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Can we skill and activate children through primary school physical education lessons? "Move it Groove it"—a collaborative health promotion intervention

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Abstract

Background. Physical education (PE) lessons are an ideal setting to improve child fundamental movement skills (FMSs) and increase physical activity (PA) for optimal health. Despite this, few studies have assessed the potential to do both simultaneously. The "Move It Groove It" primary school intervention in New South Wales, Australia, had this opportunity.

Methods. A whole school approach to implementation included establishment of school project teams, a teacher "buddy" system, project Web site, teacher training workshops, and small grants for equipment. The quasi-experimental evaluation involved 1,045 year 3 and 4 children (aged 7 to 10 years) in nine intervention and nine control rural primary schools (53% boys/47% girls). It utilised pre- and postobservational surveys of (1) mastery or near mastery levels for each of eight FMSs, (2) proportion of PE lesson time spent in moderate to vigorous PA (MVPA) and vigorous PA (VPA), and (3) teacher- and lesson-related contextual covariates. Data were analysed by hierarchical logistic multiple regression.

Results. For FMSs, overall mastery or near mastery level at baseline was 47% ranging from 22.7% for the overarm throw among girls to 75.4% for the static balance among boys. The intervention delivered substantial improvements in every FMS for both genders ranging from 7.2% to 25.7% (13 of 16 comparisons were significant). For PA level, mean MVPA at baseline was 34.7%. Baseline MVPA for boys was 38.7% and for girls was 33.2%. The intervention was associated with a nonsignificant 4.5% increase in MVPA and a significant 3.0% increase in VPA. This translates to a gain of <1 minute of MVPA per average 21-minute lesson.

Conclusions. This is the first study to show that by modifying existing PE lessons, significant improvements in FMS mastery can be gained without adversely affecting children's MVPA and VPA. To increase PA levels, we recommend increasing the number of PE lessons per week.

Keywords: Schools; Child; Exercise; Health behavior; Logistic models; Evaluation studies; Cardiovascular disease

Introduction

Insufficient physical activity (PA) is becoming a major public health concern [1–11]. There is increasing evidence that PA during childhood may enhance health both in the short term and throughout later life [1,8,9,12–15]. It improves psychological health and immune status during childhood, enhances bone development, and affects precursors of various lifestyle diseases [1,10,14–18]. It may also be correlated to reducing crime [19].

Children in developed countries are not adequately active, are spending the greater part of their free time in sedentary pastimes, and are becoming more obese [8,10, 11,14,18,20–22]. As the benefits of moderate accumulated PA have become evident, recommended adequate PA levels

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have changed [9,10,13,23]. The UK Expert Consensus Conference recommendations regarding children's PA levels are that "... all young people should participate in physical activity of at least moderate intensity for 1 hour per day. Young people who currently do little activity should participate in physical activity of at least moderate intensity for at least half an hour per day. The subsidiary recommendation is that, at least twice a week, some of these activities should help to enhance and maintain muscular strength and flexibility and bone health" [24]. In recognition of the role of schools in achieving the above PA levels, the NSW (Australia) Board of Studies recommended that children in NSW schools should have the opportunity to engage in 120 minutes of PA during the school week [25].

Childhood PA levels show some correlation with adolescent levels and development of fundamental movement skills (FMSs) and pleasurable exposure to PA in the school setting appear to enhance children's sporting activities [26,27]. It is clear that FMSs underpin prowess in sport. For example, a skill such as 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 [28,29]. It now also appears that improved performance of FMSs among children is positively correlated with participation in organised sport [27,30]. Although more evidence is required, failure to incorporate PA as a part of daily life and failure to master a basic set of motor skills may prove a major barrier to participation in PAs and to achieving recommended PA levels for maintenance of good health.

In view of the gap between current and recommended PA levels of children [31] there is an urgent need for action. School PE classes offer an opportunity to equip children with necessary FMS and also contribute valuable PA time toward recommended requirements. Opportunities to engage in moderate to vigorous PA (MVPA) during PE classes vary greatly and depend on several factors [32,33]. Present levels of two of these factors, the frequency of PE classes and the opportunities to be active during PE classes, have been shown to be less than desirable [31,34–37].

Current Australian education policies include FMS training and more active PE lessons as key components of broader integrated initiatives to increase PA among children [38,40]. Although some descriptive data on child FMS performance and on PA levels in PE is now available, the efficacy of PE-based interventions to improve FMSs or increase PA levels has not been tested [31,41]. One particular challenge to such interventions, which was also apparent during the "Move It Groove It" (MIGI) program, is how to achieve both improved FMSs and increased PA levels of targeted children in the light of limited time allocated to PE.

The current article explores this issue. It describes FMS mastery and PA levels in PE lessons surveyed as part of the MIGI collaborative program [42]. MIGI involved a health promotion team from an area health service, 18 rural primary schools, and a university. The MIGI 1-year intervention adopted a multistrategic approach including all elements recommended by the Ottawa Charter for Health Promotion [43].

