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Long-term effectiveness of a fundamental motor skill intervention in Belgian children: A 6-year follow-up.

Running title: Long-term effectiveness of Multimove

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ABSTRACT

The aim of this study was (1) to examine the long-term effectiveness of the 'Multimove for Kids' program, a 30-week fundamental motor skill intervention (approximately 1 hour per week) for typically developing children between 3 and 8 years, and (2) to determine the influence of participation in organized sports on motor competence (MC) six years after the intervention.

Of the 992 children who took part in the 'Multimove' program, 399 (intervention group: N=228, control group: N=171) were tested again at 6-year follow-up. MC was measured with the Test of Gross Motor Development, 2nd Edition. To examine the long-term impact of 'Multimove' on MC and the effect of participation in organized sports a latent growth curve analysis was conducted.

After the 30-week intervention, the intervention group outperformed the control group (β=5.57, p<.001). However, when the entire study period, including the 6-year follow-up, was considered, the intervention group made less progress in MC than the control group (β=-0.41, p<.05). Looking at the engagement in organized sports, it was found that years of experience before the intervention had no significant influence on the evolution of MC over time, whereas a positive effect was observed for children's average sports participation (h/week) during the 6-year retention period (β=0.14, p<.001). Finally, children practicing predominantly object control-oriented sports during retention, obtained slightly better MC scores at follow-up (β=0.01, p<.01).

The effect of the 'Multimove' intervention does not have a long-term effect on the development of MC. However, participation in organized sports has a positive influence on MC evolution over time.

Keywords: community-based intervention, long-term impact, motor competence, Multimove, organized sports participation

1 Introduction

Motor competence (MC) represents the degree of proficient performance in various motor skills as well as its underlying mechanisms (e.g., motor control and coordination)[1]. MC is associated with a range of health-related outcomes and is considered important in developing an active lifestyle[2–4]. Apart from displaying positive relationships with physical activity (PA)[5,6], MC is also associated with physical fitness[2,7], psychosocial well-being[8], cognitive skills[9], and inversely related to weight status[2,10] across childhood and adolescence. As a result, MC is considered an important prerequisite towards sports participation[11], since it is a key factor in learning new motor skills and building the necessary proficiency for novel motor tasks.

In order to improve health-related outcomes in children, numerous MC intervention programs have been implemented[12–14]. One of those interventions was the policy-based 'Multimove for Kids' program, implemented in 2012 in Flanders (Belgium), which is a fundamental motor/movement skill (FMS) intervention for typically developing children between 3 and 8 years. This 30-week program, consisting of weekly 1-hour sessions and focusing on 12 FMS themes, was found to significantly improve MC, both locomotor and object control skills[13].

The main aim of such programs is to counter the secular decline in MC and to have all children enjoy the lifelong benefits of an adequate MC level in the domains of physical activity, health, mental, and psychological well-being[6,15]. However, while most MC intervention studies provide evidence of short-term positive effects on MC, there is a dearth of studies looking into long-term effects[16]. As an exception, Barnett and colleagues[17] investigated the long-term impact of the "Move It, Groove It" intervention in primary school children by re-assessing children's FMS six years later, which yielded mixed results. The intervention group scored better on catching, jumping, and galloping, whereas no differences were found in throwing and kicking when compared to the control group. An important factor that may explain the discrepancy between findings is the child's engagement in sports or other activities during the retention period, since Logan et al.[5] provided strong evidence of positive associations between MC and physical activity. Previous studies already demonstrated that children practicing (a larger number of) organized sports or children being involved in more hours of organized sport per week displayed a more pronounced improvement in MC over developmental time[18–20]. In addition, Henrique et al.[19] and Barnett et al.[21] suggested that the effect of sports participation on long-term MC development may depend on the type of sports practiced in an organized context. Likewise, the biological constructs age and sex could also influence the development of MC. While previous research has already shown that girls have better scores on the balance tasks, no clear differences between both sexes were found on the locomotor tasks[21,22]. In addition, boys outperformed girls on object control-oriented tasks[13,21]. When it comes to age, a positive relationship with MC has been demonstrated[21–24]. However, the effect of potentially important factors such as sex or age, has yet to be extensively studied to fully appreciate the long-term impact of MC interventions.

To fill this gap, we studied the long-term effectiveness of a MC intervention while taking into account the potential influence of sex, age and organized sports participation. Therefore, the primary aim of the present study was to investigate the long-term effect of the 30-week 'Multimove' intervention, measured after a retention period of six years. The second aim was to study to what extent sex, age, as well as aspects of participation in organized sports (i.e., the years of experience in organized sports at the start of the study, the average amount of hours on weekly basis during retention, the type of organized sports practiced during retention) are responsible for MC improvement over six years.

2 Methods

2.1 Participants

The present study is a follow-up of the large-scale 'Multimove' project[13], in which 992 children, between 3 and 8 years, took part. Of this sample, 523 children received a 30-week intervention in 2012 (see procedures). The remaining 469 children did not receive any intervention and were classified as the control group. Follow-up data were then collected between August 2018 and

February 2019, approximately six years after the end of the intervention. Of the original 992 participants, 399 participants were re-assessed. A total of 228 children were part of the intervention group (response rate 43.6%; 125 boys; mean age: 11.82±1.41 years) and 171 belonged to the control group (response rate 36.5%; 91 boys; mean age: 10.79±1.17 years). Written informed consent to participate in the follow-up study was provided for each child by their parent(s) or legal guardian. The study protocol was approved by the Ethics Committee of Ghent University Hospital.

2.2 Procedures

In 2012, children in the intervention group received 30 weekly one hour exercise sessions focusing on FMS development. The 'Multimove' program provided a wide range of activities using six locomotor themes (i.e., running, climbing, swinging, gliding, rotating, jumping) and six object control themes (i.e., catching and throwing, pushing and pulling, lifting and carrying, hitting, kicking, dribbling) and has been described in detail elsewhere[13]. Briefly, the development and selection of the program content (i.e., developmentally appropriate activities for each skill theme) was based on motor development literature. During each session of approximately one hour, children of the intervention group practiced two or three FMS, using appropriately selected activities. For instance, hitting can be performed in different ways (e.g. underhand, overhand), alone or in a group, with different tools (e.g. hand, racket, stick) and objects (e.g. balloon, beach ball, tennis ball), stationary or moving, in various setups (e.g. even-inclined, high-low), and with different targets (e.g. small-large, close-distant). Six years later, all participants of the original intervention and control group received an invitation to be part of the follow-up measurement. During each measurement point (i.e., before the intervention (pre), after the 30-week intervention (post), six years later (follow-up)), participants wore light sports clothing and were barefooted. Test administration was conducted by experienced examiners conducting the assessments using standardized instructions in accordance with the test manual.

