

## Chapter 8

# **Effectiveness of a school-based physical activity-related injury prevention programme on risk behaviour and neuromotor fitness; a cluster randomised controlled trial**

*Collard DCM, Chin A Paw MJM, Verhagen EALM, Bakker I, van Mechelen W. Effectiveness of a school-based physical activity-related injury prevention program on risk behaviour and neuromotor fitness; a cluster randomized controlled trial. International Journal of Behavioral Nutrition and Physical Activity. 2010. 28;7:9*

**Abstract**

**Background:** To investigate the effects of a school-based physical activity-related injury prevention programme, called 'iPlay', on risk behaviour and neuromotor fitness.

**Methods:** In this cluster randomised controlled trial 40 primary schools throughout the Netherlands were randomly assigned in an intervention (n=20) or control group (n=20). The study includes 2,210 children aged 10-12 years. The iPlay-intervention takes one school year and consists of a teacher manual, informative newsletters and posters, a website, and simple exercises to be carried out during physical education classes. Outcomes measures were self-reported injury preventing behaviour, self-reported behavioural determinants (knowledge, attitude, social-influence, self-efficacy, and intention), and neuromotor fitness.

**Results:** The iPlay-programme was not able to significantly improve injury-preventing behaviour. The programme did significantly improve knowledge and attitude, two determinants of behaviour. The effect of the intervention-programme on behaviour appeared to be significantly mediated by knowledge and attitude. Improved scores on attitude, social norm, self-efficacy and intention were significantly related to changes in injury preventing behaviour. Furthermore, iPlay resulted in small non-significant improvements in neuromotor fitness in favour of the intervention group.

**Conclusion:** This cluster randomised controlled trial showed that the iPlay-programme did significantly improved behavioural determinants. However, this effect on knowledge and attitude was not strong enough to improve injury-preventing behaviour. Furthermore, the results confirm the hypothetical model that injury-preventing behaviour is determined by intention, attitude, social norm and self-efficacy.

**Trial number:** ISRCTN78846684

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## Introduction

The benefits of regular physical activity are widely known and include enhanced cardio-respiratory fitness, increased muscular strength and endurance, and prevention of obesity<sup>1-3</sup>. However, participation in physical activities can lead to unwanted consequences, such as injuries. Data from the period 2000-2005 revealed that in the Netherlands 1,5 million sport-related injuries are reported each year and 51% of these injuries required medical treatment<sup>4</sup>. The sport injury incidence in Dutch children aged 0-17 is 1.3 (95%CI:1.2-1.4) per 1000 hours sport participation<sup>5</sup>. Physical activity-related injuries may result in pain and disability, high medical costs and school or parental work absence<sup>6-8</sup>. Therefore, PA-related injury prevention in children is of great relevance for public health.

School-based prevention programmes are promising because of their potential to reach almost all children in the population. To our knowledge, school-based injury prevention programmes are lacking. Therefore, we developed a school-based injury prevention programme. The aim of this programme, called iPlay, was to decrease physical activity-related injuries by changing injury-preventing behaviour and neuromotor fitness<sup>9</sup>. A physical activity-related injury was defined as any injury occurring during the entire scope of physical activity modalities and leading at least to cessation of the current activity.

To improve injury-preventing behaviour, we need to change the underlying determinants<sup>10</sup>. The iPlay-programme was based on the Attitude - Social influence - self Efficacy (ASE) model, a basic model describing determinants of health behaviour. The ASE model is based on the assumption that the intention to engage in behaviour is the result of the attitude, social influence and self-efficacy towards performing the specific behaviour. The ASE model is based on the theory of planned behaviour<sup>11</sup> and the social learning theory<sup>12</sup>. Because attitude is partly based on knowledge, improving knowledge about injury prevention was also an aim of iPlay-programme.

In addition, iPlay also aimed to improve neuromotor fitness (e.g. flexibility, strength and balance/proprioception). Sport-specific studies suggest that improving certain dimensions of neuromotor fitness can decrease physical activity-related injuries<sup>13-17</sup>. Furthermore, in the focus groups interviews PE teachers mentioned in particular the great diversity in neuromotor fitness in children. Although this common opinion could not be supported by scientific literature, it showed that teachers believe that improvements in neuromotor fitness can decrease injury risk<sup>9</sup>. Additionally, low levels of neuromotor fitness may negatively affect children in their daily physical activity levels and in their health status in the long term<sup>18,19</sup>. Figure 8.1 shows the hypothetical model that was used for the iPlay-programme.