Methods

Sample and setting

MIGI had a quasi-experimental design with nine control and nine intervention schools, randomly selected and stratified by NSW Department of Education and Training (DET) district and school size from a pool of schools in the Northern Rivers Area of NSW that had expressed interest in participating in the project. Primary schools in the sample varied in size from 18 to 575 pupils. Year 3 (age range 7–9 years) and year 4 (age range 8–10 years) pupils in 1999 were tested pre and post intervention. For FMSs, all 1,045 able pupils (53% boys and 47% girls) were tested. For PA in PE, four children were randomly sampled and observed in 231 lessons and 234 lessons, respectively, pre and post intervention. Pre and post intervention testing took place between February and June 1999 and August to December 2000, respectively.

The Move It Groove It intervention

The five strategies undertaken as part of the MIGI 1-year intervention fell under two main headings, (1) supporting teachers, and (2) creating supportive environments and healthy school policies. The strategies used were school project teams, a buddy program, professional development for teachers, a project Web site, and funding for purchase of equipment.

On recruitment to MIGI, schools established a project team to coordinate the project locally and to provide a "whole school approach." MIGI project staff recommended that the team include the school principal, relevant teachers, parents, the school's preservice teacher (the "buddy"), a health worker, and any interested upper primary school students; however, the final makeup was left to the school. The individual teams aimed to select and customise policy and environmental strategies for their school.

The buddy system was seen as a significant strategy to improve PE teaching in terms of increasing PA levels and FMS mastery and entailed the matching of preservice teachers (third year education students) with generalist teachers in intervention schools. Buddies provided updated strategies, resources, and knowledge in increasing PA during PE lessons and increasing FMS mastery, and the generalist teachers provided teaching knowledge and experience for the preservice teachers. Buddies also distributed resources on personal development, health, and physical education to teachers, helped teachers access resources, particularly the web site, and participated on school project teams. As the

program was incorporated under a health and fitness elective at the local university, there were also certain unit requirements such as attendance at schools, attendance at weekly tutorials, participation in school project teams, submission of a journal and assignments for assessment, and an end-of-term presentation.

There were two buddy intakes. The first group commenced June 1999 and finished in December 1999 and the second group commenced in February 2000 and finished in June 2000. Both intakes partook in a five-day training program that included familiarisation with DET resources and priorities, general PE teaching strategies, strategies to teach fundamental movement skills, and lesson planning using the personal development, health, and physical education syllabus.

A MIGI web site was produced, containing resources for teachers such as lesson plans, ideas and activities, FMSs, i.e., how to test and how to teach; planning, assessment, and evaluation, ideas regarding policies, environmental changes, and community involvement with regard to PA in schools, and links to other useful sites. The content came from relevant published resources as well as buddies' contributions. It was password protected so that only intervention schools could access it.

Schools were also offered a nominal amount ($AU375.00) to purchase equipment to assist them in maximising PA. Schools had to itemise requested equipment and explain how purchase would contribute to the achievement of one or more MIGI goals.

Finally, four workshops were conducted for teachers in intervention schools, one to introduce the project, one in mid project to share progress reports and project updates, and two on improving teaching strategies of fundamental movement skills and dance in direct response to teachers' expressed professional development needs.

Skills and their measurement

The eight FMSs tested were the static balance, sprint run, vertical jump, kick, hop, catch, overhand throw, and side gallop (Table 1). These were selected because (1) they have been clearly defined and successfully measured in other studies, (2) they are recognised as vital to development of higher skills, (3) they should ideally be mastered by the time children complete year 4, and (5) as a set, they favour neither boys nor girls [31,38,44]. Skill components were assessed by using a written protocol in accordance with methods of the NSW DET resource on FMSs [39]. Briefly, groups of children were taken to each testing station, a trained tester demonstrated an FMS, asked each child to perform it five times, and rated each component of that 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 [45].

Table 1
Baseline levels and observed changes in FMS[a] Mastery + Near Mastery (MNM) in nine intervention schools

Skill/gender	Baseline %MNM	% change (int/control)	*Z* (*P*)
Sprint/run			
Boy	38.75	25.70	3.96 (<0.001)*
Girl	26.31	21.56	1.04 (0.149)
Side gallop			
Boy	48.13	21.91	3.72 (<0.001)*
Girl	65.70	21.72	1.65 (0.049)*
Kick			
Boy	55.4	21.10	3.65 (<0.001)*
Girl	16.8	12.11	1.99 (0.023)*
Throw			
Boy	61.99	14.38	1.82 (0.034)*
Girl	21.13	7.22	1.73 (0.042)*
Jump			
Boy	30.07	14.28	2.661 (0.004)*
Girl	37.54	16.44	2.79 (0.002)*
Hop			
Boy	35.82	11.39	0.94 (0.174)
Girl	38.44	11.40	1.78 (0.037)*
Catch			
Boy	51.10	11.38	3.51 (<0.001)*
Girl	38.13	22.72	3.64 (<0.001)*
Balance			
Boy	68.61	9.13	1.41 (0.079)
Girl	73.16	8.08	0.85 (0.197)

[a] Fundamental movement skill.
* Changes significant at $P < 0.05$.

PE observation tool

The validated System for Observing Fitness Instruction Time (SOFIT) was used to assess PA levels and lesson context [46,47]. Standard guidelines were followed except for minor modifications resulting from piloting in local schools. Briefly, four children were randomly selected prior to the start of the PE lesson. The first child was observed for 12 periods of 20 seconds each and the PA level (1–5) and lesson context (management/instruction, skill practice, game, fitness, or other) recorded at the moment the time period ended. A particular context was attributed to an observation on the basis of more than 50% of the children being engaged in that context. Once the 12 observations were completed on the first child, the second child was observed for 12 periods, followed by the third and fourth child. If any lesson time remained after the fourth child was observed, the first child was observed again and the cycle repeated until the lesson ended.

