

Interventions targeting motor skills in preschool-aged children with direct or indirect parent engagement: a systematic review and narrative synthesis

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Background: Competency in fundamental movement skills (FMS) lays the foundation for developing more complex motor skills and supporting a physically active future. Preschool-aged children are at a crucial window of development so intervening with planned motor skill programmes increases the likelihood of future participation in physical activity (PA). Parents/carers are the principal gatekeepers for children's PA during the early years and largely influence their motor competence. Interventions which involve parents have shown to be effective in mediating improvements in FMS yet to date, no studies have reviewed types of parental engagement within interventions in relation to motor competence outcomes. The purpose of this review is to evaluate the effectiveness of motor skill interventions for pre-schoolers with the inclusion of a parental/home component. **Methods:** Literature searches were carried out in PubMed, Sports Discuss and the Cochrane Library. Studies were included if they implemented an intervention with direct or indirect parental engagement and evaluated FMS as an outcome measure. **Results:** Seventeen studies were included in the review and a narrative synthesis of results suggests the level of parental engagement may be associated with improvements in motor skills for pre-schoolers. **Conclusion:** It can be suggested that early years motor skill interventions should include parent involvement; ideally encouraging active participation from parents, which may be the most influential form of parent engagement.

Keywords: motor skills, intervention, movement programme, pre-school, parents, family

Introduction

Overweight and obesity levels in pre-schoolers are alarming. In recent years approximately thirty-eight million children worldwide under the age of five were classified as overweight or obese (WHO, 2019). Children who are overweight or obese are inclined to show lower levels of physical activity (PA) and have low motor competence (Cheng et al., 2016; Logan et al., 2012). Motor competence encompasses fundamental motor/movement skills (FMS)

which include locomotor skills (LS), object control skills (OCS) and stability (Gabbard, 2011). These foundational movements such as balancing, running and catching are building blocks for more complex movement patterns (Bellows et al., 2013) and critical for children to acquire in early childhood (Gallahue, Ozmun & Goodway, 2012), as without developing these skills as a base for physical competence, it is unlikely that children will be motivated or confident to be physically active as they progress through to adolescence (Lubans et al., 2010). As well as low proficiency in FMS associated with less engagement PA in later life, it relates to reduced cognitive abilities, poor perceived physical competence (Robinson, 2011) and depressive behaviour at school age (Piek et al., 2010). On the positive side, higher motor competence has been shown to link with better health outcomes including greater cardiorespiratory fitness and a lower body mass index (Veldman, Jones & Okely, 2016).

Preschool-aged children are at a crucial window for development of motor skills (Clark and Metcalfe) as cognitive development occurs rapidly (Ayres, 2005). According to a recent review, interventions targeting FMS in pre-schoolers have been effective demonstrating large effects on OCS and moderate effects on LS (Van Capelle et al., 2017). Expert-led interventions are most effective in mediating improvements in FMS (Wick et al., 2017), yet interventions are primarily teacher led and some include parent education (Van Capelle, 2017). Veldman, Jones and Okely (2016) criticised that many interventions ignore the home/parental component which is key to ensuring important messages are shared to the home environment.

Parents influence their child through both direct and indirect actions (Hingle et al., 2010). Direct parent involvement includes parents actively participating which may be one of the most advantageous forms of parental influence (Rhodes et al., 2018) as it encourages reciprocal reinforcement, parental role modelling and opportunities for encouragement. Although previous FMS systematic reviews have taken parental engagement into account, these have not evaluated ways in which parents are involved and discussed subsequent influences on motor skill outcomes. Following a similar scope to the current review, van de Kolk et al. (2019) evaluated the effectiveness of childcare based interventions with direct parental involvement on weight status and energy, balance-related behaviours (EBRBs) of

2-5-year olds. They concluded that interventions with direct parental involvement demonstrated promising effects on improving children's EBRBs with most effects observed for motor skill development. This review included studies with direct parent involvement; however, considering indirect parent involvement may also provide useful insight. It may not always be feasible for some settings to include direct parent involvement, therefore programmes with indirect parental engagement were evaluated within this review. The current review aims to provide a narrative synthesis evaluating the inclusion of parental engagement within interventions and how this may influence motor competence outcomes for preschool-aged children.

