



**Appendix A: Figure.1 Flowchart of study selection**

## Appendix B. Level of parent engagement and corresponding studies with components

<b>High</b>	<p>1 - take home bag and sessions plans, workshop</p> <p>3 - direct active parent involvement with children</p> <p>6 – direct active parent led intervention with support from mentors and multiple parent workshops</p> <p>9 - direct active parent involvement with children –limited reporting of parent involvement</p> <p>10 - multiple parent workshops, newsletters, home tasks and a take home CD to incentivise home activity</p> <p>15 - multiple parent workshops, parent peer training, information leaflets, home tasks and take-home activity equipment</p> <p>17 - multiple parent workshops, newsletters, home tasks and organised family events</p>	<b>Moderate</b>	<p>4 - newsletters, home session tasks and a take home CD</p> <p>11 - newsletters, noticeboards, take home activity equipment</p> <p>12 - multiple parent workshops, home session tasks</p> <p>13 - multiple parent workshops, newsletters and home session tasks</p> <p>14 - multiple parent workshops and noticeboards/staff sharing</p> <p>16 - multiple parent workshops and newsletters</p>	<b>Low</b>	<p>2 – newsletters</p> <p>5 - single parent workshop, newsletter</p> <p>7 - newsletters and noticeboard</p> <p>8 - single parent workshop</p>
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**Table 1. Methodological quality assessment items**

Item	Description
A	Key baseline characteristics are presented separately for treatment groups (age, and at least one outcome measure) and for cluster randomised controlled trials and controlled trials, positive if baseline outcomes were statistically tested and results of tests were provided
B	Randomisation procedure clearly and explicitly described and adequately carried out (generation of allocation sequence, allocation concealment and implementation)
C	Validated measures of motor development used (validation in same age group reported and/or cited)
D	Drop out described and $\leq 20\%$ for $< 6$ -month follow-up or $\leq 30\%$ for $\geq 6$ -month follow-up
E	Blinded outcome assessments (positive when those responsible for assessing motor development at outcome were blinded to group allocation of individual participants)
F	Motor development assessed a minimum of 6 months after pretest
G	Intention to treat analysis for motor development outcomes(s) (participants analysed in group they were originally allocated to, and participants not excluded from analyses because of non-compliance to treatment or because of some missing data)
H	Potential confounders accounted for in motor development analysis (eg, baseline score, group/ cluster, age)
I	Summary results for each group+treatment effect (difference between groups)+its precision (eg, 95% CI)
J	Power calculation reported, and the study was adequately powered to detect hypothesised relationships

**Table 2. Methodological Quality Assessment of included studies**

Study		Key baseline characteristics reported for each group	Randomisation procedure clearly described	Valid measure of FMS	Dropout $\leq 20\%$ for $< 6$ months follow-up or $\leq 30\%$ for $\geq 6$ months follow-up	Assessor blinding	Motor development assessed min of 6 months after pretest	Intention-to-treat analysis	Potential confounders accounted for in analysis	Summary results presented + treatment effect t+ precision estimates	Power calculation reported	TOTAL SCORE
1	Altunsöz 2016	+	-	+	+	-	-	+	+	-	-	5
2	Bayer 2009 (RCT)	+	+	-	-	-	-	+	-	+	-	4*
3	Bedard 2017	+	-	+	+	-	-	+	+	+	-	6
4	Bellows 2013 (RCT)	-	-	+	-	-	-	-	+	-	-	2*
5	Bonvin 2013 (RCT)	+	+	+	+	+	+	+	+	+	+	10
6	Hamilton 1999	-	+	+	+	-	-	+	+	-	-	5
7	Hardy 2010 (RCT)	-	+	+	+	+	+	+	+	+	+	9
8	Klein 2015	+	-	-	+	-	+	-	-	-	-	3*
9	Piek 2013 (RCT)	+	+	+	+	-	+	+	+	+	+	9
10	Puder 2011 (RCT)	+	+	-	+	+	+	+	+	-	+	8
11	Reilly 2006 (RCT)	+	+	-	+	+	+	+	+	+	+	9
12	Roth 2015 (RCT)	+	+	-	+	+	-	+	+	+	+	8
13	Wasenius 2018 (RCT)	+	+	+	-	+	+	+	+	+	-	8
14	Winter 2011	+	-	+	-	-	+	-	+	+	-	5
15	Yin 2012	+	-	+	+	-	-	+	+	-	-	5
16	Zask 2012 (RCT)	+	+	+	+	-	+	+	+	+	+	9
17	Zhou 2014	+	-	+	+	-	+	+	+	+	-	7