Testers and training

FMS testers were trained by using established protocols, by an experienced tester from the NSW School Fitness and Physical Activity Survey [31]. Training included repetitive rating, by each prospective tester, of children performing

each FMS on a video, previously rated by a panel of experts. The required observer accuracy agreement rate was >85%. Interrater reliability was subsequently checked during field observation periods in schools on sets of 48 scores for every observer pair (mean kappa = 0.61, representing fair to good agreement [48]).

For PE, observers were trained in the modified SOFIT system [46]. The required observer accuracy agreement rate was >90% against a SOFIT gold standard video [34]. Interobserver reliability checks were conducted opportunistically on 13% (30 of 231) of lessons. Mean agreement rates for activity level (96.1%) and for lesson context (97.9%) compared favourably with those of McKenzie et al. [34].

Data and analysis

For FMS analysis, the binary variable "mastery plus near mastery" (MNM) was created, with value 1 if all, or all but one, components of a skill were correctly performed and value 0 if the child did not attain this standard (skills either had five or six components). For PA analysis, a binary variable was constructed from the five-point SOFIT rating to classify the observed child as engaged (1) or not (0) in moderate to vigorous PA (MVPA = SOFIT category 4 or 5). A vigorous physical activity (VPA = SOFIT category 5) binary variable was created in the same manner for a subanalysis to determine what part of any overall change in MVPA was due to the VPA component. The above were used as dependent variables in multiple hierarchical logistic regression models to determine intervention effects [49,50]. The data were modelled as constituting a hierarchy of nested sources of variation so that for FMSs, child observations were nested in schools, and for PA, child observations nested within lessons and lessons within schools.

Models were built up from the basic variance components (intercept only) models by adding independent variables one at a time. Dummy-coded variables for school year and child gender were added to adjust the estimates for subsequent variables regardless of whether they were found to be significant predictors. This reflected expectations that PA indicators vary with age and gender. For PE analysis, other covariates included dummy lesson context variables, a dummy teacher gender, and the variables lesson start time (hours from 9:00 AM) and lesson duration (minutes). For PA analysis, apart from school year and child gender, any independent variable found not to have a significant effect in either the MVPA or VPA models was removed. Second order penalised quasi-likelihood (PQL2) [50,51] estimates and standard errors were obtained. Parameter estimates were considered significant (two-tailed at $\alpha \leq 0.05$) if they were 1.96 or more times their standard errors.

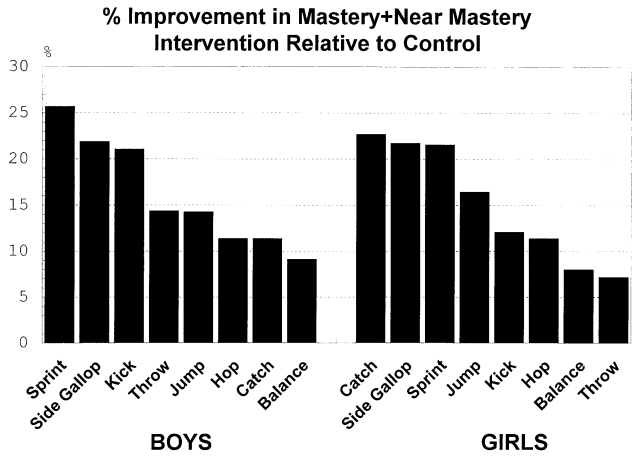

Fig. 1. Percent improvement in mastery + near mastery for intervention group relative to control.

Results

Fundamental movement skills

Baseline FMS results from MIGI have been presented previously as a cross-sectional survey of 18 schools [52]. In summary, less than half (47%) of all tests on all children rated as MNM. Static balance was most mastered (MNM 75%) followed by the side gallop (MNM 59%). The poorest performance was for the jump and sprint (MNM 38% and 40%). Gender-specific profiles differed substantially. Although balance was the most-mastered skill for both boys and girls, the skills best achieved thereafter by boys (throw and kick) rated as the 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. These differences between genders were mostly significant ($\chi^2_{\text{throw}} = 84.84$, $df = 1$, $P < 0.001$; $\chi^2_{\text{kick}} = 134.53$, $df = 1$, $P < 0.001$; $\chi^2_{\text{hop}} = 1.80$, $df = 1$, $P = 0.179$; $\chi^2_{\text{side gallop}} = 14.60$, $df = 1$, $P = <0.001$).

Year 3 and 4 MNM level comparisons provided a developmental insight into FMSs. For boys, the least difference (0%) occurred in the jump ($\chi^2 = 0.12$, $P = 0.97$), the least mastered skill in year 3 (MNM = 33%). The greatest development was apparent in the kick with a 7.0% ($\chi^2 = 2.526$, $df = 1$, $P = 0.112$) difference from an initial 55.0%. For girls, the least change was apparent in the hop with a 3.2% ($\chi^2 = 0.489$, $df = 1$, $P = 0.485$) increase from 44.0% and the greatest was a 19.0% improvement from 34.2%, for the catch ($\chi^2 = 18.014$, $df = 1$, $P = 0.001$).

