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Promoting motor skills in low-income, ethnic children: The Physical Activity in Linguistically Diverse Communities (PALDC) nonrandomized trial

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Abstract
This study reports the long-term effects of a professional learning program for classroom teachers on fundamental motor skill (FMS) proficiency of primary school students from ethnically diverse backgrounds. Design: A cluster non-randomized trial using a nested cross-sectional design. Methods: The study was conducted in 8 primary schools located in disadvantaged and culturally diverse areas in Sydney, Australia. The intervention used an action learning framework, with each school developing and implementing an action plan for enhancing the teaching of FMS in their school. School teams comprised 4-5 teachers and were supported by a member of the research team. The primary outcome was total proficiency score for 7 FMS (run, jump, catch, throw, kick, leap, side gallop). Outcome data were analyzed using mixed effects models. Results: Eight-hundred and sixty-two students (82% response rate) were assessed at baseline in 2006 and 830 (82%) at follow-up in 2010. Compared with students in the control schools, there was a significantly greater increase in total motor skill proficiency among children in the intervention schools at follow-up (adjusted difference = 5.2 components, 95%CI [1.65, 8.75]; p. = 0.01) and in four of the seven motor skills. Conclusions: Training classroom teachers to develop and implement units of work based around individual FMS is a promising strategy for increasing FMS among ethnically diverse children over an extended period of time.

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TITLE

Promoting motor skills in low-income, ethnic children: The Physical Activity in Linguistically Diverse Communities (PALDC) nonrandomized trial

STRUCTURED ABSTRACT

Objectives

This study reports the long-term effects of a professional learning program for classroom teachers on fundamental motor skill (FMS) proficiency of primary school students from ethnically diverse backgrounds.

Design

A cluster non-randomised trial using a nested cross-sectional design.

Methods

The study was conducted in 8 primary schools located in disadvantaged and culturally diverse areas in Sydney, Australia. The intervention used an action learning framework, with each school developing and implementing an action plan for enhancing the teaching of FMS in their school. School teams comprised 4-5 teachers and were supported by a member of the research team**.** The primary outcome was total proficiency score for 7 FMS (run, jump, catch, throw, kick, leap, side gallop). Outcome data were analysed using mixed effects models.

Results

Eight-hundred and sixty-two students (82% response rate) were assessed at baseline in 2006 and 830 (82%) at follow-up in 2010. Compared with students in the control schools, there was a significantly greater increase in total motor skill proficiency among children in the intervention schools at follow-up (adjusted difference=5.2 components, 95%CI [1.65, 8.75]; P=0.01) and in four of the seven motor skills.

Conclusions

Training classroom teachers to develop and implement units of work based around individual FMS is a promising strategy for increasing FMS among ethnically diverse children over an extended period of time.

KEY WORDS: fundamental movement skills; physical education; physical fitness; disadvantaged; culturally diverse.

INTRODUCTION

Fundamental motor or movement skills (FMS) are defined as an organized series of basic movement patterns in which two or more body segments are combined [1]. They are grouped into locomotor, object control, and stability skills and include running, jumping, catching, throwing, balancing, and twisting. These skills are considered the foundation of human movement as they provide the basis for many of the specialized skills used in popular games and sports [2]. FMS have also been shown to be related to several health outcomes such as higher levels of physical activity, physical self-esteem, perceived competence, cardiorespiratory fitness, and lower levels of adiposity[3-5]. For these reasons, FMS are considered an important component of primary school physical education curricula.

Where representative data exist, FMS proficiency levels have been shown to be lower than what might be expected for boys and girls of specific ages. In Australia, Hardy and colleagues [6] found that just under two-thirds of boys and nearly all girls (96%) were not proficient in seven common FMS assessed by the age of 11 years (run, vertical jump, side gallop, leap, catch, throw, and kick). Similar results have been found in Irish children. O'Brien and Colleagues reported that only 11% of 12- and 13-year olds were proficient in nine FMS [7]. Low proficiency levels are even more common among primary school children from low socio-economic and ethnic backgrounds [8]. In Australia, these children are generally between one-and-a-half to three times less likely to be as proficient as children from middle-to-high socioeconomic statuses and from English-speaking backgrounds [6]. These data reinforce the need to provide additional support to children from low income and non-English speaking backgrounds to increase their FMS proficiency.

