Effects of a kindergarten-based, family-involved intervention on motor performance ability in 3-6 year old children: The ToyBox-study

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Abstract

This study aimed to examine the effect of the ToyBox-intervention, a kindergarten-based, family-involved intervention on different components of motor performance ability in children aged 3 to 6 years. We also assessed the influence of demographic and anthropometric, social and behavioural factors on effects of the intervention. The intervention and control were cluster-randomized (2:1 ratio) and children's anthropometry and two motor test items covering coordination (jumping from side to side, JSS) and strength (standing long jump, SLJ) were assessed before and after the intervention over one year. 1,293 children with different socio-economic status from 45 kindergartens in Germany were included (intervention, n=863; control, n=430). The intervention group showed a better improvement in JSS over time (P=0.01) and tended to improve better in SLJ (P=0.08). The intervention was more effective in boys than in girls with respect to SLJ (P=0.01). Children aged <4.5 years did not show a significant benefit of the intervention while older children improved (SLJ, P=0.004; JSS, P=0.04). The subgroup of children with low SES improved in JSS (P=0.0001) whether no significant changes were detectable in the subgroups with medium and high SES. The ToyBox-intervention improved specific components of motor performance ability in early childhood. Future programs should consider specific targeting of subgroups based on gender, age and SES.

Introduction

The age of about 3 to 6 years is a critical period for a child´s motor development. During these years children learn the basic types of motor skills like running and hopping which promotes the process of development of their basic motor abilities, such as speed, strength, coordination and balance (Sentderdi, 2008). These skills and abilities are the foundations of a variety of physical activities (Gallahue, 2006) and may influence later physical activity levels in adolescence and adulthood (L. M. Barnett, van Beurden, Morgan, Brooks, & Beard, 2009; Stodden, Langendorfer, & Roberton, 2009). Children with higher levels of motor skill performance are more physically active than those with less well developed skills (Fisher et al., 2005; Laukkanen, Pesola, Havu, Saakslahti, & Finni, 2014; Williams et al., 2008; Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006). Reilly et al. (Reilly et al., 2006) suggested that physical activity improves movement skills in preschoolers.

The process of children's motor development is depending on internal and external factors such as family's social-economic status (Mongraw-Chaffin et al.) (Lammle, Worth, & Bos, 2012), parent's educational level (Cools, De Martelaer, Samaey, & Andries, 2011), gender (Greendorfer, 1980) and age (Morris, Williams, Atwater, & Wilmore, 1982). But in general without a sufficient degree of movement, the necessary stimuli for the development are missing. The process of acquisition needs a variety of active play experiences and structured programs (Goodway, Crowe, & Ward, 2003; Hands & Martin, 2003). Kindergartens can play a key role in promoting the development of motor skills and abilities. They are an ideal setting where opportunities for being physically active can be provided through existing

personnel, equipment and facilities (Lubans et al., 2012) and where a large number of children and their parents, independently from their SES can be reached. Many studies give evidence that physical activity intervention programs promote the motor development in preschool children. For example, movement programs improved children's skills like galloping, leaping, horizontal jump and skipping (Derri, Tsapakidou, Zachopoulou, & Kioumourtzoglou, 2001) and motor performance like coordination and physical fitness (Krombholz, 2012). However, the number of high quality randomized controlled trials in preschool age group is low and reported results are conflicting (Riethmuller, Jones, & Okely, 2009).

The aim of the current study was to evaluate the effectiveness of the ToyBox- intervention, a multi-component, kindergarten-based, family-involved intervention on motor performance abilities, namely strength and coordination measured by the test items standing long jump and jumping from side to side in 3-6 year old children in Germany. The children included in this study represent a subgroup of the ToyBox-intervention performed in six European countries, but motor tests were only regularly performed in Germany. We also evaluated the influence of demographic and anthropometric (age, gender, BMI, parental BMI), social (SES, parental educational level) and behavioural (membership in sports club) parameters on effects of the intervention.