At follow-up, improvements in the intervention group compared to controls were observed in every FMS for both boys and girls. Overall, there was a highly significant 16.8% improvement for all skills combined ($z = 9.64$, $P < 0.0001$). The smallest change was a 7% improvement in throwing among girls and the largest was a 26% improvement in sprint run for boys (Fig. 1). Most of the improvements were significant (13 of 16).

Moderate to vigorous PA in PE lessons

Baseline results of PE PA have been presented elsewhere as a cross-sectional survey of the 18 schools [53]. In brief, PE lessons commenced between 9:00 AM and 2:55 PM, with a mean duration of 21 minutes (range 12 to 46 minutes). The median number of observed lessons within each school was 12. The year breakdown was 21% year 3, 54% years 3/4 composite, and 25% year 4.

The overall adjusted mean %MVPA for baseline observations was 34.7% (Table 2). Of potential predictors, lesson duration and school year were nonsignificant (but year was retained to adjust estimates of remaining variables). Girls were significantly less physically active than boys. Teacher gender was a nonsignificant predictor for MVPA (but was left in the model as it was a significant predictor of a subanalysis of the VPA component). Lesson start time was significant, with activity levels declining as the day progressed. Lesson context was significant with %MVPA highest in the context of fitness, followed by skill, game, and last, management/instruction.

Follow-up analysis (of pre plus post) data revealed a 4.5% nonsignificant increase in %MVPA in intervention schools, compared to control schools ($z = 1.33$, $P = 0.09$). A specific analysis of the vigorous (VPA) part of MVPA indicated that most of the observed increase in MVPA was due to changes in vigorous PA (VPA = SOFIT level 5) in that intervention schools showed a significant 3.3% increase in VPA compared to controls ($z = 2.43$, $P = 0.008$).

In descriptive analysis of the combined pre plus post data, child gender and context again emerged as significant predictors of MVPA [53]. Start time was no longer significant, suggesting a reverse trend or larger variation in relevant follow-up data. Teacher gender became a significant predictor such that lessons of male teachers were more active. The predictive model for MVPA explains approximately equal amounts of variance at lesson (20%) and school levels (18%). The variance components (null) model revealed considerably more variance at the "lesson within school" (86%) than at the "school" level (14%) (Table 3).

Table 2
Estimated mean percentages and 95% confidence intervals (CIs) of moderate to vigorous physical activity (MVPA) for each predictor variable computed at "average" levels of the other variables

Variable[a]	MVPA		
	Mean %	L CL %[b]	U CL %[c]
Constant	34.7	29.8	39.9
Boys	36.2	31.2	41.6
Girls	33.2	28.4	38.4
Male teacher	34.4	28.7	40.5
Female teacher	35.0	30.1	40.3
9:00 AM	39.5	32.7	46.7
11:00 AM	34.7	29.8	39.9
1:00 PM	30.2	25.1	35.8
Fitness	61.9	56.0	67.5
Skill	46.4	40.5	52.4
Game	42.6	37.0	48.4
Manage/Instruct	17.1	14.1	20.7

[a] Values were computed for a year 4 class at "average" levels of the other variables (i.e., child and teacher gender ratios of 50:50, whole sample lesson context proportions and 11 AM start).
[b] Lower Confidence Limits.
[c] Upper Confidence Limits.

Table 3
Follow-up parameter estimates and standard errors from variance components and predictive models for %MVPA

		Null model		Predictor model	
		Coefficient	SE	Coefficient	SE
Fixed effects					
Intercept	β_{1jk}	−0.3970	0.0850*	−1.205	0.154
Post[a]	β_{2jk}			0.142	0.101
Intrvnt[b]	β_{3k}			0.070	0.171
Post*intrvnt[c]	β_{4jk}			0.184	0.138
Start time[d]	β_{5ijk}			−0.008	0.026
Girl child[e]	β_{7ijk}			−0.191	0.027
Female teacher[e]	β_{8jk}			−0.307	0.074
Fitness[f]	β_{10ijk}			1.841	0.053
Game[f]	β_{11ijk}			1.023	0.039
Skill[f]	β_{12ijk}			1.274	0.041
Other[f]	β_{13ijk}			0.694	0.175
Random effects[g]					
School	V_{1k}	0.102	0.043	0.084	0.038
Lesson	u_{1jk}	0.537	0.042	0.422	0.036
Child[h]	e_{0ijk}	1.000	0.000	1.000	0.000
Statistics					
ICC = ρ_1[i]		0.160		0.166	
ρ_2[j]		0.832		0.838	
R_1^2[k]				0.208	
R_2^2[l]				0.183	

[a] Post variable, i.e., baseline or follow-up.
[b] Intervention-variable, i.e., intervention or control.
[c] Post × intervention variable, i.e., interaction to determine effect of intervention.
[d] Beginning time of lesson in hours from 9:00 AM.
[e] Dummy codes to represent child and teacher gender (reference category = male).
[f] Dummy codes to represent lesson context (reference category = class management/instruction).
[g] Variance components and their standard errors (SE).
[h] These values are default.
[i] ρ_1 = proportion of (school and lesson within school) variance at the school level.
[j] ρ_2 = reliability of mean of 12 (the median) lessons as measure of a school.
[k] R_1^2 = proportion of lesson variance accounted for.
[l] R_2^2 = proportion of school variance accounted for.