2.3 Measurements

Motor competence. The Test of Gross Motor Development, 2nd edition (TGMD-2) was used to evaluate MC. It is a process-oriented, validated, reliable, and norm-referenced test battery to assess actual MC in 3- to 10-year-old children[25]. The TGMD-2 shows an excellent test-retest reliability ($r \geq 0.88$) and inter-rater reliability ($r > 0.98$) as well as good internal consistency

(Cronbach α=0.85 for locomotor subtests, 0.88 for object control subtests, 0.91 for the total score). Content, construct, and concurrent validity have also been documented[25]. The TGMD-2 includes six locomotor skills (i.e., run, gallop, hop, leap, horizontal jump, and slide) and six object control skills (i.e., striking a stationary ball, stationary dribble, kick, catch, overhand throw, and underhand roll). Children are given two trials per skill and for each trial the performance is compared against technical criteria (three to five per skill), each of which is rated as present (=1) or absent (=0). A total of 24 criteria is assessed for both locomotion and object control skills, resulting in a maximum score of 96 (24 criteria × 2 trials × 2 types of skills). The total raw sum score was used in the analysis.

Organized sports participation. General information about children's participation in organized sports (i.e., average hours on a weekly basis and current type of sport) was obtained using sections of the Flemish Physical Activity Questionnaire (FPAQ)[26], which is shown to be a reliable instrument (test-retest reliability coefficients ranging from 0.69 to 0.93) to assess different dimensions of usual physical activity. Children's parent(s) or legal guardian completed a demographic questionnaire, including questions on their child's present engagement in organized sports activities and his/her sports history during retention (i.e., years of experience in organized sports at the start of the study, average hours of participation in organized sports on weekly basis during retention, and types of organized sports practiced during retention). Regarding the average number of hours in organized sports participation on weekly basis during retention, three questions related to each year of life were answered (1. *"Did your child participate in organized sports when he/she was X years old?"*, 2. "*Which organized sports did your child do when he / she was 2 years old?"*, 3. *"As a X year old child, how many hours per week in total did your child practice these organized sports activities during a regular week?")*, starting at the age of 2 years up to the current age of the child at the follow-up measurement (with a maximum of 14 years of age). When the answer to the first question was negative or when all three questions were completed for a certain age, the three questions were repeated for the child being one year older.

The child's experience in organized sports at baseline was calculated by subtracting his/her starting age in organized sports participation (reported in the first question for each year of life of the child) from his/her calendar age at baseline. For example, a 6-year-old child who participated in organized sports starting at the age of four was considered to have two years of experience in organized sports at the start of the study. Since most sports clubs in Belgium follow the school calendar (including terms and holiday breaks, starting in September and finishing in June) we decided to calculate this in the same way for all children. In addition, we verified the received information with the governing body overarching all Flemish sports federations, allowing us to check whether or not the children were actually enrolled in organized sports in the period of this research.

As suggested in the review of Hardesty and colleagues[27], the opinion of experts should be used when using a new scale to determine face validity. Therefore, we used the opinion of 13 academic experts in the field of motor development (all with a master degree and / or PhD in movement science) to determine the type of sports in which the children of this study participated during retention. The experts were asked to classify these sports as follows: predominantly locomotor (score -1), mixed (score 0), predominantly object control (score +1). Reliability analysis was performed by using Fleiss' kappa[28], which measures inter-rater agreement between the experts. Fleiss' kappa showed moderate agreement between the experts (κ=.428 (95% CI, .428 to .429); p<.001). Based on the input of the experts, an averaged value between -1 and +1 was obtained for all reported sports (see supplementary material). For example, all experts agreed '*running*' to be a predominantly locomotor-oriented sports with a value of '-1', '*Multimove*' to be a mixed sports with a value of '0', and '*golf*' to be a predominantly object control-oriented sports with a value of '1'. Three experts considered '*basketball*' to be a predominantly object control-oriented sports, while 10 other experts considered it as a mixed sport. This resulted in an averaged valued of 0.23 on the continuous scale '-1 to +1'. Finally, an individual weighted mean value was calculated for each participant. This was based on the expert-based values of the different reported sports the child practiced each year during retention, using the following formula: *weighted mean value = (mean (values of sports practiced in year 1) +…+ mean (values of sports practiced in year 6)/6).*

2.4 Statistical Analysis

A series of latent growth curve models (LGCMs; see Figure 1) were conducted for overall MC, locomotor skills, and object control skills to examine the change in MC over time. LGCM is a statistical technique used to analyze longitudinal data, to estimate growth over a period of time. Using this statistical approach allows for the estimation of inter-individual variability in intra-individual trajectories of change over time[29]. Effects of potentially confounding factors sex, age, and intervention participation (intervention versus control) were considered in the analysis. Additionally, it was examined whether participation in organized sports (i.e., years of experience in organized sports measured at baseline, average hours of organized sports participation on weekly basis as well as type of sports practiced during retention) affected the slope. Finally, the effect on the slope of MC evolution was also examined specifically for the intervention participation at post-measurement (T2) (see Figure 1). Maximum likelihood estimation was used for the LGCMs and significance level was set at $p<.05$.

A series of LGCMs were conducted. First, an intercept-only model with the intercept mean and residual variance constrained across time points was run (Model 1). In Model 2, the intercept variance was estimated. Next, the slope mean, and variance were included in Model 3 to estimate change in MC over time. In Model 4, sex and age were added to the model as covariates. Sex was inserted as a dummy variable (i.e., 0=boy, 1=girl), whereas mean-centered age (years) was inserted as a continuous variable. In Model 5, we included group as a dummy variable (i.e., 0=control group, 1=intervention group) and the effect of the intervention on the MC level at 30 weeks (i.e., post-intervention). In Model 6, participation in organized sports was included. We entered the experience in organized sports (years) as a continuous variable centered around the start of baseline assessment. Organized sports participation (mean hours/week) and type of sports (expert-based value) were included as continuous variables to examine their influence on change in MC. Finally, a model with all significant effects was run (Model 7). All latent growth curve analyses (LGCA) were conducted in R version 3.5.2 using the *lavaan* package[30].