Methods

Study Design

The ToyBox-study (www. toybox-study.eu) developed a multi-component, kindergarten-based, family-involved intervention at the kindergarten setting

for use in different European countries with the focus on healthy snacking, water consumption, physical activity and sedentary behavior. The development of the program was based on a systematic approach that combines the use of the PRECEDE-PROCEED model and intervention mapping protocol performed by a multidisciplinary team of 15 partners across the EU (De Craemer et al., 2014; Duvinage et al., 2014; Manios et al., 2012). During the academic year 2012-2013, the application of the intervention for one year was evaluated in a cluster-randomized trial in six European countries (Belgium, Bulgaria, Germany, Greece, Poland and Spain), but this study focuses only on the German sample. The first assessment of the children was performed prior to the intervention during May to June 2012, followed by a second assessment at respective same time period one year later (De Miguel-Etayo et al., 2014; Manios et al., 2014; Mouratidou et al., 2014). The study protocol was accepted by the Ethical Committee of the Medical Faculty, Ludwigs-Maximilians-University of Munich. The ToyBox-study is registered with the clinical trials registry clinicaltrials.gov ID: NCT02116296. (Manios et al., 2014)

Settings and randomization

Kindergartens were recruited from 9 different municipalities with different SES in the region of Upper Bavaria, Germany. The selection followed a list of municipalities classified into tertiles (low, middle, high) based on annual income. At baseline, 58 kindergartens agreed to participate in the project (11 low SES; 17 middle SES; 30 high SES). The kindergartens were randomly assigned in a 1:2 ratio to the control (19 kindergartens) or to the intervention group (39 kindergartens) on the level of municipalities to avoid

contamination between kindergartens in the same area. The program was applied to all children of intervention kindergartens starting with teachers' training sessions and distribution of the related educational material. The kindergartens in the control group continued their usual routine based on their kindergarten curriculum (Bayerisches Staatsministerium für Arbeit und Sozialordnung, 2006).

ToyBox-intervention

The intervention targeted preschool-children, their parents/caregivers and their kindergarten teachers and focused on four energy balance-related behaviours (EBRBs): healthy snacking, water consumption, physical activity and sedentary behavior. The intervention was implemented over one academic year; a common time frame was followed by all intervention countries. The intervention was implemented during the academic year 20012-2013 and conducted at four levels (Manios et al., 2014):

Level 1. Teachers conducted permanent environmental changes in the classroom/kindergarten, in order to create supportive environment to the execution of the four targeted EBRBs (e.g. for the behavior physical activity: rearrangements of the classroom/kindergarten to create some free space to assist children's movement).

Level 2. Teachers promoted the four targeted EBRBs on regular basis and predefined time within each day in the classroom/kindergarten aiming at total class participation (e.g. for the behavior physical activity: performing two physical education sessions per week with duration of 45 min each).

Level 3. Teachers implemented interactive classroom activities aiming at total class participation, for a minimum of 1 h per week (e.g. for the

behavior physical activity: children's participation in excursions, kangaroo stories with children following the movements described in the stories, etc.). Teachers were also instructed to use the kangaroo hand puppet and perform the four EBRBs themselves, so as to enhance the effects of the intervention via role modelling.

Level 4. Parents/caregivers were encouraged and advised via simple and friendly to read material (nine newsletters and eight tip cards, as well as four posters which were coloured by their child) to apply relevant environmental changes at home, act as role models and implement these lifestyle behaviours together with their children.

Process evaluation on the implementation of the Toybox intervention, was performed (Androutsos, Apostolidou, et al., 2014).

As teachers were the key persons for implementation of the program three different training sessions were conducted by project staff; at least one teacher per class were encouraged to attend each training session. In the first and second session, which took place before the start of the intervention and four weeks thereafter, respectively, the teachers were informed about the background, objective and details of the intervention and about the importance of being a role model in establishing a healthy and active life style. The third training session was scheduled before the start of the repetition period, with the aim of sharing experience and preserving motivation and enthusiasm. Detailed information about the development and implementation of the training sessions are described elsewhere (Androutsos, Katsarou, et al., 2014; Payr et al., 2014).