Lesson context

Because the MIGI intervention encouraged teachers to focus on activity and skill acquisition during PE lessons, a further series of logistic regression models were run to test for changes in the proportion of lesson time spent in each context within intervention schools compared to controls.

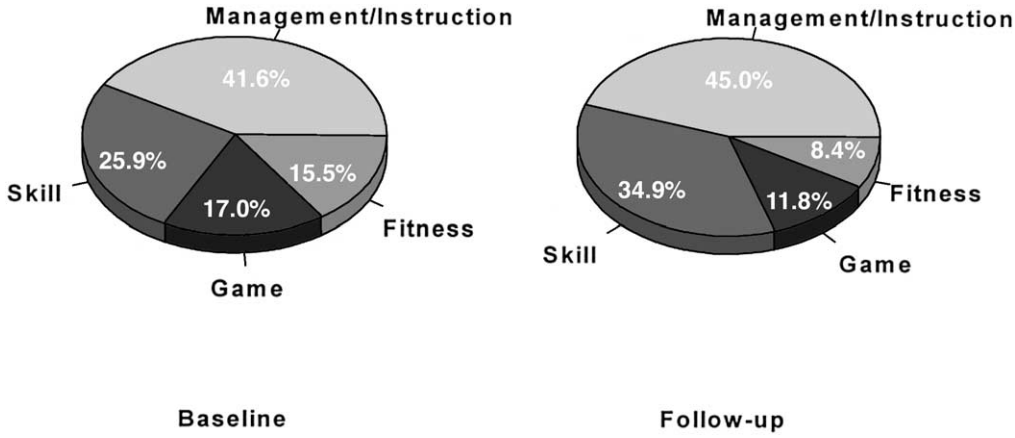

Fig. 2. Changes in intervention physical education context proportions after adjustment for changes in controls.

This revealed an increase in time spent on skill training ($\beta = 0.413$, $z = 6.55$, $P < 0.001$), no significant change in time spent on management/instruction ($\beta = -0.002$, $z = 0.038$, $P > 0.49$), a decrease in time spent on fitness ($\beta = -0.404$, $z = 5.32$, $P < 0.001$), and a decrease in time spent on games ($\beta = -0.120$, $z = 2.14$, $P = 0.016$) relative to controls (Fig. 2).

Because the intervention also encouraged teachers to increase child activity during fitness, skill, and game contexts of PE, a further series of logistic regression analyses was conducted to test the hypotheses that within intervention schools, changes in MVPA would occur within these contexts. This revealed that during "fitness" there had been a significant increase in %MVPA ($\beta = 0.608$, $z = 3.07$, $P < 0.001$). During "skill" there was no change ($\beta = 0.137$, $z = 0.86$, $P = 0.19$) and during "game" there was a decrease in %MVPA ($\beta = -0.290$, $z = 1.66$, $P = 0.045$).

Discussion

Changes in FMS mastery

In view of the brevity of the MIGI intervention, FMS outcomes were substantial. It is clearly possible to improve year 3 to 4 childrens mastery of FMSs in a brief time frame through a well-planned, collaborative intervention. Gains reported here are over and above those due to the usual development as a child moves from one year to the next [52]. They also represent a large proportion of the overall improvement that normally occurs in the mastery of these skills between years 4 and 10 [31].

Gender differences found in other studies were corroborated by our baseline findings [28,30,44,54,55], and it was heartening to find that overall, the degree of improvement was similar for boys and girls, suggesting that at a broad level the intervention strategies suited both genders. Furthermore, it was promising to find substantial improvements had been made among boys and girls in some of their less mastered skills (i.e., boys' jumping, sprinting, and side galloping, and girls' sprinting, jumping, and catching). Others have also found that by developing supportive gender-specific social environments for learning, it may be possible to substantially diminish differences in performance of boys and girls [56].

It is unclear why some skills proved more amenable to change than others. For example, the smallest improvements for boys were in the hop, catch, and balance, which initially represented poor, mid, and well-mastered skills.

Until a long-term follow-up is done, it will not be possible to establish whether gains due to the MIGI intervention will be sustained. Furthermore, if they are, then to what degree and for how long will an improvement remain compared to unexposed children, and what effect will the relative improvement have in terms of participation in recreational PA and organised sporting activities? If the underlying assumptions on which the MIGI rationale for targeting FMSs do prove correct, then children from the nine intervention schools who were exposed to MIGI strategies will have more confidence to become physically active, will become involved in more organised sports, and will remain more active than their lesser skilled peers throughout their lives [9,41,59].

Changes in physical activity level

The mean percent MVPA of 34.7% at baseline (Table 2) is well below recommended levels and comparable to that found by McKenzie et al. [34] of 36.2%. The change in MVPA, while nonsignificant, was in the right direction. That VPA did increase significantly supports qualitative feedback from the teachers, during professional development, that they believed they were increasing PA in their PE lessons. It also suggests that if MIGI had continued for 3 years it may have achieved results more akin to the Child and Adolescent Trial for Cardiovascular Health (CATCH) project.