3 Results

Table 1 presents the means and standard deviations of levels of MC (total raw scores on the TGMD-2) at each time point for the original intervention and control group separately as well as for the total sample. The children aged from 3-8 years at baseline to 9-14 years at follow-up (mean age at follow-up: 11.3 years ± 1.33). Their MC generally increased over time, which is also visualized in Figure 2A (the intervention group) and Figure 2B (the control group). Both figures show the variability in individual change of MC visualized by the thin lines, representing the individual trajectories of MC across six years. The results of the LGCA, based on the TGMD-2 total raw score, are reported in Table 2. The LGCMs with random intercepts and slopes demonstrated an average to good model fit[31] (RMSEA≤.099; SRMR≤.036; CFI≥.961). The analyses showed a positive linear evolution in TGMD-2 score over time (β=3.88, *p*<.001) with significant inter-individual variance (*p*<.001).

Girls had a lower TGMD-2 score at baseline (β=-4.06, *p*<.001). However, the improvement over time was not different for boys and girls. Older children had a significantly higher TGMD-2 score at baseline (β=8.41, *p*<.001) and demonstrated less change in TGMD-2 score over time (β=-1.11, *p*<.001).

At baseline, no significant difference existed between the intervention and control group. After the 30-week intervention, the intervention group outperformed the control group (β=5.57, *p*<.001). However, the intervention group made less progress in MC than the control group across the entire study period, including the 6-year follow-up (β=-0.41, *p*<.05).

With respect to participation in organized sports, the LGCA showed that the years of experience in organized sports at baseline was associated with a higher TGMD-2 score at baseline (β=0.57, *p*<.001), but had no influence on the evolution of MC. Organized sports participation (mean hours/week) during retention was positively related to change in TGMD-2 score over time (β=0.14, *p*<.001). With respect to type of sports, children predominantly practicing object control-oriented sports during retention showed a better evolution in MC (β=0.01, *p*<.01). The fit indices indicated that Model 5 seems to be the best model, showing that the organized sports variables are of no large influence when fitting the best model for change in MC over time.

Additional analyses for the raw locomotion scores and raw object control scores are presented in Table 3 and Table 4, respectively. The results of these additional analyses were generally in line with the abovementioned findings for the total test battery, described in Table 2.

4 Discussion

The purpose of this study was to investigate the long-term effect of the 'Multimove' program, six years after the intervention. In addition, the effect of sex, age, and the impact of participation in organized sports (i.e., years of experience in organized sports at baseline, organized sports participation (mean hours/week) during retention and type of sports (expert-based value) during retention) on MC evolution was examined.

A significant positive average change in MC over time was found, which is consistent with previous research[23,24,32,33]. In addition, significant variability in change in MC among individuals was established, similarly to the findings of Coppens et al.[33] and Rodrigues et al.[34]. This variability in the rate of change across the current sample is also visible in Figure 2A and 2B. The results show that the intervention group demonstrated higher levels of MC at post-measurement compared to the control group, which is in line with the findings of Bardid et al.[13]. Nonetheless, while there was an overall positive change in both groups during the retention period, the control group seemed to have caught up with their peers from the intervention group, indicating no long-term 'Multimove' effect on MC. Previous studies of Barnett et al.[17] and Zask et al.[35] have found mixed results with regard to the long-term effects of interventions on MC. For instance, Zask et al.[35] found differences in object control skills between the intervention and control group three years after the intervention. However, no differences were found when it comes to locomotor skills. One explanation for not finding a persistent effect of the Multimove program in this study may be the age difference between groups at baseline. Children in the control group were approximately one year younger than those in the intervention group at the time of follow-up, maybe providing them with a somewhat greater window of opportunity to level up their MC. However, after controlling for age, no significant difference between the intervention and control group at baseline was found. Another explanation might be that the 30-week intervention was not long or intensive enough to accomplish sustained effects. Since time spent in FMS practice is of great importance in improving MC[16], further investigations are needed to determine the optimal characteristics of interventions for long-term success, including program duration and frequency.

At baseline, boys outperformed girls on object control skills and overall MC, which is consistent with the findings in the systematic review of Barnett et al.[21]. No differences were found between boys and girls at baseline for locomotor skills. However, sex did not influence the change in MC over time, which is in agreement with the findings of Rodrigues et al.[34]. In fact, the role of sex on MC development seems to be ambiguous as Dos Santos et al.[32] and Coppens et al.[33] found contrasting results. Both of these studies used the product-oriented Körperkoördinationstest für Kinder, which focuses on a different aspect of MC when compared to the process-oriented

TGMD-2 used in the current study. The wide variation of MC instruments often inhibits the comparison of results across studies[4,36]. In light of these contrasting findings, there is a need for more research into how sex relates differently to various aspects of MC (evolution) and how this might be moderated by factors such as organized sports participation.

Older children had a higher level of MC at baseline. At the same time, our study results indicated that younger children show a more pronounced improvement of MC, which is consistent with previous findings of Coppens et al.[33]. Since the TGMD-2 is a criterion-referenced battery with a theoretical maximum total raw score, it is possible that the instrument encounters a ceiling effect, which limits the chance to identify changes in MC[37], especially in older and more skilled children[16,37]. Indeed, the distribution of total raw scores on the TGMD-2 in our sample was slightly skewed to the left, with 79.2% of the participants scoring above P75 and 11.0% even above P90 at follow-up. It is important to note here that the age at follow up ranged between 9 and 14 years, which implies that the majority of the group was older than the upper limit of the TGMD-2 (i.e. 10 years).

A second purpose of this study was to examine how participation in organized sports might influence the children's individual trajectories of change in MC. Therefore, we investigated three outcomes in relation to organized sports participation in order to answer three related secondary research questions (i.e., years of experience in organized sports at baseline: *Do the years of experience a child has in organized sports at baseline influence the subsequent development of MC, when looking at it six years later?*, average amount of hours on a weekly basis: *Do the children who spend more time participating in organized sports during retention have a better evolution in their MC development over the years?*, type of organized sports: *Does the type of sports practiced during retention has any influence on the MC development over time?*).