Methods

Literature Search

Between August 2020 and September 2020, a literature search was conducted of electronic databases (PubMed, Sports Discuss, Cochrane Library) which was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (Moher et al., 2009).

The **search strategy** included all possible combinations of key words from the following groups: (1) 'motor skill*', 'motor competence', 'motor proficiency', 'motor performance', 'motor ability' 'fundamental motor skill*' 'fundamental movement skill*' or 'motor coordination'; (2) 'preschool child*', 'pre-schooler*', 'young child*', 'early childhood', 'early years', or 'early childhood'; and (3) 'parent', 'famil*', 'parent involvement', 'parent engagement' or 'carer'. Following the keyword search, titles and abstracts from the articles identified were screened against the review criteria. Possibly relevant articles were downloaded for full text evaluation. From the full-text articles selected, reference list searches (backward reference search) and a cited by reference searches (forward reference search) were carried out. Literature reviews, systematic review and meta-analysis were also screened as part of the literature search to identify relevant studies which included a parent or family component. Results from the searches were collated within a bibliographic library and duplicates were removed.

Eligible studies included clustered or un-clustered control trials, randomized controlled trials, pre and post-test designs or quasi-experimental designs where typically developing preschool children were assigned to an intervention or control group with an aim of improving FMS or motor skills. The preschool years (3–5 years of age) is considered the ‘golden age’ of motor skill competence (Figueroa, 2017) but to account for differences globally in ages considered as preschool, the age range for studies included in the current review is 2-6 years of age. The intervention could take place in a range of settings including preschools, childcare centres, community settings or home-based and required the inclusion of direct or indirect parental engagement. The duration of the intervention had to be at least 4 weeks and report a motor skill outcome measure in analysis. Studies which did not measure motor skills, despite involving parents were not included within the current review. Intervention studies were excluded if they were not written in English, not applying pre-post-test design or pilot studies.

Methodological Assessment

A methodological assessment tool (Altman et al., 2001) aligning with **PRISMA** guidelines (Van Sluijs et al., 2007) was implemented into this review, as previously applied in existing systematic reviews within the field of motor development (Veldman, Jones and Okely, 2016). This tool determined methodological quality using a 10-item quality assessment scale, displayed in table 1. Studies were regarded as high quality if they had a total score greater than 5 or if they were a randomized control trial, then if the total score was greater than 6.

Table 1. Methodological quality assessment items

Results

Study Selection

A flow diagram illustrating the study selection is displayed in Appendix A (table.1). Initial literature searching produced 7950 hits which were reduced to 168 to be screened by title and abstract. Records were addressed for eligibility based on the inclusion criteria. Key

reasons for exclusion included the age participants, lack of reporting, no measurement of motor skills or no parent component. Finally, 17 studies were considered in this review.

Study Characteristics

Seventeen studies were included in the review. Six took place in Europe (2,5,8,10, 11 & 12), five in the USA (1,4,6,14 & 15), two in Canada (3 & 13), three in Australia (7, 9, 16) and one in China (17). Thirteen interventions were delivered by childcare providers or preschool teachers, five by experts and one by parents, facilitated by experts. Eleven studies used a cluster randomised control trial design (2, 4, 5, 7, 9, 10, 11, 12, 13, 16), six used a quasi-experimental design (1, 3, 6, 14, 15, 17) and one a retrospective design (8).

Methodological Quality

Methodological quality of the studies is displayed in Table 2. All studies apart from three were rated high for methodological quality and the three weak ratings were due to a lack of reporting such as failure to report blinding.

Intervention Components

The intervention components with details on the parent engagement element are displayed in Table 3 and explained further within the narrative synthesis. Level of parent engagement was rated and categorised into low, moderate or high based on amount and intensity of parental components (see Appendix B). A low level of parent engagement was assumed if the study included one or a small number of indirect methods such as providing newsletters or attending one training workshop. A moderate rating of was assumed if the study included a number of methods combined. Studies were assumed to have high parental engagement if they included coactivity.

Synthesis of Results

From the seventeen studies in this review, 14 (78%) reported significant favourable FMS results for the intervention group compared to control groups. A narrative synthesis of results, whilst evaluating intervention components revealed some trends.