What was achieved, however, does not translate into a

meaningful contribution toward recommended children's PA requirements. Since the proportion of MVPA at baseline was only 7.04 minutes of an average lesson of 21.2 minutes, the increase of 4.53% in MVPA only translates to an extra 58 seconds per lesson. Even if a child participated in three PE lessons per week, they would only partake in approximately three more minutes of MVPA.

Our finding that MVPA levels were significantly higher for boys than girls supports the findings of McKenzie et al. [34]. However, McKenzie claimed the result was due to boys being more active than girls during free play opportunities within PE lessons. While our study confirms the findings of others, that boys are more active than girls during free play in the playground [32,42,58], such free playtime was almost nonexistent during PE lessons in MIGI (1.3% of lesson time) compared to the 5.2% reported by McKenzie et al. [34]. This suggests other factors may be responsible for boys' greater overall activity in MIGI. Further research into such gender differences may highlight strategies for enhancing activity levels of girls during PE lessons.

Likewise the impact of teacher gender on children's activity levels is also worthy of further investigation. Only one other study could be located, regarding influence of teacher gender on PE lessons, which examined teacher time spent on varying lesson contexts and found there were no significant differences between the lessons taught by male and female teachers in any lesson context [59]. Most other major studies on levels of PA among primary school children in PE lessons have not recorded information on teacher gender [32,35,58,60,61].

Improved FMS or increased PA

In aiming to increase PA levels in PE lessons, it was thought that a decrease in the proportion of lesson time spent in management/instruction and/or an increase in the time spent in fitness would produce the desired result. What actually occurred was that the proportion of management/instruction did not change, skill increased, and fitness and games decreased. We had also envisaged that if teachers structured each context stream to promote more PA, this would also effectively raise the PA of the lesson. This did not occur, with fitness context being the only context to become more active (possibly due to one of the MIGI emphases, which was to increase warm-up and cool-down activities). These results are both possible explanations for the small nonsignificant increase in MVPA.

Increased time spent in skill context is probably reflective of teachers putting more emphasis on teaching FMSs, and may underlie the impressive results in FMS mastery. That skill context did not become more active, and that time spent in fitness decreased, is disappointing as it suggests that the objective of improving children's skills may have countered that of increasing PA. Less time spent on games could also be because of the increased emphasis on skill development but can be considered a positive outcome in that game context was not as active as skill, and does not have the same emphasis on the learning of FMSs. That the proportion of time spent on management/instruction did not change highlights that it may be difficult for teachers to reduce the time spent on these aspects of PE teaching. We recommend further research to establish the minimum necessary time teachers might spend on management/instruction.

Study limitations

A potential and unavoidable limitation of the study design is that most schools required MIGI to inform them of what lessons were to be observed prior to the observation. This theoretically gave the schools a chance to structure the lesson differently to a 'typical' lesson. However, even if teachers occasionally restructured their lessons, there was little likelihood of systematic bias in measured variables due to (1) the range of school type and setting, (2) the lengthy time period of observations (4 months), and (3) that teachers were not aware of what we were measuring, and (4) how the measurement was performed.

An improvement to the study, had more resources been available, would be to have recorded and analysed primary lesson focus. MIGI only recorded broad context categories of "fitness," "skill," "game," "management/instruction," and "other," rather than detail about the type of activity the children engaged in, e.g., soccer, dance, or cricket. Such information may have enabled us to discover which particular games, skill practice activities, or fitness activities have higher PA levels. This information would be invaluable to schools wishing to increase PA levels and is recommended as a focus for future research.

Conclusions and implications for future intervention and research

The U.S. National objective is that regardless of the focus of the lesson, the aim should be for children to be engaged in MVPA for at least 50% of the lesson [9]. MIGI was aiming toward this goal, primarily by following the suggestion of Simons-Morton et al. [36] that PE lessons should be restructured to spend less time in management/instruction and more time generally in fitness activity.

While these are fine recommendations in principle, MIGI has demonstrated that there is a dilemma between keeping children active in PE and furthering development of FMS. Theoretically, it is possible to utilise strategies that work on skill development and keep PA levels high (i.e., circuits/tabloids). However, furthering skill development will also require a proportion of time spent on skill instruction, which can lower PA levels. Further investigation is needed to explore how to improve children's mastery of FMS within a PE lesson without compromising the PA levels of children.

In summary, while PE lessons can be improved and

restructured to become more active, future health promotion interventions must weigh up what resources will provide the best value for money in terms of gain that *significantly* contributes to children meeting recommended levels of PA. In Australia, no health promotion intervention as large as the CATCH program [47] has ever been implemented. If projects are unlikely to be on such a scale, then it may be more useful to concentrate on increasing PA in other ways.

Increasing the number of PE lessons per week may be a more appropriate target, as an extra daily fitness lesson of 20 minutes would possibly achieve a greater change in terms of minutes per week of PA than raising the PA level within the lesson. In this we concur with the recommendations of Kemper [62], from a review of research into the role of paediatric exercise, that we need to ". . . enhance current levels of physical activity by increasing the number of lessons of PE to at least one lesson per school day. At the same time the quality of the PE lesson has to be changed placing more emphasis on improving physical skill development and on motivating children to be active in their free time." It is therefore recommended that future interventions focus on encouraging and supporting schools to increase the total weekly time spent in PE lessons with a lesson focus on improving children's FMS mastery.