**Table 3. Intervention Characteristics**

Reference	Design, Setting & Sample	Intervention Groups & Childcare Component	Parent component	Motor Skill Assessment	Main results & Discussion Points
Altunsöz 2016, USA (1)	<b>Quasi-experimental</b> <i>Pre-school</i> INT1: 22 (48.05 months ± 6.45) INT2: 25 (49.47 ± 6.41) CON: 25(47.68 ±7.10)	<b>INT1: SKIP</b> programme (30 mins 2x/week for 8 weeks) <b>INT2: SKIP-PI</b> - Same dose as INT1 + 24 home-based sessions. Implemented by a trained motor skill expert, designed to develop OCS through developmentally appropriate practice & LS in warm-up. Delivered in a multi-purpose room or playground and all preschoolers had their own space and equipment. <b>CON:</b> Control group received regular curriculum	24 home sessions (10-15 mins each) for 8 weeks; Family equipment bag (balls, bean bags, scarves, balloons, milk jugs, rolled paper bats, bubble wrap and paper spots) & lesson plans; 1.5 hour workshop for parents on FMS	<b>Test of Gross Motor Development-2 (TGMD-2)</b> (Ulrich 2000)	SKIP & SKIP-PI were significantly better than the CON group in OC skills. Inability to control the home environment meant fidelity was hard to determine. Return rate for parent game sheets were low. Authors highlighted the need to reconsider incentives for parents to be culturally relevant.
Bayer 2009, Germany (2)	<b>Cluster-RCT</b> <i>Kindergarten</i> 64 kindergartens in four regions INT: 13, CON:	<b>INT: TigerKids</b> (30 mins 5x/week for 1 year) delivered by teachers involving playful vigorous PA games & regular consumption of fruit/vegetables and regular consumption of water in day care. Folder for teachers containing materials, modules for daily activities and a CD <b>CON:</b> Maintained usual curriculum	Four parent newsletters; ‘TippCards’ providing messages on health-related behaviour e.g. ways to encourage healthy eating & examples of integrating regular PA into family’s daily routine	<b>Karlsruher Motorik-Screening für Kindergarten kinder (KMS 3–6)</b> (Boes et al., 2004)	No significant advantage in the motoric testing results obtained in the INT group. The motoric testing performed in the study might have been a poor surrogate marker for increased PA
Bedard 2017, Canada (3)	<b>Quasi-experimental</b> <i>Community</i> INT/EXP: n=8 (41.4 months ± 6.99) CON:n=11(45.6±7.30)	<b>INT: Move to Learn</b> (1 hour/week for 10 weeks) led by physical literacy graduate students. Specific movement skills were focused on each week. Free play opportunities with access to play items and equipment for gross & fine motor skills (play balls and puzzle pieces). Parents/caregivers were actively involved. <b>CON:</b> Control group participated after second testing	Active involvement of one parent of each child in the direct instruction; parents provided with handouts outlining weekly activities	<b>Peabody Developmental Motor Scales-2nd edition</b> (Folio & Fewell, 2000)	Significant effect of group on gross motor raw scores overall ( $F=4.67, p < 0.05$ ). Significant gains in gross motor despite the relatively low dose of the intervention (1x/week for 1 hour) highlights importance of parental component.