Physical activity component of ToyBox-intervention

The main focus in the physical activity component was the increase in the children's physical activity level based on a concept of unstructured and structured physical activity sessions. In order to achieve this objective: (i) the kindergarten was rearranged to be more attractive and provide more free space for being physically (level 1); (Yasmeen et al.) 2 structured physical activity sessions with duration of 45 minutes each were scheduled per week and were divided into different levels of difficulty. These sessions contained playful exercises to promote children´s motor skills and motor abilities (level 2) (iii) additional activities e. g. reading interactive kangaroo stories and excursions were scheduled for at least one hour per week to provide an increase of the children's knowledge, skills and self-efficacy about physical activity (level 3) and (iv) the distribution of two newsletters, two tip-cards and one poster on physical activity to the parents. Level 1 was applied before the start of the academic year 2012-2013 and continued until the end, Level 2 started in week 5 of the ToyBox-Intervention and continued until the end of the academic year. Level 3 of the physical activity component was conducted in weeks 5to 8 with a repetition period in week 19 and 20. During the other weeks, the behaviours snacking, water consumption and sedentary behaviour were implemented. Level 4 was applied on predefined time points. The detailed content of this module and its development are described elsewhere (De Craemer et al., 2014; Duvinage et al., 2014).

Data collection

Measurements of the main outcomes were conducted in the morning among small groups in the movement rooms of the kindergarten. Exercises were

explained and demonstrated by trained research assistant. Two to three children were arranged in groups for measurements of weight, height and two different motor tests.

Data characteristics

Height was measured using the Seca® type 214 stadiometer, weight with an electronic scale Seca® type 861 and waist circumference with Seca® type 201. While being measured, children were allowed to wear underwear and socks only. The average of two measurements was used for both weight and height. The BMI was calculated as weight in kilos divided to height in square meters and classified according to the percentile graphs of Kromeyer-Hausschild et al. (Kromeyer-Hauschild et al., 2001). Children with a BMI $<10^{th}$ percentile were classified as underweight, ≥10 to $<90^{th}$ percentile as normal, ≥ 90^{th} to $<97^{th}$ percentile as overweight and ≥ 97^{th} percentile as obese.

Motor performance tests

Motor performance ability for children is defined in this study referring to the theoretical model of Bös (Bös, 1987), namely endurance, strength, speed, coordination and flexibility. In this study two different motor assessments were chosen to test children´s motor performance and to get insights in the basic motor abilities coordination and strength: Jumping from side to side (JSS) (coordination, i.e. total body coordination under time pressure, speed and muscular endurance capabilities of the lower extremities) and standing long jump (SLJ) (strength, i.e. jumping power and speed strength) (Lämmle, Tittlbach, Oberger, Worth, & Bös). Both

assessments are part of the Kinderturntest (Bös, 2006) and valid for children aged 3 to 10 years. The test was established for use in schools and day care settings and was shown to be feasible and sensitive (Bappert, 2006). The test-retest reliability coefficient is 0.84 for JSS and 0.91 for the SLJ (Karger, 2009). Both tests were carried out in shoes.

Jumping from side to side (JSS)

The children were asked to jump from side to side over a marked line with both feet together for 15 seconds, as quickly as possible. Jumps with mistakes i.e. child touched the line, jump was not done with both feet, child was not jumping sideways, were not counted. There were two attempts; the results of both series of jumps were added together.

Standing long jump (SLJ)

The child was positioned with both feet behind a marking and asked to jump as far as possible forwards and land on both legs without falling back. The distance from heel of the back feet to the standing marking was measured in centimeters. The best jump of two attempts was rated.

Demographic, anthropometric, social and behavioural factors

Data on child age, parental height and weight, parental school education and child's membership in sports clubs were obtained using parent-completed questionnaires at baseline (Gonzalez-Gil et al., 2014). The child's age was calculated by date of baseline measurement. The parents BMI were classified according the WHO criteria ("Obesity: preventing and managing the global epidemic. Report of a WHO consultation," 2000) as underweight

with BMI < 18,5 kg/m^2, normal with BMI ≥ 18.5 and < 25 kg/m^2, overweight with BMI ≥ 25 and < 30 kg/m^2 and obese with BMI ≥ 30 kg/m^2. Parental school education was classified into four categories: 12 years or less, 13-14 years, 15-16 years, more than 16 years.