The years of experience in organized sports at baseline did not influence the evolution in overall MC or object control. However, children with less years of experience in organized sports, showed a steeper evolution in locomotor skills. This might be due to a greater margin for improvement in children with less expertise, who would score lower at baseline. Children involved in more weekly hours of organized sports during retention, displayed a more pronounced MC improvement. These findings are in line with other longitudinal studies[18–20], showing a positive association between MC and sports participation. This indicates that organized sports participation supports children in developing their motor skills, which is in agreement with the positive spiral of engagement as suggested by Stodden and colleagues[4]. As noted by Henrique et al.[19] and Barnett et al.[38], the effect of sports participation on long-term MC development may depend on the type of sports. Indeed, our study showed that children practicing predominantly object control-oriented sports during retention, displayed a slightly better evolution in MC. It may be that predominantly object control-oriented sports (e.g., football) provide more opportunities to develop both object control and locomotor skills compared to predominantly locomotor-oriented sports (e.g., running). However, while this is in line with previous studies that demonstrated an advantage of object control skill over locomotor skill development in childhood due to continued and more varied participation in sports and games[39,40], the effect in the present study was only marginal. Furthermore, when the progress in locomotion and object control was considered separately, the effect of the type of sports practiced during retention was negligible, given the very small coefficient value. It is clear that organized sports participation benefits MC development but more research is needed to understand what type of organized sports participation influences MC development and to what extent. This will help further inform policy and practice.

Strengths and limitations

Our longitudinal design with a retention period of six years and the use of LGCA are major strengths of the current study. In addition, to our knowledge, this is the first intervention study in the field of motor development research that studies the impact of three different outcomes in relation to organized sports participation. However, some limitations need to be addressed. First, since 40.2% of the original sample agreed to participate in the follow-up measurement, there is a chance of non-random failure in the data. In order to correct for any baseline differences, group was included in the model as a covariate for the intercept. Secondly, the TGMD-2 was used for the assessment of MC across time although the majority of children already fell outside the age range of the test during follow-up measurement. However, few MC instruments have been developed for use in both children and adolescents and many focus on child populations[41]. As noted by Hulteen et al.[41], there is a need for further investigation into the use of existing instruments in adolescent populations. Third, we have used proxy-report for the outcomes of organized sports participation, which are subjective and prone to recall bias, especially with retrospective information requested on sports participation history. However, this is a first attempt to capture organized sports participation in a more detailed and systematic manner using specific questions on type and frequency of participation across years. Nonetheless, more research is needed to further investigate this proxy-report and its psychometric properties.

5 Perspectives

As current research mainly provides insight in the short-term effect of MC interventions, studies investigating the long-term impact are needed. Equally important is to gain more insight in the individual and environmental factors underlying children's MC trajectories over time, especially in view of the secular decline in MC levels among youth[24,42]. More longitudinal evidence is needed to determine the optimal characteristics of effective interventions in order to expose children to positive sports experiences, allowing them to develop MC[24], which is a key factor in improving the likelihood for long-term engagement in sports and other forms of physical activity[43]. While previous studies already indicated that the duration of effective intervention programs varied[12,13], further investigations are needed to determine the optimal characteristics of a MC program (e.g., type of approach, amount of instruction time, frequency, duration) to be successful in maintaining its intervention effects in the long run. This can help us in order to provide guidelines for a more efficient design to facilitate an effective long-term impact of interventions like the 'Multimove' project. In addition, this will help to support positive health trajectories across childhood and adolescence[3], and to inform decision making in policy and practice.

CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

6 References

1. Utesch T, Bardid F. Motor Competence. In: Hackfort D, Schinke R, Strauss B, eds. *Encyclopedia of Exercise Medicine in Health and Disease*. Amsterdam: Elsevier; 2019:595-595. doi:10.1007/978-3-540-29807-6_4369

2. Cattuzzo MT, dos Santos Henrique R, Ré AHN, et al. Motor competence and health related physical fitness in youth: A systematic review. *J Sci Med Sport*. 2016;19(2):123-129. doi:10.1016/j.jsams.2014.12.004

3. Robinson LE, Stodden DF, Barnett LM, et al. Motor Competence and its Effect on Positive Developmental Trajectories of Health. *Sport Med*. 2015;45(9):1273-1284. doi:10.1007/s40279-015-0351-6

4. Stodden D, Goodway JD, Langendorfer S, Roberton MA, Rudisill M. A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. *Quest*. 2008;60(2):290-306. doi:10.1080/00336297.2008.10483582

5. Logan SW, Webster EK, Getchell N, Pfeiffer KA, Robinson LE. Relationship Between Fundamental Motor Skill Competence and Physical Activity During Childhood and Adolescence: A Systematic Review. *Kinesiol Rev*. 2015;4:416-426. doi:10.1123/kr.2013-0012

6. Hulteen RM, Morgan PJ, Barnett LM, Stodden DF, Lubans DR. Development of Foundational Movement Skills: A Conceptual Model for Physical Activity Across the Lifespan. *Sport Med*. 2018;48(7):1533-1540. doi:10.1007/s40279-018-0892-6

7. Utesch T, Bardid F, Büsch D, Strauss B. The relationship between motor competence and physical fitness from early childhood to early adulthood: A meta-analysis. *Sport Med*. 2019;(0123456789). doi:10.1007/s40279-019-01068-y

8. Skinner RA, Piek JP. Psychosocial implications of poor motor coordination in children and adolescents. *Hum Mov Sci*. 2001;20(1-2):73-94. doi:10.1016/S0167-9457(01)00029-X

9. van der Fels IMJ, te Wierike SCM, Hartman E, Elferink-Gemser MT, Smith J, Visscher C. The relationship between motor skills and cognitive skills in 4-16 year old typically developing children: A systematic review. *J Sci Med Sport*. 2015;18(6):697-703. doi:10.1016/j.jsams.2014.09.007

10. D’Hondt E, Deforche B, Gentier I, et al. A longitudinal analysis of gross motor coordination in

overweight and obese children versus normal-weight peers. *Int J Obes*. 2013;37(November 2011):61-67. doi:10.1038/ijo.2012.55

11. De Meester A, Aelterman N, Cardon G, De Bourdeaudhuij I, Haerens L. Extracurricular school-based sports as a motivating vehicle for sports participation in youth : a cross-sectional study. *Int J Behav Nutr Phys Act*. 2014:1-15.