Most physical education (PE) in Australian primary schools is taught by classroom teachers. In the state of New South Wales (NSW) (pop. 7.4 Million, June 2013)**,** around 75% of primary schools use classroom teachers to teach PE [9]. Many of these teachers have undergone little training in how to observe and teach FMS as part of their pre-service university training. As a result, these teachers commonly report not feeling confident or competent in teaching FMS [10]. It has been shown that training classroom teachers can result in significantly greater improvements in FMS compared with non-trained classroom teachers [11]. To our knowledge, no studies have examined the efficacy of training classroom teachers to teach FMS in schools with a high proportion of children from low income and ethnic backgrounds, over an extended intervention period (greater than three years) and targeted both locomotor and object control skills [12].

Using a Quality Teaching and Learning Materials (QTLM) model and an Action Learning framework [13], this study aimed to build the capacity of primary schools with a high proportion of children from low income and ethnic backgrounds, to promote children's competency in FMS. Classroom teachers were trained to develop and implement lessons that met curricular outcomes and provided developmentally appropriate physical activity experiences for students. The QTLM is a school-based professional development model that uses the action learning principles proposed by Kemmis and McTaggart's [14]. It provides a structured approach to school-based professional development where a group of schools all work on the same area of change. [15] The purpose of this paper was to report the long-term impact of this school-based intervention on the FMS of students, in primary schools with a high proportion of students from low-SES and culturally diverse backgrounds.

METHODS

The reporting of this study has been according to the TREND Statement [16], CONSORT 2010 checklist [17], and CONSORT statement: extension to cluster randomised trials [18].

The Physical Activity among Linguistically Diverse Communities (PALDC) study was a non-randomised cluster trial, using a nested cross-sectional design [19] and comparing a whole-of-school intervention with an active control condition. This design was selected over a nested cohort design because the aims of the PALDC study were to bring about environmental-level rather than individual-level changes [20]. Participants were recruited from eight government (public education) primary schools in Western Sydney, Australia. These districts were pre-selected by the NSW Department of Education and Communities (DEC), and the primary schools within each district were selected on the basis of containing schools with a high proportion of students from culturally diverse backgrounds. Within each school, all students participated in the intervention, but only students in Grades 1, 3 and 5 were assessed at baseline and Grades 2, 4, and 6 at 44-month follow-up. As a nested cross-sectional study, this meant different students were assessed at each time point.

The study was approved by the Human Research Ethics Committee at the University of Wollongong (HE06/182) and the State Education Research Approval Process (SERAP) of the NSW DEC. Active consent from parents/carers was required for the students to participate in the study and information sheets and consent forms were translated into Arabic and other languages, as required. Data were collected within each school setting. Recruitment of schools occurred in May and June 2006. The funding organisation had no role in the collection, analysis or

112 interpretation of data. It was a requirement for them to approve the manuscript prior to
113 publication.
114
115 The PALDC intervention took a *whole-of-school* health promotion approach [21]. Using an Action
116 Learning framework [15], each school developed an action plan for the intervention targeting the
117 structure and delivery of FMS and school sport (with a focus on initiating a sustainable change in
118 the delivery of FMS in their school context), modifying the physical and social environment in
119 the school, and developing links with the home and local community. These action plans were
120 similar across all schools. Schools nominated a team of 4-5 teachers (one per Stage [Grades K, 1-
121 2, 3-4, and 5-6] plus an Executive Teacher [Principal or Deputy Principal]) to be part of the
122 school "team". One member of the school team was designated the "Program Champion." Their
123 role was to be the school liaison for the research team for the project and to be the team leader
124 within the school for the project. A member of the research team was assigned to each school
125 and acted as a "critical friend." This involved helping identify relevant research and resources for
126 the development and implementation of the school's action plan, explaining the rationale for the
127 project to other school staff, and providing feedback on the implementation process to the school
128 team.
129
130 School teams participated in three workshops supported by personnel from the NSW DEC
131 Curriculum K-12 Directorate. This included a one-day planning workshop in Term 2, 2006 as an
132 introduction to the PALDC Project and the QTLM model and a two-day workshop in Term 3,
133 2006 for schools to develop an action plan that would drive sustainable change in the area of
134 FMS and that met the needs of the students at their school. An additional final sharing workshop

in March 2010 was held to provide an opportunity for schools to share the progress of the program in their school towards the end of the project. All members of the school team in each school attended the first two workshops and two members of each school team attended the final sharing workshop. Interviews were held with the Principal and teachers in the control school to gauge if they knew about the interventions occurring in the PALDC schools. None of the staff were aware of the details of the intervention and there was no threat of contamination.