We found a substantial and relevant reduction in physical activity-related injuries, especially in children in the low active group because of the iPlay-intervention<sup>20</sup>.

This manuscript describes the effectiveness of the iPlay-programme on injury-preventing behaviour, the targeted behavioural determinants (i.e. knowledge, attitude, social influence,

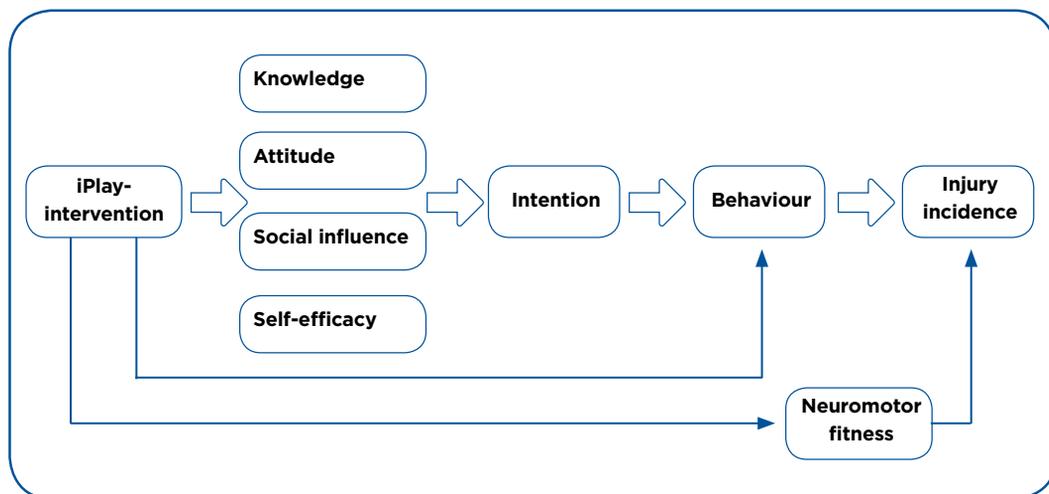
self efficacy and intention) and neuromotor fitness. In addition, we tested whether the hypothesized behavioural determinants indeed mediated the intervention effects on behaviour. Furthermore, the aim of this manuscript is to identify the mediating mechanisms targeted by the iPlay-programme. Mediation analysis is useful, because it gives insight in the elements of the intervention that were successful or not.

## Methods

### Study design and participants

The effectiveness of the iPlay-programme was evaluated using a cluster randomised controlled trial. From January 2006, a random sample of Dutch primary schools located in urban as well as in suburban areas were selected and invited to participate in the iPlay-study. Inclusion criteria were: being a regular primary school, providing physical education classes twice a week for 45 minutes, and being willing to appoint a contact person for the duration of the study. All children from grades 5 and 6 (aged 10-12 years) were eligible to participate in the study. Before baseline measurements, we performed a stratified randomisation based on geographic location of the school (urban/suburban) and professional status of the physical education teacher (certified/uncertified). Randomisation took place at school level. Parents of all participating children received a passive informed consent, involving a letter that explained the nature of the study and procedures. If parents and/or their child did not want to participate in the study they were able to indicate this. The Medical Ethics Committee of VU University Medical Centre approved the study design, protocols and informed consent procedures.

**Figure 8.1:** Hypothetical model that was used for the iPlay-programme.



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### iPlay-programme

The intervention-programme was developed according to the Intervention Mapping protocol<sup>21</sup>. The development of the iPlay-programme is extensively described in another manuscript<sup>9</sup>. In short, the 8-month intervention-programme focused on both children and parents. During one school year children received monthly newsletters aimed at improving knowledge about and attitude and self-efficacy towards the prevention of physical activity-related injuries. Parents received a monthly newsletter aimed at improving knowledge about and attitude towards injury prevention, and also suggesting strategies to reduce the physical activity-related injury risk in their child. Children took the parent newsletter home. Besides the newsletters, attractive posters were displayed in the classroom addressing the main intervention topics regarding injury prevention. The programme also provided access to an informative website about injury prevention for children and parents. In addition, short 5-minute exercises were given at the beginning and end of each physical education class aimed at improving muscle strength, speed, flexibility and coordination. A teachers' manual contained information about the intervention programme including time schedule, exercises, and topics of the newsletters.