Three studies included active engagement from parents in the intervention (3, 6, 9), all resulting in significant improvements in motor skills compared to control groups. These were delivered by a range of facilitators: parents with support from experts (6), teachers (9) and graduate experts (3). The abovementioned studies were classed as having a high parental engagement. Four additional studies with high parental engagement (1, 10, 15 and 17) included a range of features such as multiple parent workshops (10, 15, 17), home session-plans or tasks (1, 10, 15, 17) take home equipment bags (1, 15) or CDs (10). One study organised family events (17) and one trained parents to deliver training to their peers (15). These all resulted in significantly improved motor skills compared to control groups.

Most studies with insignificant improvements in motor skill outcomes included lower levels of parent engagement within the intervention (2, 5, 8). Types of parent involvement in these studies included providing tip cards or newsletters (2, 5), single parent education sessions (2, 8) or encouragement of a parent information evening (5). Four other studies had lower parent engagement and mediated improvements in gross motor skills (3, 7, 10, 16).

Seven studies classified as having moderate parental engagement (4, 11, 12, 13, 14 and 16) resulted in significant increases in motor skills compared to control groups. Parents partook in interactive lessons (12), participated in multiple workshops (13 and 14) or received take-home resources (4, 11 and 13).

Three studies compared centre-based intervention group to a second intervention group with an additional parent/home component, as well as control (1, 13 and 15). One study (15) reported impacts were greater among children who received the combined intervention, and the other two studies found both intervention groups were significantly different from the comparison group, but no differences were reported between those with the parent component and those without.

Table 2. Methodological Quality Assessment of included studies

Table 3. Intervention Characteristics

Discussion

This review reveals useful trends of motor skill competence following interventions for preschool aged children with the inclusion of a parental component. Evaluation should be interpreted cautiously with findings based on a narrative synthesis.

Studies incorporating child and parent co-activity documented positive outcomes in motor competence. The oldest study in this review incorporated parent assisted delivery (6) which established that parents can be effective in instructing children's motor skill development with support from professional mentors which may be a nonthreatening parental engagement approach. Other studies also encouraged children and parents to participate in the intervention, practicing FMS (3 and 9) or attending family events like sports days (17). These studies resulted in significant improvements in motor skills suggesting that children participating alongside parents may contribute to enhancing motor competence. With this type of parent involvement, reinforcement and parental role modelling is able to occur (Watchman, T. and Spencer-Cavaliere, 2017) and underpinned by social cognitive theory, children are able to learn by observing their parents' behaviours (Bandura, 1986). This postulates that direct parent involvement may be one of the most valuable forms of parental influence (Rhodes et al., 2018) for pre-schoolers. Similarly, a recent review reported that actively involving parents through participatory designs had stronger likelihood to influence children's energy balance-related behaviours including motor skills (van de Kolk et al., 2019). Including parents may promote skill learning to continue outside an intervention which could compensate if there was a smaller intervention dose. Bedard (2017) suggested running one session per week with parents may confer similar skill gains to a higher-dose program. This may suit parents' preferences as according to Spoth and Redmond (2000), parents may prefer shorter programmes due to time demands.

Studies that incorporated moderate parent involvement also resulted in significant increases in motor skills. A factor notably linked to these positive outcomes was the inclusion of developmentally appropriate equipment. The MAGIC intervention (11), which provided parents with resource pack worth £16 of appropriate equipment, lead to the

intervention group having significantly higher performance in movement skills compared to the control group at six months follow up. This postulates that providing equipment or play materials may support sustained FMS competence. Van de Kolk (2019) similarly reported large effects seen on motor skill development in interventions with parental involvement and provision of equipment. Other studies which incorporated take home equipment or session plans (1 and 15) lead to significant improvements in motor skills compared to control groups, suggesting that incorporating take home equipment or activities may be a key intervention component, with its influence on the home environment (Ferrira et al., 2018). Evidence from a longitudinal study supports this as Barnett et al. (2019) discovered that engagement in daily toy use for 3.5-year olds was associated with OCS at 5 years old. Similarly, Zeng, Johnson, Boles and Bellows (2019) reported that PA equipment and play spaces in the home are positively related with locomotor skills.