Statistical analyses

Baseline characteristics between the intervention and control group were compared using mean and standard deviation (SD) or percentages. To analyze the main outcomes, namely the improvements in both motor tests, the difference between the results of the first and second measurements were calculated. We calculated mean and design effect corrected confidence intervals for graphical representation of the main outcomes. In order to test for a difference in improvements between intervention and control group we used generalized estimating equation (GEE) accounting for clustering of children within kindergartens. The role of other anthropometric, social and behavioural factors of interest was assessed by successively incorporating them into the models and testing for an interaction effect with the intervention group variable using an ANOVA. In case of ambiguous results, stratified analyses were used to explore the effect of the intervention on improvements in the motor tests.
For all analyses, statistical significance level was set at $p < 0.05$. All analyses were performed using R (version 3.0.1).

Results

Participants and anthropometric data

Written informed consent forms were obtained from 1952 German parents/caregivers of children aged 3-6 years. Three intervention kindergartens withdrew during the implementation due to teachers shortages. Both baseline and final examination measurements of the main outcomes were available for 1293 children (intervention, n=863; control, n=430). Drop outs occurred because children were unable to participate to the respective tests because of family-holiday, diseases, injury or other refusals. Also, children below age of three years were excluded from the analyses.

Table 1 shows the baseline characteristics for the intervention and control group. These data show an equal distribution of the anthropometric, biological and social parameters between the two groups, except for a difference in SES. In the control group only 22% were of medium SES, compared to 42% in the intervention group. In contrast, 61% of the control group were of high SES, compared to 39% in the intervention group.

Motor performance

Children in both groups improved their coordination and strength along with the increase in age by one year, but the children in the intervention group had a greater increased in JSS (P=0.01) and tended to a greater increase of SLJ (P=0.08), suggesting a beneficial effect of the intervention on motor performance. This effect is dependent of any demographic or social parameter. The results of motor tests at baseline (pre) and at follow up examination (Androutsos, Apostolidou, et al.) are shown in Figure 1.

Influence of demographic, anthropometric, social and behavioural parameters on the intervention effect on motor performance abilities

The intervention effects on motor performance abilities were dependent on sex, age and SES. Boys achieved a greater improvement in JSS than girls (P=0.007; Table 2). The intervention, however, had similar positive effects in both sex (P of interaction effect=0.69), as the interaction effect sex*intervention shows. Regarding SLJ, we found no sex effect (P=0.18), but for this outcome the intervention was more effective in boys than girls (P=0.01). There was a borderline significant interaction effect between the intervention*age regarding JSS (P=0.08). Stratified analyses showed that the intervention yielded better results with increasing age (Table 3) in both tests. There is a greater improvement in JSS in children aged 4.3 - 5 years (P=0.04) and in those aged > 5 years (P=0.004). Regarding the SLJ, the intervention was effective only in children aged > 5 years (P=0.038). Stratified analyses by SES revealed a significant effect of the intervention on JSS in children of low SES (P=0.0001). In the subgroups of children with medium and high SES this was not significant, although the intervention group tended to improve compared to the control group (Table 4). Regarding SLJ, a significant and positive intervention effect was seen in children of medium (P=0.02) and high SES (P=0.02). In children of low SES, the intervention showed a significant negative effect (P <0.001).

None of the other demographic, anthropometric, social or behavioural parameters, namely BMI, parental BMI, years of education of the mother and father, nor membership in sports clubs significantly influenced the effect of the intervention. However, we observed significantly worse scores

in JSS for (i) overweight/obese and underweight compared to normal weight children, (Yasmeen et al.) children with obese mothers compared to normal weight mothers, and (iii) children who were not a member of a sports club. The improvement in the SLJ test of the children did depend on their parents` years of education. Children whose parents had a higher education improved (significantly) less than children of parents that went to school for less than 13 years (Table 5 in supplementary section).

Discussion

This study shows that a kindergarten-based, family-involved intervention, the ToyBox-intervention, improved some components of motor performance ability, namely coordination and strength in preschool children in Germany.