Bellows 2013, USA (4)	<b>Cluster-RCT</b> <i>Childcare setting</i> INT: n = 98 (53 months ± 6.8) CON: n = 103 (51.5 ± 6.6)	<b>INT: Mighty Moves</b> (15-20 mins 4x/week for 18 weeks) led by teacher in classroom. Each week activities focused on either stability, locomotor or manipulation skills which were introduced by superhero characters. The intervention also included a ‘food friends’ nutrition programme <b>CON:</b> Food Friends, a 12-week nutrition programme	Weekly home connection materials; music CD to practice motor skills activities along to	<b>PDMS–2 (Folio &amp; Fewell, 2000)</b>	INT group demonstrated significant changes in gross motor skills compared with the CON group
Bonvin 2013, Switzerland (5)	<b>Cluster-RCT</b> <i>Childcare centres</i> INT: n = 313 (3.4 years ± 0.6) CON: n = 335 (3.3 ± 0.6)	<b>INT: Youp’là Bouge</b> (9 months) - Governmentally led programme, socio-ecological model: individual (children, educators & parents) & environmental (childcare, daily PA) levels. Five PA workshops for educators delivered by sports scientists. Every 2 months, educators exchanged ideas. Childcare centres received grant to improve environment. <b>CON:</b> Received regular preschool program	Parent information session encouraged to discuss programme & benefits of PA; Parent flyers with intervention info	<b>TotFMS</b> (Kakebeeke et al., 2012)	No intervention effect on motor skills. Issues relating being governmentally led - no demands regarding daily PA time or structured PA curriculum, no info about organisation of a parental info session obtained.
Hamilton 1999, USA (6)	<b>Quasi-experimental</b> <i>Preschool children</i> INT: n=15 (3.9 yrs±.2) CON:n=12 (4.0± .3)	<b>INT: Parent Assisted programme</b> (45 mins x 2/week for 8 weeks), delivered by parents/facilitated by experts. Lessons included a minimum of 2 of the 5 OCS. 15-minute parent instruction sessions before sessions with experts. <b>CON:</b> Regular activity program including songs with parents	Two parent meetings before study; TGMD performance criteria presented to parents with feedback; parents provided with key teaching points prior to sessions	<b>TGMD (Ulrich, 1985)</b>	Gains in OC total score from pretest to post-test by the INT group, CON group showed no or little change in total OC score. Change was evident in all 5 OC skills tested in the study in the INT group.
Hardy 2010, Australia (7)	<b>Cluster RCT</b> <i>Preschool</i>	<b>INT: Munch and Move</b> (1-day professional development) Government initiative -Grant for preschools to support staff training, purchase PA equipment and for health professionals to support programme delivery. Intervention promoted healthy eating, active play and FMS.	Childcare providers spoke directly to parents; letters home and messages on notice board	<b>TMGD-2</b> (Ulrich 2000)	At follow up, LS, OCS and total FMS significantly improved in the INT group compared to CON group. INT group showed a larger (non-significant)