Developmentally appropriate equipment was recognised as a common feature of successful interventions resulting in significant increases in gross motor skills particularly where the inclusion of parental engagement was lower. One study (4) sent a CD home rather than equipment, but within the teacher-led programme equipment was incorporated including activity scarves, balls, bean bags and ropes. This appropriate equipment may have contributed to the significant increases in motor skills arguably more than the parent component which was relatively low. Likewise, Winter and Sass (2011) (14) provided equipment to facilitate children's participation in fun, play based physical activities and the intervention group experienced significantly more improvement in gross motor skills from pretest to post-test compared to a control group. Similarly, Puder (10) documented provision of equipment in the childcare setting including balls and skipping ropes. They implemented weekly fun take-home cards (PA and nutrition focused) and families received a CD to match the PA cards. This home component along with an interactive information session for parents contributed to significant improvements in children's motor agility through an obstacle course when compared to a control group (10). This review identifies take home CDs as a popular resource to indirectly encourage family involvement and possibly motivate children to be physically active in the home environment which in turn may support motor development. Another benefit is that these provide a minimum length of time to spend doing the activity.

Lower methods of parent engagement such as providing flyers or tip cards may be ineffective in influencing motor skills, due to these studies showing no favourable effects from the intervention group. Klein (8) who reported no significant outcomes for motor performance incorporated one parent information session. Rhodes and Lim (2018) suggested that there may be limited benefits of educational interventions due to a ceiling effect to what parents know as being healthy. Other studies, despite having low parent engagement, implemented multi-component interventions with the inclusion of a nutritional element (7 and 16) and documented promising effects on motor skills.

Only three studies within this review compared intervention groups to a separate a home component group (1, 13, 15) therefore analyses of parental influence alone was somewhat limited. One study (15) found that impacts were greater among children receiving the home-based component, supporting the notion that involving parents directly may enhance their knowledge and skills which would in turn influence their children (Veldman, Jones and Okely, 2016). On the contrary, the two other studies reported that children within the parent engagement group did not improve motor skills significantly more compared to those who did not experience the home component (1, 13). This reveals that in this case, regardless of parental engagement, if high quality structured motor skill intervention is provided, children are likely to gain significant motor skill improvements. Difficulty in controlling the home environment and inability to observe families at home may be limiting. The SKIP-PI intervention (1) was classed as having high parent engagement yet there was low reporting of completion of home activities. Therefore without ability to observe activities at home, it can be difficult to monitor if parents implement session plans effectively. Low implementation of home activities may be down to lack of familiarisation of activities and without experiencing demonstrations of appropriate activities, parents may lack in confidence or knowledge to implement them. In support of the evaluation that parent familiarisation of activities may benefit home engagement, Bedard (3) reported that the rate of at-home practice for movement activities was around 50%, implying that activities were practiced for roughly half of the days not spent in the programme. Given that parents actively participated in this intervention, it can be assumed they were familiar with the movement activities and therefore perhaps more

confident to practice at home. As well as monitoring activities, providing culturally relevant incentives are important to encourage at home participation; including developmentally appropriate equipment and CDs which are engaging and provide a time frame to participate in the activity.

Limitations

This review incorporated a broad literature search on multiple databases, ensuring suitable studies were extracted, yet limitations should be noted. The intervention characteristics varied across the studies with inconsistencies in duration and frequency of activities. The subjective rating of parental engagement in this review should be considered cautiously as intensity or quality of parent workshops was not reported. Another limitation to consider is that the interventions measured motor competence with a range of tools, preventing the ability to conduct a meta-analysis. Researchers have formerly questioned the interchangeable use of motor assessments (Stodden et al., 2008) and to date, no standardized motor test is used for children under three years old, thus making it challenging to compare intervention effectiveness. Participants were not always randomly assigned to intervention or control groups which may have resulted in imbalanced baseline characteristics. A lack of assessor blinding was reported for certain studies which may have led to biased results given that FMS measures are often subjective.