We found that children participating in this intervention had significantly improvement in JSS and a trend towards improvement in SLJ. This observation is in line with a Swiss study examining the influence of physical activity program on motor performance such as balance and jumping. They confirmed relevant intervention effects after 7 months for side- to side jumping in preschool children (Donath, Imhof, Roth, & Zahner, 2014). The CHILT study found significant improvement in motor abilities, assessing lateral jumps and endurance performance in primary school children (Graf et al., 2005). A review of interventions to improve motor skills in children younger than five found that more than half of 17 studies significantly improved children´s motor skills (Riethmuller et al., 2009). Thus, our results can be attributed to the physical activity component of the intervention, which included (i) the rearrangement of the classroom in order to assist the children to be more active, (Yasmeen et al.) the performance of two

structured physical education sessions per week and (iii) children's active participation in classroom activities of a minimum of one hour per week and (iv) distribution of intervention material to parents/caregivers.. As children do not learn motor skills and abilities naturally (Hardy, Reinten-Reynolds, Espinel, Zask, & Okely, 2012) it is important to differentiate the implementation of guided physical education sessions. Children need to be instructed and practice through a varied range of active play experiences and multifaceted structured programs (Hardy et al., 2012). In this context an additional strength of the ToyBox program is the focus on training sessions for teachers who implemented the intervention. This importance is supported by Martin et al. suggesting that early childhood teachers may have limited knowledge about the individual components of motor skills (Martin, 2003). Many teachers lack the skill to teach physical education efficiently (Morgan & Hansen, 2008). It is necessary for teachers to understand the process of developing motor skills and abilities, their importance and ways of teaching.

Another important finding is the sex difference in the effectiveness of the intervention. Boys profited more from the program and improved more in SLJ than girls. In contrast, the intervention had similar positive effects regarding JSS in both sexes. Inconsistent findings regarding movement skills interventions in relation to sex differences are summarized in the review of Morgan at al. (Morgan et al., 2013). In general boys are more physically active than girls (Hinkley, Crawford, Salmon, Okely, & Hesketh, 2008; Pate, Pfeiffer, Trost, Ziegler, & Dowda, 2004; Williams et al., 2008) and girls tend to skip and hop more and do activities such as dancing and gymnastics (Okely & Booth, 2004). A meta analyses about sex differences in

motor performance in childhood reported males outperforming females in tasks involving power and strength, and females being the better performer on flexibility and balance tasks (Thomas & French, 1985). Although the ToyBox intervention addresses all children, there may be a gender specific lack of attention and different preferences in physical activities. Girls may need to be addressed with gender specific opportunities. Thus, gender should be taken into consideration when designing appropriate physical activity sessions in education setting. Further research is needed in order to examine gender specific offerings and teaching strategies for physical activity in early childhood.

We found different intervention effects in relation to the children´s age. The intervention was mostly effective on motor ability outcomes in children older than 5 years. A significant positive intervention effect was already detected in children aged 4.3 to 5 years for JSS, but it was not significant for SLJ. We could show that the intervention had no effect on children aged 3 to 4.3 years. This is in line with a study of Williams at al. (Williams et al., 2008) detecting that four year old children had higher scores in motor skill performance and stronger relationship between level of motor skill performance and physical activity than three year old children. At this age, motor skills are still emerging and the acquisition is determined by appropriation and elaboration of movements (Scheid, 1994; Williams et al., 2008). Hopping for example, is a complex skill requiring a considerable degree of strength and coordination, and it is a latter maturity skill (Payne & Isaacs, 2012). Thus, to also address younger children, future interventions in setting kindergarten need to include more age specific games and exercises.

We found that different socio-economic status does influence the effects of the intervention. Intervention children with low SES showed significantly greater improvement in JSS. Their increase in JSS was six jumps higher to the control group. In contrast, children with high SES revealed the smallest amelioration in both tests. In general, children with lower SES background are less physically active (Federico, Falese, & Capelli, 2009), have lower levels of physical fitness (Lammle et al., 2012) and motor skills (Sprague, Kile, Lipscomb, McClelland, & MacDonald, 2013) compared to children with higher SES background. This can be attributed to socio-environmental factors e.g. lack of physical activity opportunities and unsafe playgrounds in low SES (de Vet, de Ridder, & de Wit, 2011; Evans & Kantrowitz, 2002) and home environments. Children from lower SES have greater media access, but lower access to portable play equipment (Tandon et al., 2012). Barnett at al. confirm that having skill-related equipment present at home is positively associated with motor skills (L. Barnett, Hinkley, Okely, & Salmon, 2013). In this context, our data suggest that the program is more activating children and their families with low SES and illustrates the importance of designing school-based approaches to promote physical activity and motor performance in kindergarten.