	INT: n= 263 (4.4 years $\pm$ 0.5) CON: n = 167 (4.5 $\pm$ 0.3)	Programme manual included a range of games related to health eating and FMS activities designed to develop LS, OCS and stability skills. <b>CON:</b> Received health info on other topics (road safety)			improvement across range of skills compared to CON group. Higher proportion of children in INT group improved in 2 or more OCS.
Klein 2015, Germany (8)	<b>Retrospectively</b> <i>Preschool</i> N = 1436 (4.7 years $\pm$ 0.9) INT1: 16 preschools, INT2: 2, INT3: 11, CON: 11	<b>INT1: The Kindergarten Mobile</b> ( <i>1 info session 90-120 mins</i> ) for parents and educators - messages for healthy lifestyle, FMS, PA & booklets with child's info <b>INT2: Ball &amp; Pear</b> ( <i>60mins x1day/week for 6 months</i> ) Health promotion including movement, body perception & nutrition. Hand puppets lead the programme <b>INT3: Nursery Fit 1</b> <i>info session</i> for parents and educators & <i>60mins x1day/week for 6 months</i> of PE in groups of 10-15 children. No structured guidelines defined. <b>CON:</b> Participated in usual curriculum for 6 months.	<b>KIMO&amp;NF:</b> Single info session on healthy lifestyle; fitness passes with test results	<b>KiMo-test</b> (Klein et al., 2012)	Outcomes were inconsistent for motor performance. All groups improved in all test items as a result of natural development, but no intervention was superior to the CON group. More intensive and targeted activity is necessary to effect motor abilities.
Piek 2013, Australia (9)	<b>Cluster RCT</b> <i>Children aged 4–6 from low SE area</i> N= 511 (5.42 yrs $\pm$ 3.58 mnths) INT: 6 schools, CON: 6	<b>INT: The Animal Fun program</b> ( <i>30 mins x4/week for 10 weeks</i> ), delivered by teachers. Programme involved imitating animal movements to develop motor and social skills. Children were challenged appropriately depending on their ability. Teachers participated in a 1-day training course prior to programme implementation <b>CON:</b> Normal curriculum	Parents participated with children in the intervention (their involvement was not described in detail in the paper)	<b>Bruininks-Oseretsky Test of Motor Proficiency-- 2</b> (BOT-2SF) (Bruiniks,2005)	Program significantly improved motor performance, although motor ability of INT group was significantly poorer than CON group at baseline (although matched for SES/ school)
Puder 2011, Switzerland (10)	<b>Cluster RCT</b> <i>Preschool children-area with high proportion of migrants</i> N = 625 (326 boys); INT: n = 167 (5.2 years $\pm$ 0.6), CON: n= 159 (5.2 $\pm$ 0.6)	<b>INT: Ballabeina</b> intervention ( <i>45 mins x 4/week for 1 school year</i> ), delivered by teacher & 1x/week by the health promoters. Activities based around themes (superheroes) Intervention intervened at individual (children, teachers, and parents) and environmental (school curriculum and built environment of class) levels & included workshops, lessons, home activities & adaption of environment as well as nutritional component <b>CON:</b> Continued regular school curriculum	3 info evenings promoting PA, healthy food, limiting TV and importance of sleep; Parent brochures containing key messages; Bi-weekly take home PA or nutrition card with exercises to be done at home; CD for the PA cards.	<b>Motor agility (obstacle course) and dynamic balance (balance beam)</b>	Significant improvement in motor agility (time to complete obstacle course) in INT group compared to CON group (mean difference: -0.54, p = 0.004). No significant difference in dynamic or static balance between the INT and CON group.
Reilly 2006, Scotland (11)	<b>Cluster RCT</b> <i>Childcare/Nursery</i> N = 545, INT: n = 268 (4.2 years $\pm$ 0.3),CON: n = 277 (4.1 $\pm$ 0.3)	<b>INT: Movement and Activity Glasgow intervention in children (MAGIC)</b> ( <i>30 mins x3/week for 24 weeks</i> ). Intervention group received PA program (focusing on FMS) plus home-based health education to increase PA through play and reducing sedentary behaviour. Sessions were delivered by nursery staff who had attended 3 training sessions. <b>CON: Usual curriculum</b>	Family resource pack (£16) including guidance on linking physical play at nursery and home; Two parent health education leaflets; posters on increasing PA displayed in nursery setting	<b>Movement Assessment Battery</b>	The INT group had significantly higher performance in movement skills than CON group at 6-month follow-up
Roth 2015, Germany (12)	<b>Cluster RCT</b> <i>Preschool children</i> INT: 21 preschools CON: 20 preschools N = 664 children (4.7years $\pm$ 0.6 yrs)	<b>INT: The Prevention through Activity in Kindergarten Trial (PAKT)</b> ( <i>30 mins daily for 11 months</i> ). Intervention targeted children, parents and preschool teachers. Children received a daily 30-minute PA lesson delivered by preschool teachers, developing motor skills through games and tasks. Teachers attended 2 workshops and were supervised at least once every 8weeks. <b>CON:</b> Continued routine schedule	PA homework cards once/twice a week; Three 3 interactive parent lectures with info on healthy development and promotion of motor skills;.	<b>Obstacle course</b>	INT group showed significantly higher motor skill performance than CON group –significant improvements in explosive leg strength, jumping coordination and static balance; no significant differences in agility dynamic balance or throwing. Improvements sustained at 2month follow up
	<b>Cluster RCT</b> <i>Childcare centres</i> INT:12, CON: 6	<b>INT1: Activity Begins in Childhood (ABC) Childcare Group</b> <b>INT2: ABC Childcare + Home Group.</b> ( <i>6 months</i> ) Both INT1&2 2 x 3hr workshops for childcare providers to motivate and increase PA. 60 min/day PA program including FMS	Two online training webinars for parents; Parents/ received ABC program training	<b>TGMD-2</b> (Ulrich 2000)	Raw LS scores increased significantly in both the CC group and the CC+HOME compared to CON group. Short term follow-up showed a significant difference