Intervention schools also worked as part of a cluster group on this project. This provided opportunities for the schools to network and share ideas and to work towards the goals of whole-of-school change in teaching and learning in FMS, increasing opportunities for students to be more active throughout the school day, and strengthening community partnerships and communication regarding healthy and active lifestyles.

The implementation plan for this Project was based on the Quality Teaching and Learning Materials (QTLM) [22] model developed by the NSW Department of Education and Communities [13]. QTLM is a process for effecting school change based on a model of action research. The QTLM model allowed school teams to work towards significant whole-of-school change by building a supportive leadership team to facilitate identified change.

The control schools were asked to continue with their current PE programs and were provided with information and professional development at the completion of the follow-up data collection period. In addition, a member of the research team (ADO) met with the Principal of each of the four control schools and offered them professional development and resources in an

158 area not related to PE. Each school identified an area of concern such as bullying, peer support
159 and mentoring for beginning teachers. The research team and Curriculum Support Directorate of
160 the NSW DEC provided this professional development.
161
162 Baseline data were collected between June and September 2006 and 44-month follow-up data
163 were collected between February 2010 and March 2010. At each time point, a team of up to 19
164 teachers, blinded to group allocation, were seconded to the project as data collectors. The data
165 collectors attended a five-day orientation and training program prior to data collection. This
166 program provided background and justification for the study, and training in anthropometry,
167 questionnaire administration, FMS assessments and measurement of cardiorespiratory
168 endurance. The field teams were also provided with a minimum of two practice days in schools
169 prior to data collection. All data collectors were required to reach 99% inter-observer agreement
170 for all anthropometry measures and 80% inter-observer agreement for all FMS assessment
171 against pre-coded videotapes. [23]
172
173 The primary outcome for the study was FMS proficiency. Children performed seven FMS (sprint
174 run, vertical jump, catch, over-arm throw, kick, leap, and side gallop), and these were measured
175 using the *Get skilled: Get active* process-oriented checklists [24, 25]. The skills assessed form the
176 basis of common activities and sports played by children. FMS proficiency was assessed by
177 scoring each component of each skill as present or absent. Briefly, children performed each skill
178 the required number of times according to the instructions. If they demonstrated the skill
179 component consistently (defined as 80% of the time for the sprint run and as four out of five
180 trials for the other skill components), they were recorded as possessing that skill component. The

number of components of each skill correctly demonstrated by each child was summed to give a score for each skill. There were five components assessed for the side gallop and six components for all other skills. The scores for all seven skills were also added to calculate the total FMS proficiency. The maximum score possible for the total score was 41. Detailed information on the validity and reliability of the skills and their components can be found in the supplementary file.

For students in Grades 3 and 5 at baseline and in Grades 4 and 6 at follow-up, cardiorespiratory endurance (secondary outcome) was assessed using the Multistage Fitness Test (PACER) [26]. Students were required to run and shuttle back between two lines placed 20m apart, at increasing speeds. Scores were recorded as the level and shuttle reached in the test and converted to the number of laps completed to provide a continuous variable for analyses.

Demographic data were collected from consent forms and parent questionnaires, and included language most spoken at home (to determine ethnicity), postcode of residence, the highest level of education completed by each parent, and the sex and date of birth of their child. Postcode of residence was used as a proxy for socioeconomic status (SES), based on the Australian Bureau of Statistics' Index of Relative Socioeconomic Disadvantage, and was used to rank children in deciles of SES [27].

Interviews were conducted with staff in each intervention school during 2010 (post-intervention) to gather their feedback on the role the PALDC project had on their understanding of the change process in schools and their understanding of the PE curriculum and on FMS. Notes were taken by the Project Officer during these interviews, written up, and compared across schools to

identify common themes that emerged for each of these areas across the intervention schools. Interview data were supplemented with informal observational data collected by research staff on the effect of the intervention on the school environment and on links with the home and local community. The notes were also analysed thematically to provide supporting evidence on the effectiveness of the intervention on these aspects of their school action plan. Critical friends also documented the professional learning provided to staff in each of the schools, and what occurred in response to the professional learning in terms of the writing and implementation of the specific action plans that each school was asked to develop.