In this context we had expected similar results in SLJ. In contrast to the positive intervention effect for children in low SES regarding JSS, we found controversial results in SLJ. While intervention children of medium and high SES increased their strength significantly more compared to control children, we found a negative intervention effect for children of low SES. This finding is caused by the fact that the children of two control kindergartens increased their SLJ scores by 23.1 and 17.7 on average -

compared to the mean amelioration of 10.4 among the control group. These two kindergartens, however, showed no abnormalities with respect to biological or socio-economic characteristics. Therefore, we are not able to give comprehensive explanation about this observation.

The strength of this study was the large sample of children with different socio-economic status. Furthermore, the intervention followed a standardized and evidence based protocol and assessments were done by trained field workers. The main limitation of the study was the low assessment of motor characteristics. As we only conducted two different tests measuring coordination and strength, we are not able to give any statement regarding the basic abilities flexibility and endurance. To capture a full description of motor performance ability status it is necessary to measure all motor abilities as research implies that motor performance ability is a complex multidimensional construct and cannot be described by using only one parameter (Lämmle et al.).

Our study indicates that a well designed and implemented intervention in the kindergarten setting can be effective for improving specific motor performance ability in 3-6 year old children. Based on our findings, it is important to put particular focus on targeting girls, children aged 3-4.3 years, and with low SES. Planned and structured activities that promote motor development should be a pivotal component in education settings, and they should aim at specifically targeting subgroups based on age, gender and SES.

Abbreviations: BMI: body mass index; SES: socio-economic status; JSS: jumping from side to side; SLJ: standing long jump; SD: standard deviation; EBRBs: energy balance-related behaviours.

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Table 1 Anthropometric, demographic, social and behavioural characteristics of the intervention and control group at baseline.

Characteristics		Intervention (n = 863)	Control (n = 430)
Anthropometric data			
Age (years)	Mean ± SD	4.6 ± 0.71	4.6 ± 0.65
Weight (kg)	Mean ± SD	18.3 ± 2.97	18.6 ± 3.13
Height (cm)	Mean ± SD	107.6 ± 6.28	108.2 ± 6.65
BMI	Mean ± SD	15.7 ± 1.52	15.8 ± 1.37
Demographic Parameters			
Sex	Male	434 (50%)	234 (54%)
	Female	429 (50%)	196 (46%)
Child BMI [2]	underweight	43 (5%)	16 (4%)
	normal	741 (87%)	381 (89%)
	overweight	44 (5%)	17 (4%)
	obese	26 (3%)	14 (3%)
	(missing)	9	2
Mother BMI[3]	underweight	30 (4%)	13 (3%)
	normal	469 (64%)	256 (66%)
	overweight	166 (23%)	86 (22%)
	obese	64 (9%)	33 (9%)
	(missing)	134	42
Father BMI [3]	underweight	2 (0%)	2 (1%)
	normal	271 (40%)	142 (38%)
	overweight	332 (49%)	182 (49%)
	obese	68 (10%)	43 (12%)
	(missing)	190	61
Social and behavioural			
Parameters			
Socio-economic status[4]	Low tertile	175 (20%)	72 (17%)
	Medium tertile	351 (41%)	94 (22%)

	High tertile	337 (39%)	264 (61%)
Member in sports club	No	368 (50%)	203 (51%)
	Yes	372 (50%)	196 (49%)
	(missing)	123	31
Years of education mother	<=12yr	172 (24%)	92 (23%)
	13-14 years	213 (30%)	117 (30%)
	15-16 years	110 (15%)	79 (20%)
	≥ 16 years	221 (31%)	108 (27%)
	(missing)	147	34
Years of education father	<=12yr	153 (23%)	75 (20%)
	13-14 years	161 (24%)	97 (26%)
	15-16 years	116 (17%)	64 (17%)
	≥ 16 years	242 (36%)	138 (37%)
	(missing)	191	56

P values were assessed using χ^2 test for categorical variables (except for father BMI where we used Fisher`s exact test) and t-test for normally distributed variables. Significance levels were as follows: *P<0.05;**P<0.01; ***P<0.001; Missing, not available data; [1] Age: low tertile (3.03 – 4.26 yrs), medium tertile (4.27 – 4.98 yrs), high tertile (4.98 – 6.51 yrs); [2] BMI according to classification by Kromeyer-Hausschild et al; [3] Parental BMI according to WHO classification; [4] Socio-economic status classified according to annual income

Table 2 Regression coefficients from GEE models for the effect of the intervention on jumping from side to side (JSS) and standing long jump (SLJ) on sex with and without interaction effect.