Wasenius 2018, Canada (13)	N = 215 (3.6 ± 0.5 yrs) Retention: 34.4%	training and <b>MusiGo</b> preschool program (17% creative play, 33% OCS & 50% LS). Bi-monthly sessions for preschool staff with goal setting, planning and feedback. <b>CON:</b> Continued with regular curriculum	manual; bi-weekly postcards outlining fun physical activities		in LS between both INT groups and the CON group. No significant differences between INT and CON groups on OC skills.
Winter and Sass 2011, USA (14)	<b>Quasi-experimental</b> <i>4 preschools - High poverty neighbourhood</i> N=405 (3-5 years); INT:2 preschools, CON:2 preschools	<b>INT: Health &amp; Ready to Learn</b> ( <i>Add duration</i> ) School readiness & obesity prevention strategies with a multi-level approach (ecological theory) for children, parents & teachers. Teachers and parents were trained to implement activities targeting gross motor skills and encourage movement. Equipment, music, materials, and guidance were provided to facilitate participation in fun, play-based PA. <b>CON:</b> Followed standard curriculum	Monthly group training sessions to practice family activities; alignment of curriculum across home and preschool contexts	<b>Brigance Diagnostic Inventory of Early Development - 2</b> (Glascoe, 2004).	The INT group experienced significantly more growth from pretest to post-test in gross motor skills when compared to CON group on the mon-locomotor and LS, despite starting behind on initial motor competence.
Yin 2012, USA (15)	<b>Quasi experimental</b> <i>Childcare centres</i> <i>Sample-</i> INT1: n = 179 (4.1years ± 0.6) INT2: n = 80 (4.2 ± 0.5) CON: n = 97 (4.1 ± 0.5)	<b>INT1: Miranos!</b> ( <i>30-45min x5/week for 18 weeks</i> ) Employed theories of early childhood development and a systems approach to modify eating and PA behaviours. Age-appropriate gross motor programme delivered by childcare staff with outdoor play including motor skills & dance instruction. Characters used for PA & healthy eating. <b>INT2: Miranos!</b> (centre & home based) – Same intervention with additional take-home activities, parent education and family support for healthy eating and PA <b>CON:</b> regular schedule, including unstructured free play 5/week	14 newsletters about healthy habits; 7 parents trained (10-hours) as peer educators & delivered 6 poster sessions on PA; at each session parents received a take-home bag including a storybook, family activities and a developmentally appropriate interactive game	<b>Learning Achievement Profile Version 3 (LAP-3) TotFMS</b> (Hardin et al., 2004)	Significant difference between the INT and CON group in gross motor development at short term follow-up. Impacts greater among children in combined intervention. Authors speculated that homebased intervention contributed to increased PA & success likely due to increased parental knowledge in health and obesity prevention
Zask 2012, Australia (16)	<b>Cluster RCT</b> <i>Preschools 3-6 years</i> INT1: 18 preschools, CON: 13 preschool (50.5months ± 6.7)	<b>INT: The Tooty Fruity Veggie</b> ( <i>25-30 mins x2/week for 10 months</i> ) FMS lessons 2/week, delivered by preschool teachers. Grant for equipment & playground review. Programme was based on The Health Belief Model and the Competence Motivational Theory <b>CON:</b> Regular curriculum	Workshop for parents on limiting sedentary time, promoting PA and FMS; monthly newsletter	<b>TGMD-2 (Ulrich 2000)</b>	Significant improvements of FMS among INT group compared to CON. Significant differences between gender; girls improved more than boys. This study showed good sustainability of the acquired motor competence
Zhou 2014, China (17)	<b>Quasi experimental</b> <i>Childcare centres</i> 1 int. centre 1 con. Centre, N = 387 (4.40 ± 0.78 yrs.	<b>INT:</b> Intervention ( <i>12 months</i> ) - 30 mins morning & afternoon outdoor play for 3-year olds & extra 30mins for 4-5year olds. 10min daily exercise routine delivered by teachers. Intervention based on socio-ecological model, competence & motivation theories. Teachers attended 20-hour training period & centres received developmentally appropriate play equipment, drawings of motor skills on walls & skipping markings. Healthy eating component was included. <b>CON:</b> regular curriculum - teachers implemented outdoor play activities as normal	Monthly parent seminars on physical development, gross motor skills, family PA & nutrition; newsletters with tips on developing healthy habits; handbook & website with updates on child's fitness; individualised PA feedback; family events e.g. making play equipment	Battery test: Chinese National Measurement Standards on People's Physical Fitness inc Motor	Significant difference between INT and CON group in 20 m agility run, broad jump, tennis ball throw, sit-and-reach, balance beam walk, 20 m crawl and 30 m sprint.