School allocation to intervention or control was done by the NSW DEC, independent of the research team. To minimize potential bias due to non-randomization, intervention schools were matched as closely as possible with control schools on demographic variables such as student population, proportion of students from ethnic and low-income backgrounds, and geographic location of the school (located in the same District). None of the researchers involved in working with the intervention schools as critical friends were involved in the assessments.

As allocation to intervention or control group was at the school level, the analysis was performed using a mixed effects model to account for random subject effects within each group [16].

Data were analysed using the procedures outlined in Murray [19] for a nested cross-sectional design. This model has a fixed effect for group (control or intervention), school, and time (baseline or follow-up) as a categorical variable. School grade, sex and the ethnicity of students (defined as language spoken most at home) were modelled as covariates. The main estimate of

interest (group by time interaction) was also included as a fixed effect. Time and the time-by-school (group) terms were modelled as random effects to account for the school level clustering. The PROC MIXED procedure in SAS v9.1 (SAS Institute Inc. Cary NC) was used for all analyses. Data were analysed from November 2011 to June 2012.

RESULTS

All four schools initially approached to be intervention schools in the project agreed and nine schools were approached for the four matched control schools. All eight schools (four intervention and four control) that participated in the baseline assessments from June to September 2006 were followed up between February and March 2010. A flow diagram of study recruitment is shown in Figure 1.

A total of 1053 students and their parents were approached at baseline. Of these, 862 students completed baseline assessments (82% response rate) with 527 parents returning questionnaires (50% response rate). A total of 1016 students and their parents were approached at 44-month follow-up. Of these, data were collected from 830 students (82% response rate) with 301 parents completing questionnaires (30% response rate).

Demographic characteristics of the students at baseline and follow-up are presented in Table 1 and show that the sample was ethnically diverse and from low-income communities. Approximately one-quarter of students were from English-speaking backgrounds, well below that reported nationally (84%) [27]. Just over half the sample was from Middle-Eastern speaking backgrounds and around one-fifth was from Asian-speaking backgrounds. These proportions

were well above those reported nationally (1.2% for Middle-Eastern and 2.3% for Asian backgrounds) [27].

Less than half of parents surveyed at baseline had completed high school (Grade 12) and this proportion, whilst slightly higher at follow-up, was still below 60%. Around one-third of parents had completed Grades 9, 10, or 11, whilst between 10% and 20% had either never attended school or only had a Grade 8 education level.

The project was also successful in recruiting low-income families. Almost all the sample (99% at baseline and 97% at follow-up) were in the two lowest deciles on the Australian Bureau of Statistics' Index of Relative Socioeconomic Disadvantage.

Table 2 shows the primary and secondary outcomes for the intervention and control groups at baseline and follow-up. Cohen d's showed that there were small beneficial effects on all FMS outcomes, with these being statistically significant for total FMS score ($p=0.009$), sprint run ($p=0.001$), vertical jump ($p=0.006$), catch ($p=0.02$) and the leap ($p=0.004$). The results for the catch were due to a smaller decline in the intervention group compared with the control group over the intervention period. The effect size for cardiorespiratory endurance was small and not statistically significant.

Analyses of the interview data collected post-intervention indicated that the intervention was somewhat successful in increasing teachers' understanding of the change process and of the PE curriculum and FMS in their schools. These data showed that the most success in understanding

the change process was among teachers who were part of the school team. These teachers reported being more aware of the steps required to bring about change in their school. However, they believed that the project was not generally successful in enhancing other teachers' understanding of the change process in their schools. In addition, teachers who were part of their school committee identified through the interviews a number of barriers they encountered to bringing about change in their school. These included a lack of support from the school executive, especially the Principal, the high turnover in staff over the four years of the project, negative attitudes towards change from some of the staff, and the lack of equipment and facilities available.

In all schools, the project team completed some form of professional learning in writing units of work and in how to teach FMS. This was delivered by a Senior Curriculum Officer from the NSW DEC and was well received by school staff. In three of the schools, a Scope and Sequence (overview of content to be covered in a specific key learning area, in this case physical education) was written for each stage and the staff wrote units of work for each FMS. In these same three schools, there was evidence that staff were using these units and teaching FMS on a regular basis. In addition, most staff at these schools were more aware of explicit teaching points relating to development of FMS as a result of the project.