			JSS			**SLJ**	
	Independent variable	Estimate	P	Significance	Estimate	P	Significance
Sex							
without interaction	Intervention	2.3	0.0074	**	2.79	0.08	
	Female	-2.69	0.0003	***	-1.4	0.20	
with interaction	Testgroup Intervention	2.61	0.06		5.13	0.0049	**
	Female	-2.26	0.10		1.89	0.15	

	Female * Intervention	-0.65	0.69		-4.94	0.0110	*

*P<0,05;**P<0,01; ***P<0,001

Table 3 Regression coefficients from GEE models for the effect of the intervention on jumping from side to side (JSS) and standing long jump (SLJ) stratified by age.

Stratification variable	Independent variable	JSS			SLJ		
Age		Estimate	P	Significance	Estimate	P	Significance
Low tertile	Testgroup Intervention	0.79	0.44		-0.02	0.99	
Medium tertile	Testgroup Intervention	2.45	0.035	*	2.66	0.19	
High tertile	Testgroup Intervention	3.38	0.0044	**	4.18	0.038	*

*P<0.05;**P<0.01; ***P<0.001; Age: low tertile (3,03 – 4,26yrs), medium tertile (4,27 – 4,98yrs), high tertile (4,98 – 6,51yrs)

Table 4 Regression coefficients from GEE models for the effect of the intervention on jumping from side to side (JSS) and standing long jump (SLJ) stratified by SES.

Stratification variable	Independent variable	JSS			SLJ		
SES		Estimate	P	Significance	Estimate	P	Significance
Low tertile	Testgroup Intervention	5.98	0.0001	***	-5.48	0.036	*
Medium tertile	Testgroup Intervention	1.74	0.43		6.06	0.0204	*
High tertile	Testgroup Intervention	0.81	0.47		4.61	0.021	*

*P<0.05;**P<0.01; ***P<0.001; Socio-economic status (Mongraw-Chaffin et al.) classified according to annual income

Supplementary Section

Table 5 Regression coefficients from GEE models for association of jumping from side to side (JSS) and standing long jump (SLJ) with demographic and anthropometric (age, BMI child, parental BMI), social and behavioural (SES, parental years of education, member in sport club) parameters with and without interaction effect.

		JSS			SLJ		
	Independent variable	Estimate	P	Significance	Estimate	P	Significance
***Age*[1]**							
without interaction	Testgroup Intervention	2.29	0.0081	**	2.65	0.09	
	Age medium tertile	2.52	0.0001	***	-2.17	0.054	
	Age high tertile	3.6	<0.0001	***	-5.31	<0.0001	***
with interaction	Testgroup Intervention	0.75	0.48		0.42	0.84	
	Age medium tertile	1.3	0.27		-3.96	0.09	
	Age high tertile	1.74	0.06		-7.97	<0.0001	***
	Age medium tertile * Intervention	1.79	0.20		2.63	0.32	
	Age high tertile * Intervention	2.73	0.025	*	3.91	0.10	
***BMI*[2]**							
without interaction	Testgroup Intervention	2.27	0.0095	**	2.64	0.09	
	obese	-3.4	0.0028	**	-3.46	0.11	
	overweight	-2.84	0.0011	**	2.6	0.18	
	underweight	-2.5	0.0475	*	-0.04	0.98	
with interaction	Testgroup Intervention	2.31	0.011	*	2.8	0.08	
	obese	-2.87	0.20		-6.1	0.015	*
	overweight	-1.56	0.18		2.9	0.33	
	underweight	-3.68	0.08		4.7	0.26	
	obese* Intervention	-0.82	0.75		4.05	0.31	
	overweight*Intervention	-1.79	0.26		-0.43	0.91	
	underweight*Intervention	1.62	0.54		-6.52	0.14	
***BMI mother*[3]**							
without	Testgroup Intervention	2.13	0.011	*	2.83	0.09	