12. Logan SW, Robinson LE, Wilson AE, Lucas WA. Getting the fundamentals of movement: A meta-analysis of the effectiveness of motor skill interventions in children. *Child Care Health Dev*. 2012;38(3):305-315. doi:10.1111/j.1365-2214.2011.01307.x

13. Bardid F, Lenoir M, Huyben F, et al. The effectiveness of a community-based fundamental motor skill intervention in children aged 3–8 years: Results of the "Multimove for Kids" project. *J Sci Med Sport*. 2017:6-11. doi:10.1016/j.jsams.2016.07.005

14. Van Beurden E, Barnett LM, Zask A, et al. Can we skill and activate children through primary school physical education lessons ? " Move it Groove it "— a collaborative health promotion intervention. *Prev Med (Baltim)*. 2003;36:493-501. doi:10.1016/S0091-7435(02)00044-0

15. Cairney J, Dudley D, Kwan M, Bulten R, Kriellaars D. Physical Literacy, Physical Activity and Health: Toward an Evidence-Informed Conceptual Model. *Sport Med*. 2019;49(3):371-383. doi:10.1007/s40279-019-01063-3

16. Morgan APJ, Barnett LM. Fundamental Movement Skill Interventions in Youth : A Systematic Review and Meta-analysis. *Pediatrics*. 2013;132(5).

17. Barnett LM, Van Beurden E, Morgan PJ, Brooks LO, Zask A, Beard JR. Six year follow-up of students who participated in a school-based physical activity intervention : a longitudinal cohort study. *Int J Behav Nutr Phys Act*. 2009;8:1-8. doi:10.1186/1479-5868-6-48

18. Fransen J, Deprez D, Pion J, et al. Changes in Physical Fitness and Sports Participation among Children with Different Levels of Motor Competence: A 2-Year Longitudinal Study. *Pediatr Exerc Sci*. 2014;26(1):11-21. doi:10.1123/pes.2013-0005

19. Henrique RS, Ré AHN, Stodden DF, et al. Association between sports participation , motor competence and weight status : A longitudinal study. *J Sci Med Sport*. 2016;19(10):825-829. doi:10.1016/j.jsams.2015.12.512

20. Vandorpe B, Vandendriessche J, Vaeyens R, et al. Relationship between sports participation and

the level of motor coordination in childhood : A longitudinal approach. *J Sci Med Sport*. 2012;15(3):220-225. doi:10.1016/j.jsams.2011.09.006

21. Barnett LM, Lai SK, Veldman SLC, et al. Correlates of Gross Motor Competence in Children and Adolescents : A Systematic Review and Meta-Analysis. *Sport Med*. 2016;46(11):1663-1688. doi:10.1007/s40279-016-0495-z

22. Rodrigues LP, Luz C, Cordovil R, et al. Normative values of the motor competence assessment (MCA) from 3 to 23 years of age. *J Sci Med Sport*. 2019;22(9):1038-1043. doi:10.1016/j.jsams.2019.05.009

23. Ahnert J, Schneide W, Bos K. Developmental changes and individual stability of motor abilities from the preschool period to young adulthood. In: *Human Development from Early Childhood to Early Adulthood: Evidence from the Munich Longitudinal Study on the Genesis of Individual Competencies (LOGIC)*. ; 2009:35-62.

24. Vandorpe B, Vandendriessche J, Lefevre J, et al. The KörperkoordinationsTest für Kinder: Reference values and suitability for 6-12-year-old children in Flanders. *Scand J Med Sci Sport*. 2011;21(3):378-388. doi:10.1111/j.1600-0838.2009.01067.x

25. Ulrich DA. *Test of Gross Motor Development*. Austin, TX: PRO-ED; 2000.

26. Philippaerts RM, Matton L, Wijndaele K, Balduck A. Validity of a Physical Activity Computer Questionnaire in 12- to 18-year-old Boys and Girls. *Int J Sports Med*. 2006. doi:10.1055/s-2005-837619

27. Hardesty DM, Bearden WO. The use of expert judges in scale development. Implications for improving face validity of measures of unobservable constructs. *J Bus Res*. 2004;57(2):98-107. doi:10.1016/S0148-2963(01)00295-8

28. Fleiss, J. L., Levin, B., & Paik MC. *Statistical Methods for Rates and Proportions*. 3rd ed. Hoboken, NJ: Wiley; 2003.

29. Duncan TE, Duncan SC. The ABC's of LGM: An Introductory Guide to Latent Variable Growth Curve Modeling. *Soc Personal Psychol Compass*. 2009;3(6):979-991. doi:10.1111/j.1751-9004.2009.00224.x

30. Rosseel Y. Lavaan: An R Package for Structural Equation Modeling. *J Stat Softw*. 2012;48(2):1-36.

31. Hooper D, Coughlan J, Mullen MR. Structural equation modelling: Guidelines for determining model fit. *Electron J Bus Res Methods*. 2008;6(1):53-60. doi:10.21427/D79B73

32. dos Santos MAM, Nevill AM, Buranarugsa R, et al. Modeling children ' s development in gross motor coordination reveals key modifiable determinants . An allometric approach. *Scand J Med Sci Sport*. 2018;(January):1594-1603. doi:10.1111/sms.13061

33. Coppens E, Bardid F, Deconinck FJA, et al. Developmental Change in Motor Competence : A Latent Growth Curve Analysis. *Front Physiol*. 2019;10(October):1-10. doi:10.3389/fphys.2019.01273

34. Rodrigues LP, Stodden DF, Lopes VP. Developmental pathways of change in fitness and motor competence are related to overweight and obesity status at the end of primary school. *J Sci Med Sport*. 2016;19(1):87-92. doi:10.1016/j.jsams.2015.01.002

35. Zask A, Barnett LM, Rose L, et al. Three year follow-up of an early childhood intervention: Is movement skill sustained? *Int J Behav Nutr Phys Act*. 2012;9(1):1-9. doi:10.1186/1479-5868-9-127

36. da Luz CMN, de Almeida GSN, Rodrigues LP, Cordovil R. The evaluation of motor competence in typically developing children: An integrative review. *J Phys Educ*. 2017;28(1):1-18. doi:10.4025/jphyseduc.v28i1.2857

37. Barnett LM, Lai SK, Veldman SLC, et al. Correlates of Gross Motor Competence in Children and Adolescents: A Systematic Review and Meta-Analysis. *Sport Med*. 2016;46(11):1663-1688. doi:10.1007/s40279-016-0495-z

