehensive program evaluation rather than pure research. In spite of the limitations and difficulties the results are informative and useful well beyond the context of the MIGI program.

In view of the ample play areas in our rural school grounds and the year-round conduciveness of our climate to PA, our results suggest that there may be great potential to improve FMS of primary aged children in many parts of rural Australia. Even if the aim were for children to achieve near mastery levels, the improvement could be substantial in every skill category.

That grade four mastery levels were consistently (though not always significantly) higher than those in grade three for all skills tested in both grades was not surprising. Children are expected to improve their skills with experience, practice and general development. (McKenzie, Alcaraz, Faucett, & Sallis, 1997; Ulrich & Ulrich, 1985). Indeed these differences between grades at baseline provide an insight into the secular changes that might be expected during the course of the 'Move it Groove it' intervention.

Gender differences found in other studies were corroborated by our findings (Raudsepp & Paasuke, 1995; Sallis, Alcaraz, McKenzie, & Hovell, 1999; Thomas & French, 1985; Walkley, Holland, Treloar, & Probyn-Smith, 1993; Wright & Okely, 1997). By developing supportive gender-specific social environments for learning it may be possible substantially to diminish differences in performance of boys and girls (Hands & Larkin, 1997).

The breakdown of skills into components provides a good foundation for measuring change over time and the possibility of tailoring interventions to focus on the particular components of a skill that requires attention. While our study did not attempt to identify the mix of skills at the individual level, scoring of skill components in this manner could provide a detailed skill profile of every child for teachers to further target their remedial efforts.

The FMS differences by age and sex identified in this study might readily be redressed if format, content, scope and sequence of physical education programs target identified deficiencies and if social and physical environments are established to support the required changes (Hands & Larkin, 1997). For example, a strategic approach to improving kicking amongst girls could potentially provide the four out of every five girls who currently have not mastered this skill with enough component skills to achieve at least near mastery and, possibly with it, the confidence to take part in a wider range of kicking-based activities.

Part of the integrated 'Move it Groove it' intervention to increase PA among

primary school children is to pilot innovative and integrated approaches to improve FMS. The results presented here are the baseline for a longitudinal study to test their efficacy.

While the association between FMS and more advanced sport-specific skills has long been established there is little evidence to date that improved FMSs influence patterns of PA in later life. We recommend research to further clarify both the immediate and longer-term implications of such improvements within Australia. This is particularly important with respect to the large gender disparity evident in our results. In view of the likely cultural influence on the perceived value of varying skills it may be misleading simply to apply findings from other countries directly to Australian children (Wright & Okely, 1997).

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