DISCUSSION

The purpose of this study was to assess the effect of an FMS intervention, which focused on the up-skilling of classroom teachers in FMS in ethnically diverse Australian primary schools. Overall, student response rates were high, especially given the ethnic diversity of the sample and

the need for written parental consent for students to participate. Compared with children allocated to control schools, children who participated in the PALDC intervention experienced small beneficial effects on overall skill proficiency and on four of the seven individual fundamental movement skills (sprint run, vertical jump, catch, and leap).

The effect sizes found are similar to that found in a recent systematic review for overall FMS proficiency, and for locomotor and object control skills, [28] but slightly smaller than the effect sizes found in another systematic review [11]. The reason for the smaller effect sizes than the Morgan review could be that this review included some studies that were in community-based settings (such as after school programs). In addition, several of the studies in the review were implemented by trained PE teachers or personnel external to the school, such as coaches or researchers.

The results compare favorably with other primary school interventions designed to improve children's FMS through training classroom teachers. McKenzie et al. [29] reported similar effect sizes for the catch and kick (0.29 and 0.09, respectively), a larger effect size for the over-arm throw (0.27) and a slightly smaller effect size for total FMS proficiency (0.20). While their intervention was with a similar number of students and a similar duration, they used product rather than process methods to assess FMS, and only examined three object control skills, so the total FMS scores are not comparable. The lower finding for the over-arm throw in our study is interesting and may be explained by differences in the way the skill was assessed. McKenzie and colleagues tested the ability of children to hit a target when throwing (accuracy test; i.e., product-

318 oriented assessment) whereas this study focused on technique when throwing an object as far as
319 possible (i.e., process-oriented assessment).
320
321 We found the differences between intervention and control groups were highest for the catch and
322 the locomotor skills (sprint run, vertical jump, leap, and side gallop, all had effect sizes >0.20).
323 These findings are similar to those reported by van Beurden et al. [30] who found the largest
324 differences between intervention and control groups were for the sprint run, side gallop, catch,
325 and vertical jump. It could be that these skills do not require specialized equipment, in our
326 experience are easier for classroom teachers to learn and hence they feel more confident in
327 teaching these skills. This may be due to the overwhelming majority of primary school teachers
328 being female, and these five skills (catch, sprint run, vertical jump, leap, and side gallop) being
329 the skills in which females have the highest levels of proficiency based on data from the NSW
330 Schools Physical Activity and Nutrition Survey.[31]
331
332 We found the smallest differences between intervention and control groups for the over-arm
333 throw and kick. This is somewhat similar to van Beurden and colleagues [30] who reported smaller
334 improvements for the over-arm throw and McKenzie et al. [29] who found smallest improvements
335 in the kick. Reasons for this may be that the over-arm throw and kick are more complex skills,
336 with a greater number of components and a movement pattern that occurs very quickly compared
337 with the other skills [32]. This may also be a reason why these skills typically show lower
338 proficiency levels [6]. Because of this higher level of complexity in the throw and kick, we have
339 found that teachers may also require more training in teaching these skills. In the context of how
340 children are taught to develop proficiency in these skills, it is important for them to throw or kick

a ball as hard as they can for components such as the follow through, and rotation of the body during the preparatory phase to develop [1]. Schools may not have had the physical space, nor teachers with the confidence to allow students to do this safely in a PE lesson.

The null finding for cardiorespiratory endurance was not surprising given that the intervention content did not focus on increasing physical activity, but rather on FMS. The decline seen in cardiorespiratory fitness levels, especially in the control group, could be due to the time of year assessed – follow-up was immediately after a 6-week summer holiday break – which has been shown to adversely effect children's fitness levels.[33] Interventions that do target increasing physical activity in primary schools have been shown to be effective in increasing student fitness levels [34].