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References

[1] Sallis JF, Patrick K. Physical activity guidelines for adolescents: consensus statement. Pediatr Exerc Sci 1994;6:302–14.
[2] Corbin CB, Pangrazi RP. Physical activity for children. A statement of guidelines. Oxon Hill: Council for Physical Education for Children (COPEC), 1998.
[3] Pangrazi RP. Promoting physical activity for youth. J Sci Med Sport 2000;3:280–86.
[4] National Health and Medical Research Council. Acting on Australia's weight: a strategic plan for the prevention of overweight and obesity. Canberra: National Health and Medical Research Council, 0644475935, 1997.
[5] Rudloff LM, Feldmann E. Childhood obesity: addressing the issue. J Am Osteopath Assoc 1999;99:S1–S6.
[6] Booth ML, Macaskill P, Lazarus R, Baur LA. Sociodemographic distribution of measures of body fatness among children and adolescents in New South Wales, Australia. Int J Obes 1999;23:456–62.
[7] Stone EJ, McKenzie TL, Welk GJ, Booth ML. Effects of physical activity interventions in youth. Review and synthesis. Am J Prev Med 1998;15:298–315.
[8] Cale L, Almond L. Physical activity levels of young children: a review of the evidence. Health Educ J 1992;51:94–9.
[9] US Department of Health and Human Services. Physical activity and health: a report of the surgeon general. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 1996.
[10] Department of Health and Human Services, Department of Education. Promoting better health for young people through physical activity and sports. A report to the president from the secretary of education. Fall 2000. Silver Spring: Department of Health and Human Services, Department of Education, Centers for Disease Control, 2000.
[11] Booth ML. What proportion of Australian children are sufficiently physically active? Med J Aust 2000;173:S6–S7.
[12] Blair SN, Kampert JB, Kohl HW, Barlow CE, Macera CA, Paffenbarger RS, et al. Influences of cardiorespiratory fitness and other precursors on cardiovascular disease and all-cause mortality in men and women. JAMA 1996;276:205–10.
[13] Blair SN, Kohl HW, Paffenbarger RS, Clark DG, Cooper KH, Gibbons LW. Physical fitness and all-cause mortality: a prospective study of healthy men and women. JAMA 1989;262:2395–401.
[14] Goran MI, Reynolds KD, Lindquist CH. Role of physical activity in the prevention of obesity in children. Int J Obes 1999;23:S18–S33.
[15] Takada H, Harrell J, Deng S, Bandgiwala S, Washino K, Iwata H. Eating habits, activity, lipids and body mass index in Japanesse children: the Shiratori Children study. Int J Obes 1998;22:470–6.
[16] Gelermajer DS. What are the cardiovascular risk factors for Australian children and is there a need for concern? Med J Aust 2000;173: S11–S12.
[17] Rocchini AP. Raising heart healthy children. Pediatr Int 1999;41: 597–602.
[18] Falkner B, Michel S. Obesity and other risk factors in children. Ethn Dis 1999;9:284–9.
[19] Cameron M, MacDougall C. Crime prevention through sport and physical activity. Canberra: Australian Institute of Criminology, 2000.
[20] Donnelly JE, Jacobsen DJ, Whatley JE, Hill JO, Swift LL, Cherrington A, et al. Nutrition and physical activity program to attenuate obesity and promote physical and metabolic fitness in elementary school children. Obes Res 1996;4:229–43.
[21] Baur LA. How do we define or diagnose overweight and obesity in childhood? Med J Aust 2000;173:S8.
[22] Andersen RE, Crespo CJ, Bartlett SJ, Cheskin LJ, Pratt M. Relationship of physical activity and television watching with body weight and level of fatness among children. Results from the third national health and nutrition examination survey. JAMA 1998;279:938–42.
[23] Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, et al. Physical activity and public health: a recommendation from the centers for disease control and prevention and the American college of sports medicine. JAMA 1995;273:402–7.
[24] Cavill N, Biddle S, Sallis JF. Health enhancing physical activity for young people: statement of the United Kingdom expert consensus conference. Pediatr Exerc Sci 2001;13.
[25] Board of Studies NSW. Personal development, health and physical education K-6: syllabus. Sydney: Board of Studies NSW, 1999.
[26] Malina RM. Tracking of physical activity and physical fitness across the lifespan. Res Q Exerc Sport 1996;67:S48–S57.
[27] Okely AD. The relationship of participation in organised sports and games, nonorganised physical activity, and cardiorespiratory endurance to fundamental motor skill ability among adolescents. Wollongong: University of Wollongong, 1999.
[28] Thomas JR, French KE. Gender differences across age in motor performance: a meta-analysis. Psychol Bull 1985;98:260–82.
[29] Wickstrom R. Fundamental Motor Patterns. Philadelphia: Lea & Febiger, 1983.