38. Barnett L, Hinkley T, Okely AD, Salmon J. Child, family and environmental correlates of children's motor skill proficiency. *J Sci Med Sport*. 2013;16(4):332-336. doi:10.1016/j.jsams.2012.08.011

39. Stodden DF, Gao Z, Goodway JD, Langendorfer SJ. Dynamic relationships between motor skill competence and health-related fitness in youth. *Pediatr Exerc Sci*. 2014;26(3):231-241. doi:10.1123/pes.2013-0027

40. Barnett LM, Morgan PJ, Van Beurden E, Ball K, Lubans DR. A reverse pathway? Actual and perceived skill proficiency and physical activity. *Med Sci Sports Exerc*. 2011;43(5):898-904. doi:10.1249/MSS.0b013e3181fdfadd

41. Hulteen RM, Barnett LM, True L, Lander NJ, del Pozo Cruz B, Lonsdale C. Validity and reliability evidence for motor competence assessments in children and adolescents: A systematic review. *J Sports Sci*. 2020;38(15):1-82. doi:10.1080/02640414.2020.1756674

42. Roth K, Ruf K, Obinger M, et al. Is there a secular decline in motor skills in preschool children? *Scand J Med Sci Sport*. 2010;20(4):670-678. doi:10.1111/j.1600-0838.2009.00982.x

43. Hulteen RM, Lander NJ, Morgan PJ, Barnett LM, Robertson SJ, Lubans DR. Validity and Reliability of Field-Based Measures for Assessing Movement Skill Competency in Lifelong Physical Activities: A Systematic Review. *Sport Med*. 2015;45(10):1443-1454. doi:10.1007/s40279-015-0357-0

7 Tables

Table 1. Descriptive statistics of age at follow-up, motor competence raw scores at each time point and participation in organized sports in both the intervention and control group, as well as in the total sample.

	Intervention group (*N* = 228; 125 boys)	**Control group (*N*=171; 91 boys)**	**Total Sample (*N*=399; 216 boys)**
Age (years) at T3	11.82 ± 1.41	10.79 ± 1.17	11.3 ± 1.33
Motor competence at each time point			
TGMD-$2_{\text{TOTAL RAW SCORE}}$ at T1	60.38 ± 15.3	52.06 ± 14.7	56.81 ± 15.6
TGMD-$2_{\text{TOTAL RAW SCORE}}$ at T2	67.92 ± 14.9	56.17 ± 14.5	62.88 ± 15.8
TGMD-$2_{\text{TOTAL RAW SCORE}}$ at T3	82.76 ± 7.2	83.22 ± 6.8	82.96 ± 7.0
Participation in organized sports			
Experience in organized sport at baseline (years)	1.77 ± 1.88	1.45 ± 2.57	1.62 ± 2.23
Mean organized sports participation (hours/week)	3.05 ± 1.53	2.51 ± 1.48	2.83 ± 1.53
Type of sports (-1 (locomotor) to +1 (object control))	.31 ± .42	.29 ± .43	.29 ± .42

TGMD-2: Test of Gross Motor Development - 2^{nd} edition ; T1: Pre-intervention/Baseline, T2: Post-intervention, T3: Follow-up

Table 2. Results of the latent growth curve analyses based on total raw score of the TGMD-2.

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
Intercept mean	67.55	***	67.55	***	58.68	***	62.50	***	60.47	***	55.51	***	57.56	***
Sex							-3.95	***	-3.82	***	-4.31	***	-4.06	***
Age							9.19	***	8.82	***	8.13	***	8.41	***
Intervention participation									0.60	*n.s.*	-1.03	*n.s.*	-0.55	*n.s.*
Experience in organized sports (years)											0.93	***	0.57	***
Intercept variance			34.37	**	216.05	***	64.45	***	67.20	***	64.34	***	64.98	***
Residual variance	305.74		271.37		48.80		48.80		39.19		35.78		35.78	
Slope mean					3.72	***	4.02	***	4.48	***	4.29	***	3.88	***
Sex							-0.04	*n.s.*	-0.06	*n.s.*	0.02	*n.s.*	-0.04	*n.s.*
Age							-1.16	***	-1.06	***	-1.05	***	-1.11	***
Intervention participation									-0.76	***	-0.31	*n.s.*	-0.41	*
Mean organized sports participation (hours/week)											0.15	***	0.14	***
Type of sports (locomotor-mixed-object control)											0.01	**	0.01	**
Experience in organized sports (years)											-0.08	*n.s.*		
Time varying effects														
Intervention at post-measurement									5.56	***	5.57	***	5.57	***
Slope variance					2.96	***	0.52	*	0.76	***	1.08	***	1.09	***
Covariance					-26.05	***	-7.13	***	-7.42	***	-8.39	***	-8.48	***

χ2	1446.04	1431.20	76.72	82.00	15.11	43.63	46.97
df	7	6	3	5	5	10	11
RMSEA	0.718	0.772	0.248	0.196	0.071	0.1	0.099
SRMR	1.922	1.907	0.071	0.048	0.013	0.033	0.036
CFI	0.000	0.000	0.865	0.920	0.990	0.964	0.961

* $p<.05$; ** $p<.01$; *** $p<.001$; *n.s.*: not significant

TGMD-2: Test of Gross Motor Development - 2nd edition

Table 3. Results of the latent growth curve analyses based on locomotion raw score.

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
Intercept mean	36.58	***	36.58	***	32.68	***	30.33	***	29.14	***	26.12	***	26.12	***
Sex							0.99	*n.s.*	1.08	*n.s.*	0.80	*n.s.*	0.80	*n.s.*
Age							4.31	***	4.10	***	3.68	***	3.68	***
Intervention participation									0.61	*n.s.*	-0.14	*n.s.*	-0.14	*n.s.*
Experience in organized sports (years)											0.52	***	0.52	***
Intercept variance			9.93	**	55.71	**	22.14	**	22.54	**	21.50	**	21.50	**