Conclusion

In conclusion, findings indicate that most interventions with parental engagement are effective in improving motor competence and this review provides useful insight into how future interventions could best include parents. Ideally, to encourage parent engagement and translate knowledge into practice, interventions should aim to include active participation from parents, which may confer similar results to a higher dose programme. This would promote reciprocal reinforcement, parental role modelling and opportunities for encouragement. Some forms of parental engagement may be insufficient in mediating improvements in children's motor skills, such as parent education alone and indirect methods such as newsletters. Findings from this review highlight the value of developmentally appropriate take-home equipment as an incentive for family participation

in PA at home which would subsequently influence motor competence. As well as take home equipment, CDs or musical incentives may be another useful incentive to encourage increased participation and thus increase the dose and effects of an intervention. It is important to note that session plans for parents to deliver at home may be unrealistic if parents are unfamiliar with the activities. Involving parents within interventions to enhance motor skills is important given the influence motor competence has on children's likelihood to be physically active as they progress through childhood to adolescence and adulthood (Stodden et al., 2008; Robinson et al., 2015; Hulteen et al., 2018).

Key messages

- Interventions targeting motor skills in pre-schoolers should aim to include active participation from parents
- Take home equipment and activities may incentivise participation
- Parent education alone may not be sufficient in mediating improvements in children's motor skills
- Take home session plans or game ideas may be unrealistic if parents are unfamiliar with the activities
- Studies should consider how they report and monitor home engagement
- Further research comparing interventions with and without parental involvement is necessary

References

References marked with an asterisk indicate studies included in the systematic review.

- Adamo, K.B., Wilson, S., Harvey, A.L., Grattan, K.P., Naylor, P.J., Temple, V.A. and Goldfield, G.S. (2016) Does intervening in childcare settings impact fundamental movement skill development?. *Medicine and Science in Sports and Exercise*, 48(5), pp.926-932.
- Almond, L. (2014) Serious flaws in an FMS interpretation of physical literacy. *Science & Sports*, 29, p.S60.
- Altman D, Schulz K, Moher D, et al. (2001) The revised CONSORT statement for reporting of randomized controlled trials. *Ann Intern Med*;134:663–94.
- *Altunsöz, I.H. and Goodway, J.D. (2016) Skipping to motor competence: the influence of project successful kinesthetic instruction for preschoolers on motor competence of disadvantaged preschoolers. *Physical Education and Sport Pedagogy*, 21(4), pp.366-385.
- Bandura, A. (1986) *Social Foundations of Thought and Action: A Social Cognitive Theory*; Prentice-Hall: Englewood Cliffs, NJ, USA; p. 617.
- Barnett, L., Hnatiuk, J., Salmon, J. and Hesketh, K. (2019) The family home environment in the infant, toddler and preschool years—what factors influence motor skill competence at school entry?. *Journal of Science and Medicine in Sport*, 22, p.S23.
- *Bayer, O., von Kries, R., Strauss, A., Mitschek, C., Toschke, A.M., Hose, A. and Koletzko, B.V. (2009) Short-and mid-term effects of a setting based prevention program to reduce obesity risk factors in children: a cluster-randomized trial. *Clinical Nutrition*, 28(2), pp.122-128.
- *Bedard, C., Bremer, E., Campbell, W. and Cairney, J. (2017) A quasi-experimental study of a movement and preliteracy program for 3-and 4-year-old children. *Frontiers in pediatrics*, 5, p.94.
- *Bellows, L.L., Davies, P.L., Anderson, J. and Kennedy, C. (2013) Effectiveness of a physical activity intervention for Head Start preschoolers: a randomized intervention study. *American journal of occupational therapy*, 67(1), pp.28-36.
- Boes K, Bappert S, Tittlbach S, Woll A. (2004) Karlsruher-Motorik-Screening für Kin- dergartenkinder (KMS 3-6). Sportunterricht;53.
- Boland, A., Cherry, G. and Dickson, R. (2017) *Doing a systematic review: A student's guide*. Sage.
- *Bonvin A, Barral J, Kakebeeke T et al. Effect of a governmentally-led physical activity program on motor skills in young children attending child care centers: a cluster randomized controlled trial. *Int J Behav Nutr Phys Act* 2013; 10(1):90.
- Cheng, J., East, P., Blanco, E., Kang Sim, E., Castillo, M., Lozoff, B. and Gahagan, S. (2016) Obesity leads to declines in motor skills across childhood. *Child: care, health and development*, 42(3), pp.343-350.
- Clark, J.E. and Metcalfe, J.S. (2002) The mountain of motor development: A metaphor. *Motor development: Research and reviews*, 2(163-190), pp.183-202.
- Ferreira, L., Godinez, I., Gabbard, C., Vieira, J.L.L. and Caçola, P. (2018) Motor development in school-age children is associated with the home environment including socioeconomic status. *Child: care, health and development*, 44(6), pp.801-806.
- Figueroa. (2017). Motor Skill Competence and Physical Activity in Preschoolers: A review. *Maternal and Child Health Journal.*, 21(1), 136–146. <https://doi.org/10.1007/s10995-016-2102-1>