interaction	underweight	-1.24	0.46		1.51	0.58	
	overweight	-0.67	0.33		-0.49	0.66	
	obese	-2.12	0.034	*	0.81	0.72	
	Testgroup Intervention	2.33	0.02	*	3.35	0.07	
	underweight	-1.18	0.66		1.96	0.77	
with	overweight	0	1.00		-0.03	0.99	
	obese	-2.34	0.15		3.46	0.41	
interaction	underweight*Intervention	-0.09	0.98		-0.7	0.92	
	overweight*Intervention	-1	0.54		-0.7	0.77	
	obese* Intervention	0.33	0.87		-3.98	0.42	
BMI father[3]							
	Testgroup Intervention	2.28	0.0069	**	2.15	0.21	
without	underweight	1.01	0.84		4.46	0.28	
interaction	overweight	0.72	0.21		0.45	0.69	
	obese	-0.15	0.86		0.66	0.74	
	Testgroup Intervention	8.62	<0.0001	***	9.32	<0.0001	***
	underweight	2.33	0.023	*	3.95	0.053	
with	overweight	-1.15	0.68		6.85	0.18	
	obese	0.41	0.63		2.61	0.20	
interaction	underweight*Intervention	1.65	0.33		1.37	0.65	
	overweight*Intervention	4.23	0.67		-4.19	0.61	
	obese* Intervention	0.49	0.67		-3.33	0.16	
SES[4]							
	Testgroup Intervention	2.07	0.029	*	2.99	0.054	
without	Low tertile	0.62	0.59		2.41	0.29	
interaction	High tertile	-0.69	0.52		1.43	0.46	
	Testgroup Intervention	1.67	0.44		5.96	0.0228	*
	Low tertile	-2.17	0.37		10.24	0.00019	***
with	High tertile	-0.27	0.90		2.73	0.20	
interaction	Low tertile* Intervention	4.13	0.12		-11.31	0.0020	**
	High tertile* Intervention	-0.87	0.72		-1.25	0.71	
School							

education							
mother							
	Testgroup Intervention	1.96	0.026	*	2.85	0.09	
without	13-14 years	0.72	0.34		-3.47	0.029	*
interaction	15-16 years	0.13	0.86		-1.25	0.49	
	> 16 years	0.44	0.53		-1.66	0.27	
	Testgroup Intervention	2.75	0.045	*	3.04	0.31	
	13-14 years	1.98	0.07		-3.01	0.14	
	15-16 years	0.57	0.66		-0.75	0.79	
with	≥ 16 years	0.64	0.61		-2.06	0.32	
interaction	13-14 years*Intervention	-1.95	0.19		-0.71	0.81	
	15-16 years*Intervention	-0.66	0.68		-0.84	0.82	
	> 16 years*Intervention	-0.31	0.84		0.59	0.84	
School							
education							
father							
	Testgroup Intervention	2.18	0.018	*	2.11	0.22	
without	13-14 years	1.16	0.14		-3.37	0.013	*
interaction	15-16 years	0.81	0.32		-2.86	0.06	
	> 16 years	0.81	0.39		-2.53	0.047	*
	Testgroup Intervention	2.06	0.17		1.64	0.53	
	13-14 years	0.91	0.39		-2.41	0.26	
	15-16 years	0.6	0.69		-3.32	0.07	
with	> 16 years	0.86	0.53		-3.83	0.027	*
interaction	13-14 years*Intervention	0.39	0.80		-1.58	0.57	
	15-16 years*Intervention	0.32	0.86		0.73	0.79	
	> 16 years*Intervention	-0.09	0.96		2.03	0.40	
Member in							
sports club							
without	Testgroup Intervention	2.11	0.020	*	2.66	0.11	
interaction	Member in sports club	1.04	0.045	*	1.97	0.044	*
with	Testgroup Intervention	2.11	0.03	*	2.16	0.18	

interaction	Member in sports club	1.05	0.21		0.8	0.61
	member in sports club*Intervention	-0.02	0.98		1.75	0.38

*P<0,05;**P<0,01; ***P<0,001; [1] Age: low tertile (3,03 – 4,26 yrs), medium tertile (4,27 – 4,98 yrs), high tertile (4,98 – 6,51 yrs); [2] BMI according to classification by Kromeyer-Hausschild et al; [3] Parental BMI according to WHO classification; [4] Socio-economic status adjusted for annual income