[30] Raudsepp L, Paasuke M. Gender differences in fundamental movement patterns, movement performances, and strength measurements in prepubertal children. Pediatr Exerc Sci 1995;7:294–304.
[31] Booth M, Macaskill P, McLellan L, et al. NSW Schools Fitness And Physical Activity Survey 1997. Sydney: NSW Department of Education and Training, 1997.
[32] Sarkin JA, McKenzie TL, Sallis JF. Gender differences in children's physical activity levels in a structured and unstructured setting. Med Sci Sports Exerc 1994;26(Suppl):S143.
[33] Barnett L, van Beurden E, Zask A, Brooks LO, Dietrich UC. How active are rural children in Australian physical education? Journal of Science & Medicine in Sport 2002; 5:253–265.
[34] McKenzie TL, Feldman H, Woods SE, Romero KA. Children's activity levels and lesson context during third-grade physical education. Res Q Exerc Sport 1995;66:184–93.
[35] Luepker RV, Perry CL, McKinlay SM, et al. Outcomes of a field trial to improve children's dietary patterns and physical activity: the child and adolescent trial for cardiovascular health (CATCH). JAMA 1996; 275:768–76.
[36] Simons-Morton BG, Taylor WC, Snider SA, Huang IW, Fulton JE. Observed levels of elementary and middle school children's physical activity during physical education classes. Prev Med 1994;23:437–41.
[37] Simons-Morton BG, Taylor WC, Snider SA, Huang IW. The physical activity of fifth-grade students during physical education classes. Am J Public Health 1993;83:262–4.
[38] Department of Education Victoria. Fundamental motor skills: a classroom manual for teachers. Melbourne: Community Information Service, Department of Education, Victoria, 1996.
[39] Department of Education and Training NSW. Get skilled: get active. Fundamental movement skills resource for primary schools. Sydney: NSW Department of Education and Training, 2000.
[40] Department of Education Western Australia. Fundamental movement skills: assessment and support package. Perth: Department of Education, Western Australia, 2000.
[41] Booth ML, Okley T, McLellan L, et al. Mastery of fundamental motor skills among New South Wales school students: prevalence and sociodemographic distribution. J Sci Med Sport 1999;2:93–105.
[42] Zask A, van Beurden E, Barnett L, Brooks LO, Dietrich UC. Active school playgrounds—myth or reality? Results of the "Move it Groove it" project. Prev Med 2001;33:402–8.
[43] WHO Health and Welfare Canada CPHA. Ottawa Charter for Health Promotion. Ottawa: WHO, 1986.
[44] Wright J, Okely AD. Gendered measures: a feminist analysis of fundamental motor skills testing. Aukland, New Zealand: New Zealand Conference on Health and Physical Education; 1997, July.
[45] Holland B. Development and validation of an elementary motor performance test for students classified as non-handicapped, learning disabled or educable mentally impaired. Michigan: Michigan State University, 1986.
[46] McKenzie TL, Sallis JF, Nader PR. SOFIT—System for observing fitness instruction time. J Teach Phys Educ 1991;11:195–205.
[47] McKenzie TL, Strikmiller PK, Stone EJ, et al. CATCH: physical activity process evaluation in a multicenter trial. Health Educ Q 1994;1994:S73–S89.
[48] Fleiss JL. Statistical methods for rates and proportions. 2nd ed. New York: John Wiley and Sons, 1981.
[49] Snijders TAB, Bosker R. Multilevel analysis: an introduction to basic & advanced multilevel modelling. London: Sage Publications, 1999.
[50] Goldstein H. Multilevel statistical models. New York: Wiley, 1995.
[51] Goldstein H, Rasbash J. Improved approximations for multilevel models with binary responses. J R Stat Soc 1996;159:505–13.
[52] van Beurden E, Zask A, Barnett LM, Dietrich UC. Fundamental movement skills—how do primary school children perform? The "Move it Groove it" program in rural Australia. J Sci Med Sport 2002;5:244–52.
[53] Barnett L, van Beurden E, Zask A, Brooks L. Move It Groove It. Lismore: Health Promotion Unit Division of Population Health Northern Rivers Health Service, 2001.
[54] Walkley J, Holland B, Treloar R, Probyn-Smith H. Fundamental motor skill proficiency of children. ACHPER Natl J 1993;40:11–4.
[55] Sallis JF, Alcaraz JE, McKenzie TL, Hovell MF. Predictors of change in childrens' physical activity over 20 months. Variations by gender and level of adiposity. Am J Prev Med 1999;16:222–9.
[56] Hands B, Larkin D. Gender bias in measurement of movement. ACHPER Health Lifest J 1997;44:12–6.
[57] Butcher JE, Eaton WO. Gross and fine motor proficiency in preschoolers: relationships with free play behaviour and activity level. J Hum Move Stud 1989;16:27–36.
[58] McKenzie TL, Marshall SJ, Sallis JF, Conway TL. Leisure-time physical activity in school environments: an observational study using SOPLAY. Prev Med 2000;30:70–7.
[59] McKenzie TL, Alcaraz JE, Faucett FN, Sallis JF. Effects of physical education program on children's manipulative skills. J Teach Phys Educ 1997;17:327–41.
[60] Sallis JF, McKenzie TL, Alcaraz JE, Kolody B, Faucett N, Hovell MF. The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. Sports, play, and active recreation for kids. Am J Public Health 1997;87: 1328–34.
[61] Sallis JF, Patterson TL, McKenzie TL, Nader PR. Family variables and physical activity in pre-school children. J Dev Behav Pediatr 1988;9:57–61.
[62] Kemper HCG. Role of the pediatric exercise scientist in physical education, sports training and physiotherapy. Int J Sports Med 2000; 21:S118–S124.