- Gallahue, D., Ozmun, J.C., and Goodway, J. (2012) Understanding Motor Development: Infants, Children, Adolescents, Adults. (7) pp. 25.
- *Hamilton, M., Goodway, J. and Haubenstricker, J. (1999) Parent-assisted instruction in a motor skill program for at-risk preschool children. *Adapted Physical Activity Quarterly*, 16(4), pp.415-426.
- *Hardy, L.L., King, L., Kelly, B., Farrell, L. and Howlett, S. (2010) Munch and Move: evaluation of a preschool healthy eating and movement skill program. *International Journal of Behavioral Nutrition and Physical Activity*, 7(1), pp.80.
- Hingle MD, O'Connor TM, Dave JM, Baranowski T. (2010) Parental involvement in interventions to improve child dietary intake: a systematic review. 51(2) pp. 103–11
- Hulteen, R.M., Morgan, P.J., Barnett, L.M., Stodden, D.F. and Lubans, D.R. (2018) Development of foundational movement skills: A conceptual model for physical activity across the lifespan. *Sports Medicine*, 48(7), pp.1533-1540.
- Klein, D., Koch, B., Dordel, S., Strüder, H. and Graf, C. (2012) The KiMo test: a motor screening for pre-school children aged 3–6 years. *Gazzetta Medica Italiana*, 171(1), pp.13-26.
- * Klein, D., Manz, K., Ferrari, N., Strüder, H. and Graf, C. (2015) Effects of health promotion projects in preschools on body mass index and motor abilities. *The Journal of sports medicine and physical fitness*, 55(1-2), p.103.
- Logan S, Robinson L, Wilson A. et al., (2012) Getting the fundamentals of movement: a meta-analysis of the effectiveness of motor skill interventions in children. *Child Care Health Dev*, 38(3), pp. 305–315.
- Lubans DR, Morgan PJ, Cliff DP, Barnett LM, Okely AD. (2010) Review of the benefits associated with fundamental movement skill competency in youth. *Sports Med*, 40, pp. 1019–35.
- Masse, L.C., O'Connor, T.M., Tu, A.W., Hughes, S.O., Beauchamp, M.R., Baranowski, T. (2017) Physical Activity Parenting Expert Group. Conceptualizing Physical Activity Parenting Practices Using Expert Informed Concept Mapping Analysis. *BMC Public Health*, 17, pp. 574.
- Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analysis: the PRISMA statement. *PLoS Med* 2009;6:e1000097
- Piek JP, Barrett NC, Smith LM, Rigoli D, and Gasson N. (2010) Do motor skills in infancy and early childhood predict anxious and depressive symptomatology at school age? *Human movement science*, 29(5), pp 777-86.
- *Piek, J.P., McLaren, S., Kane, R., Jensen, L., Dender, A., Roberts, C., Rooney, R., Packer, T. and Straker, L. (2013) Does the Animal Fun program improve motor performance in children aged 4–6 years? *Human movement science*, 32(5), pp.1086-1096.
- * Puder, J.J., Marques-Vidal, P., Schindler, C., Zahner, L., Niederer, I., Bürgi, F., Ebenegger, V., Nydegger, A. and Kriemler, S. (2011) Effect of multidimensional lifestyle intervention on fitness and adiposity in predominantly migrant preschool children (Ballabeina): cluster randomised controlled trial. *Bmj*, 343, pp. 6195.
- * Reilly J, Kelly L, Montgomery C et al. (2006) Physical activity to prevent obesity in young children: cluster randomised controlled trial. *Br Med J*; 333(7577):1041–1043.
- Rhodes, R.E. and Lim, C. (2018) Promoting parent and child physical activity together: Elicitation of potential intervention targets and preferences. *Health Education & Behavior*, 45(1), pp.112-123.
- Robinson, L.E. (2011) The relationship between perceived physical competence and fundamental motor skills in preschool children. *Child: care, health and development*, 37(4), pp.589-596.