Factors that may have contributed to significant improvements seen for total FMS include schools being able to design and implement learning experiences that were most appropriate for their school (not a "one-size-fits-all" approach). There was considerable variation in how intervention schools implemented their programs. One school delivered the PALDC intervention for 15-minutes directly after morning recess, three times a week and involved the whole school. Another school structured their units of work by stages, (adjacent grades; e.g., Grades 1 & 2, 3 & 4, 5 & 6) with lessons scheduled twice a week for 30 minutes at a time. A third school, with approximately 800 students, wrote units of work for each Grade and organized their timetable so that all classes in that Grade (i.e., between 4 and 6 classes) participated at the same time. There was no evidence that the fourth intervention school developed new units of work or changed their current practice. This was due to the high turnover of staff on the school team and lower

levels of support and engagement from the school principal. The school also felt that they were doing enough to promote FMS through their sport program; however, our observations and discussions with other staff suggest this program consisted of children participating in sport with no structured lessons or specific teaching and instruction.

A common element in all implementation models was multiple classes being timetabled at the same time. School teams did this as they believed it would facilitate greater participation by all classroom teachers in a specific Grade or Stage. It allowed the pooling of resources such as staff, the option of including a range of learning experiences (stations, partner activities), and ability grouping of students for some activities. It also made teachers more accountable because they were being relied on by the other teachers to ensure the lessons could be implemented as planned. Finally, teachers could usually self-select an activity they felt most comfortable teaching from a number that were planned to be conducted.

Another factor that enhanced implementation was the “ownership” staff felt with the program. As each school team was responsible for developing their own program, they felt some responsibility to implement it on a whole-of-school basis. As a result of progressing through the Quality Teaching and Learning Materials process, staff also felt excited that they now had an action plan for improving FMS. That is, a model they could follow to develop units of learning over a calendar year. However, it was mostly the members of the school team who benefitted from the intervention and ways need to be found to better engage other teachers in the schools to be trained and implement the action plan developed for their school.

The role of the school Principal to support interventions such as PALDC cannot be underestimated. Their support took a number of roles, including being part of the school action team, providing funding to purchase equipment, and providing relief from teaching for the Program Champion, allowing them the time to work on the project and meet with their critical friend. The Principal also has the ability to ensure the sustainability of the project through incorporating the action plan for the project into the School Plan. This would also guarantee the commitment and responsibility of all staff to whole school change. However it should also be acknowledged that the principal could be a barrier to the success of the intervention, as was the case in at least one of the schools.

Observation and interview data from schools showed that minimal changes were made to the links between the school and the home and local community. Some of these changes were embedded into aspects of the school life, such as parent newsletters. In addition, teachers reported anecdotally that they believed there had been more parents involved in school sport and fitness activities and more information provided to parents around FMS and physical activity as a result of the PALDC intervention. The main barrier to change reported by teachers was the high number of parents who did not speak English, and the high levels of television viewing and internet use among families.

Strengths of this study include the recruitment of a large sample of children from ethnically diverse and low-income families and the high response rates achieved. Limitations include the inability to examine changes within individual students due to the longer follow-up period and that schools were not able to be randomly assigned and as such were matched. It was also

beyond the resources of the PALDC intervention to systematically and independently collect data on the fidelity of the intervention developed by each school, to video assess the FMS – which would have allowed greater measurement scrutiny, or to include a stability skill as one of the seven assessed. A further limitation was the lack of an objective measure of changes in physical activity, which would have provided useful information on the role of increasing FMS in the promotion of school-based physical activity. Given the relationship between FMS and physical activity, these results have the potential to impact on physical activity participation.

CONCLUSION

In conclusion, our research shows that a low-cost approach involving a partnership, between the public education sector, selected schools, and researchers, can be effective. Interventions that require minimal resources and seek to up-skill classroom teachers within the schools to develop and implement developmentally appropriate lessons to improve FMS hold promise to improve classroom teachers' delivery of good quality FMS lessons, and can have an effect on targeted outcomes.

Practical implications

- Classroom teachers can be trained to successfully bring about a change in their school's curricula and environment to improve students' gross motor skills
- A committed and supportive school principal appears to be a key factor in ensuring sustained whole school change.
- Researchers should be mindful that the change process in schools can take longer than expected and be prepared to commit to long-term partnerships with schools.

Competing Interests: None

Figure Captions

Figure 1. Sample selection and response rates at baseline (2006) and follow-up (2010)

SUPPLEMENTARY FILES

Supplementary File 1. Information on the validity and reliability of the checklists used to assess the seven skills in this study

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