Residual variance	74.63		64.70	*	19.11	*	19.11	*	16.80	*	16.68	*	16.68	*
Slope mean					1.63	***	2.02	***	2.29	***	2.36	***	2.36	***
Sex							-0.18	*	-0.20	*	-0.15	*n.s.*	-0.15	*n.s.*
Age							-0.59	***	-0.54	***	-0.51	***	-0.51	***
Intervention participation									-0.26	**	-0.19	*n.s.*	-0.19	*n.s.*
Mean organized sports participation (hours/week)											0.07	***	0.07	***
Type of sports (locomotor-mixed-object control)											0.00	*	0.00	*
Experience in organized sports (years)											-0.06	*	-0.06	*
Time varying effects														
Intervention at post-measurement									2.74	***	2.84	***	2.84	***
Slope variance					0.77	***	0.15	*n.s.*	0.19	*	0.24	**	0.24	**
Covariance					-7.33	***	-2.75	***	-2.76	***	-2.94	***	-2.94	***
$\chi 2$	1176.45		1156.35		47.49		47.55		19.17		45.14		45.14	

df	7	6	3	5	5	10	10
RMSEA	0.642	0.688	0.191	0.145	0.084	0.102	0.102
SRMR	1.965	1.956	0.062	0.042	0.030	0.04	0.04
CFI	0.000	0.000	0.877	0.934	0.979	0.943	0.943

* p<.05; ** p<.01; *** p<.001; n.s.: not significant

Table 4. Results of the latent growth curve analyses based on object control raw score.

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
Intercept mean	30.96	***	30.96	***	25.97	***	32.26	***	31.41	***	29.47	***	29.83	***
Sex							-5.01	***	-4.95	***	-5.21	***	-5.16	***
Age							4.87	***	4.72	***	4.44	***	4.49	***
Intervention participation									-0.03	*n.s.*	-0.86	*n.s.*	-0.78	*n.s.*
Experience in organized sports (years)											0.41	**	0.35	***
Intercept variance			13.11	***	64.21	***	18.14	***	19.10	***	18.36	***	18.38	***
Residual variance	102.82		89.72		22.80		22.80		20.27		19.16		19.16	
Slope mean					2.09	***	1.98	***	2.18	***	1.90	***	1.90	***
Sex							0.16	*n.s.*	0.15	*n.s.*	0.18	*n.s.*	0.17	*n.s.*
Age							-0.58	***	-0.54	***	-0.54	***	-0.55	***
Intervention participation									-0.14	*n.s.*	-0.13	*n.s.*	-0.15	*n.s.*

Mean organized sports participation (hours/week)									0.09	***	0.09	***
Type of sports (locomotor-mixed-object control)									0.00	*n.s.*		
Experience in organized sports (years)									-0.02	*n.s.*		
Time varying effects												
Intervention at post-measurement							2.87	***	2.84	***	2.79	***
Slope variance			0.67	***	0.07	*n.s.*	0.14	*n.s.*	0.25	**	0.25	**
Covariance			-6.83	***	-1.80	***	-1.92	***	-2.26	***	-2.25	***
χ2	1161.30	1142.95	54.27		61.33		22.58		34.12		30.58	
df	7	6	3		5		5		10		9	
RMSEA	0.640	0.687	0.206		0.167		0.094		0.084		0.084	
SRMR	1.226	1.203	0.088		0.060		0.029		0.03		0.032	
CFI	0.000	0.000	0.878		0.932		0.979		0.968		0.972	

* $p<.05$; ** $p<.01$; *** $p<.001$; *n.s.*: not significant

8 Figure legends

Figure 1. Representation of the latent growth curve models of motor competence measured at three time points (T1, T2 and T3) with baseline (T1) age, sex, intervention participation as well as experience in organized sports as time-invariant covariate. Mean weekly amount of sports participation and type of sports (in between T2 and T3) were included as time-varying covariates, potentially affecting the slope. The latent intercept is constant for any child across time points as indicated by the fixed values of 1 for the factor loadings. The latent slope represents a child's motor competence trajectory with varying values (i.e., 0, 0.58 and 6.58) for the factor loadings representing the years in between the time points. The value starts at 0 to allow the mean intercept to be interpreted as the mean motor competence score at baseline (T1).

Figure 2A. Individual trajectories in motor competence (MC) over time, measured at three time points (T1 = pre-intervention , T2 = post-intervention and T3 = follow-up), based on the TGMD-2 total raw score for the *intervention group*.

Figure 2B. Individual trajectories in motor competence (MC) over time, measured at three time points (T1 = pre-intervention , T2 = post-intervention and T3 = follow-up), based on the TGMD-2 total raw score for the *control group*.

Table 2. Results of the latent growth curve analyses based on total raw score of the TGMD-2.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept mean	67,55 ***	67,55 ***	58,68 ***	62,50 ***	60,47 ***	55,51 ***	57,56 ***
Sex				-3,95 ***	-3,82 ***	-4,31 ***	-4,06 ***
Age				9,19 ***	8,82 ***	8,13 ***	8,41 ***
Intervention participation					0,60 n.s.	-1,03 n.s.	-0,55 n.s.
Experience in organized sports (years)						0,93 ***	0,57 ***
Intercept variance		34,37 **	216,05 ***	64,45 ***	67,20 ***	64,34 ***	64,98 ***
Residual variance	305,74	271,37	48,80	48,80	39,19	35,78	35,78
Slope mean			3,72 ***	4,02 ***	4,48 ***	4,29 ***	3,88 ***
Sex				-0,04 n.s.	-0,06 n.s.	0,02 n.s.	-0,04 n.s.
Age				-1,16 ***	-1,06 ***	-1,05 ***	-1,11 ***
Intervention participation					-0,76 ***	-0,31 n.s.	-0,41 *
Mean organized sports participation (hours/week)						0,15 ***	0,14 ***
Type of sports (locomotor-mixed-object control)						0,01 **	0,01 **
Experience in organized sports (years)						-0,08 n.s.	
Time varying effects							
Intervention at post-measurement					5,56 ***	5,57 ***	5,57 ***
Slope variance			2,96 ***	0,52 *	0,76 ***	1,08 ***	1,09 ***
Covariance			-26,05 ***	-7,13 ***	-7,42 ***	-8,39 ***	-8,48 ***
χ2	1446,04	1431,20	76,72	82,00	15,11	43,63	46,97
df	7	6	3	5	5	10	11
RMSEA	0,718	0,772	0,248	0,196	0,071	0,1	0,099
SRMR	1,922	1,907	0,071	0,048	0,013	0,033	0,036
CFI	0,000	0,000	0,865	0,920	0,990	0,964	0,961

* p <.05; ** p <.01; *** p <.001; n.s. : not significant

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Model 1	=	Intercept only (fixed)
Model 2	=	Random intercept
Model 3	=	Random slope
Model 4	=	Random slope with sex, age as covariates
Model 5	=	Model 4 + intervention participation as covariates
Model 6	=	Model 5 + mean sport participation, type of sport and experience in organized sports
Model 7	=	Significant effects of Model 6 only

Table 3. Results of the latent growth curve analyses based on locomotion raw score.