- Robinson LE, Stodden DF, Barnett LM, Lopes VP, Logan SW, Rodrigues LP, et al. (2015) Motor competence and its effect on positive developmental trajectories of health. *Sports Med*, 45(9), pp. 1273–84.
- * Roth, K., Kriemler, S., Lehmacher, W., Ruf, K.C., Graf, C. and Hebestreit, H. (2015) Effects of a physical activity intervention in preschool children. *Medicine and science in sports and exercise*, 47(12), pp. 2542-2551.
- Spoth, R. and Redmond, C. (2000) Research on family engagement in preventive interventions: Toward improved use of scientific findings in primary prevention practice. *Journal of Primary Prevention*, 21(2), pp.267-284.
- Stodden, D.F., Goodway, J.D., Langendorfer, S.J., Roberton, M.A., Rudisill, M.E., Garcia, C. and Garcia, L.E. (2008) A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. *Quest*, 60(2), pp.290-306.
- van de Kolk, I., Verjans-Janssen, S.R.B., Gubbels, J.S., Kremers, S.P.J. and Gerards, S.M.P.L. (2019) Systematic review of interventions in the childcare setting with direct parental involvement: effectiveness on child weight status and energy balance-related behaviours. *International Journal of Behavioral Nutrition and Physical Activity*, 16(1), p.110.
- Van Sluijs E, McMinn A, Griffin S. (2007) Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. *BMJ*, pp. 335 - 703
- Veldman S, Jones R, Okely A. (2016) Efficacy of Gross Motor Skill Interventions in Young Children: an updated systematic review. *BMJ Open Sport Exerc Med*, 2(1)
- * Wasenius, N.S., Grattan, K.P., Harvey, A.L., Naylor, P.J., Goldfield, G.S. and Adamo, K.B. (2018) The effect of a physical activity intervention on preschoolers' fundamental motor skills—A cluster RCT. *Journal of science and medicine in sport*, 21(7), pp.714-719.
- Wick, K., Leeger-Aschmann, C.S., Monn, N.D., Radtke, T., Ott, L.V., Rebholz, C.E., Cruz, S., Gerber, N., Schmutz, E.A., Puder, J.J. and Munsch, S. (2017) Interventions to promote fundamental movement skills in childcare and kindergarten: a systematic review and meta-analysis. *Sports Medicine*, 47(10), pp.2045-2068.
- * Winter, S.M. and Sass, D.A. (2011) Healthy & ready to learn: examining the efficacy of an early approach to obesity prevention and school readiness. *Journal of Research in Childhood Education*, 25(3), pp.304-325.
- World Health Organization (2019) *Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age: web annex: evidence profiles* World Health Organization.
- * Yin, Z., Parra-Medina, D., Cordova, A., He, M., Trummer, V., Sosa, E., Gallion, K.J., Sintes-Yallen, A., Huang, Y., Wu, X. and Acosta, D. (2012) Miranos! Look at us, we are healthy! An environmental approach to early childhood obesity prevention. *Childhood Obesity (Formerly Obesity and Weight Management)*, 8(5), pp.429-439.
- * Zask, A., Adams, J.K., Brooks, L.O. and Hughes, D.F. (2012) Tooty Fruity Veggie: an obesity prevention intervention evaluation in Australian preschools. *Health Promotion Journal of Australia*, 23(1), pp.10-15.
- Zeng, N., Johnson, S.L., Boles, R.E. and Bellows, L.L. (2019) Social-ecological correlates of fundamental movement skills in young children. *Journal of sport and health science*, 8(2), pp.122-129.

* Zhou, Z., Ren, H., Yin, Z., Wang, L. and Wang, K. (2014) A policy-driven multifaceted approach for early childhood physical fitness promotion: impacts on body composition and physical fitness in young Chinese children. *BMC pediatrics*, 14(1), p.11