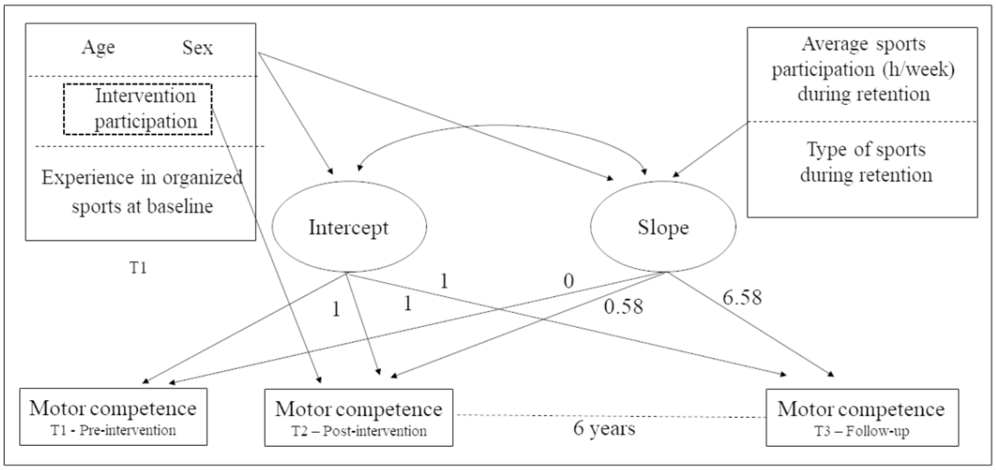
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept mean	36,58 ***	36,58 ***	32,68 ***	30,33 ***	29,14 ***	26,12 ***	26,12 ***
Sex				0,99 n.s.	1,08 n.s.	0,80 n.s.	0,80 n.s.
Age				4,31 ***	4,10 ***	3,68 ***	3,68 ***
Intervention participation					0,61 n.s.	-0,14 n.s.	-0,14 n.s.
Experience in organized sports (years)						0,52 ***	0,52 ***
Intercept variance		9,93 ***	55,71 ***	22,14 ***	22,54 ***	21,50 ***	21,50 ***
Residual variance	74,63	64,70	19,11	19,11	16,80	16,68	16,68
Slope mean			1,63 ***	2,02 ***	2,29 ***	2,36 ***	2,36 ***
Sex				-0,18 *	-0,20 *	-0,15 n.s.	-0,15 n.s.
Age				-0,59 ***	-0,54 ***	-0,51 ***	-0,51 ***
Intervention participation					-0,26 **	-0,19 n.s.	-0,19 n.s.
Mean organized sports participation (hours/week)						0,07 ***	0,07 ***
Type of sports (locomotor-mixed-object control)						0,00 *	0,00 *
Experience in organized sports (years)						-0,06 *	-0,06 *
Time varying effects							
Intervention at post-measurement					2,74 ***	2,84 ***	2,84 ***
Slope variance			0,77 ***	0,15 n.s.	0,19 *	0,24 **	0,24 **
Covariance			-7,33 ***	-2,75 ***	-2,76 ***	-2,94 ***	-2,94 ***
$\chi 2$	1176,45	1156,35	47,49	47,55	19,17	45,14	45,14
df	7	6	3	5	5	10	10
RMSEA	0,642	0,688	0,191	0,145	0,084	0,102	0,102
SRMR	1,965	1,956	0,062	0,042	0,030	0,04	0,04
CFI	0,000	0,000	0,877	0,934	0,979	0,943	0,943

* p<.05; ** p<.01; *** p<.001; n.s.: not significant

Table 4. Results of the latent growth curve analyses based on object control raw score.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept mean	30,96 ***	30,96 ***	25,97 ***	32,26 ***	31,41 ***	29,47 ***	29,83 ***
Sex				-5,01 ***	-4,95 ***	-5,21 ***	-5,16 ***
Age				4,87 ***	4,72 ***	4,44 ***	4,49 ***
Intervention participation					-0,03 n.s.	-0,86 n.s.	-0,78 n.s.
Experience in organized sports (years)						0,41 **	0,35 ***
Intercept variance		13,11 ***	64,21 ***	18,14 ***	19,10 ***	18,36 ***	18,38 ***
Residual variance	102,82	89,72	22,80	22,80	20,27	19,16	19,16
Slope mean			2,09 ***	1,98 ***	2,18 ***	1,90 ***	1,90 ***
Sex				0,16 n.s.	0,15 n.s.	0,18 n.s.	0,17 n.s.
Age				-0,58 ***	-0,54 ***	-0,54 ***	-0,55 ***
Intervention participation					-0,14 n.s.	-0,13 n.s.	-0,15 n.s.
Mean organized sports participation (hours/week)						0,09 ***	0,09 ***
Type of sports (locomotor-mixed-object control)						0,00 n.s.	
Experience in organized sports (years)						-0,02 n.s.	
Time varying effects							
Intervention at post-measurement					2,87 ***	2,84 ***	2,79 ***
Slope variance			0,67 ***	0,07 n.s.	0,14 n.s.	0,25 **	0,25 **
Covariance			-6,83 ***	-1,80 ***	-1,92 ***	-2,26 ***	-2,25 ***
$\chi 2$	1161,30	1142,95	54,27	61,33	22,58	34,12	30,58
df	7	6	3	5	5	10	9
RMSEA	0,640	0,687	0,206	0,167	0,094	0,084	0,084
SRMR	1,226	1,203	0,088	0,060	0,029	0,03	0,032
CFI	0,000	0,000	0,878	0,932	0,979	0,968	0,972

* p <.05; ** p <.01; *** p <.001; n.s. : not significant



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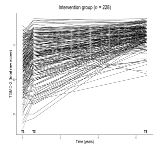

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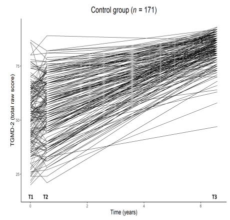

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