### Measurements

A trained research team completed the measurements according to a standardised protocol. All children completed a questionnaire and a neuromotor fitness test at the start (September 2006) and the end of the school year (June 2007). The questionnaire collected information on demographic variables, knowledge about injury prevention, self-reported injury-preventing behaviour, as well as behavioural determinants. Answers were given on a five point Likert scale varying from never (-2) to always (2) or totally not agree (-2) to totally agree (2). All questions were positively formulated. Socio economical status (SES) was defined on the basis of the highest level of maternal education, from a parental questionnaire and ranged from 1 (no qualification) to 8 (master's degree).

### Injury-preventing behaviour

A potentially modifiable risk factor for physical activity-related injuries in children is injury-preventing behaviour, i.e. not wearing appropriate protective equipment and/or footwear during physical activities<sup>22,23</sup>.

We defined physical activity-related injury-preventing behaviour as 1) wearing appropriate protective equipment during organised sport activities, 2) wearing appropriate protective equipment during leisure time activities, and 3) wearing appropriate footwear during physical activities (i.e. organised physical activities, leisure time physical activities and regular physical education class). Each sub-behaviour was measured by one question in the questionnaire.

### Determinants of behaviour

Children completed a knowledge-test at follow-up, including nine multiple-choice questions. The total score was calculated by summing up all correct answers.

Attitude, social influence, self-efficacy, and intention were assessed at baseline and follow-up. Attitude was assessed with three questions. Social influences include social norm and modelling. Social norm was assessed with two question (e.g. 'My parents think I should wear protective materials during sports activities' Yes, totally agree...No, totally disagree)). Modelling was assessed with two questions about modelling by friends and parents. Self-efficacy was assessed with two questions relating to the child's perception of his/her ability to perform injury-preventing behaviour. Intention towards physical activity-related injury prevention was assessed with one question.

### MOPER fitness test

Children performed 7 test items of the MOPER fitness test<sup>24</sup> during one physical education class (bent-arm hang test to measure upper body strength, 10 times 5-m run test to measure running speed and agility, plate tapping test to measure eye-hand coordination and arm speed, leg lift test to measure trunk/leg strength, sit and reach test to measure trunk flexibility, arm pull test to measure static arm strength and standing high jump test to measure explosive leg strength). Validity and reliability of the MOPER fitness test have been shown to be acceptable<sup>25</sup>. For logistic reasons and since iPlay did not specifically focus on improving aerobic endurance we decided to exclude the 6 minutes endurance run. In addition to the 7 test items, children performed the flamingo balance test to measure general balance<sup>26</sup>. To be able to complete all tests during one physical education class, we shortened the flamingo balance test to 30 seconds, instead of one minute as the original flamingo balance test protocol indicates.

All test items were performed barefoot to rule out the effect of footwear on the test results. In addition, children were encouraged to perform all test elements as good as possible.

### Anthropometrics

Body height was measured in meters (m), with a portable stadiometer (Seca 214, Leicester Height Measure; Seca GmbH & Co, Hamburg, Germany) with the subject standing straight, with the heels together and looking straight ahead. Body weight was measured in kilogram (kg), with a digital scale (Seca 770; Seca GmbH & Co, Hamburg, Germany). BMI was calculated by the weight in kilograms divided by height in meters squared (kg/m<sup>2</sup>).

### Statistical analyses

To compare the intervention and control group at baseline, we used the Pearson Chi-Square test (gender, SES, and BMI-class) and the independent samples-t-test (age and BMI).

To test the hypothetical iPlay-model (figure 8.1) a mediation analyses was performed us-

ing single and multiple two-level linear regression models (child and school), accounting for within-school cluster effects. The single mediator model reflects the intervention effect on the outcome measure through each mediating variable. A multiple mediator model was used to assess the independent contribution of each single mediator because the mediated effects of the potential mediators may overlap.

First, we calculated the effect of the iPlay-programme on the behavioural outcomes ( $\tau$ ). Next, we estimated the effect of the intervention on behavioural determinants ( $\alpha$ -coefficients). Then we estimated the independent effect of changes in determinants of behaviour on changes in behaviour ( $\beta$  coefficient). Change scores are the post-intervention scores, adjusted for the pre-intervention scores and therefore represent change adjusted for baseline values. We estimated the magnitude of the mediated effect over time by computing the product of the  $\alpha$ - and  $\beta$ -coefficients. Finally, the statistical significance of the mediating effect was calculated by dividing the mediated effect ( $\alpha * \beta$ ) by its standard error. Social modelling was not included in the analysis due to too much missing values.

Multi-level linear regression analyses was used to analyze between-group differences in neuromotor fitness test scores. Schools were used as a cluster level. All analyses were performed according to the intention-to-treat principle using MLWin 2.15 adjusting for baseline values, SES, BMI, and gender.

## Results

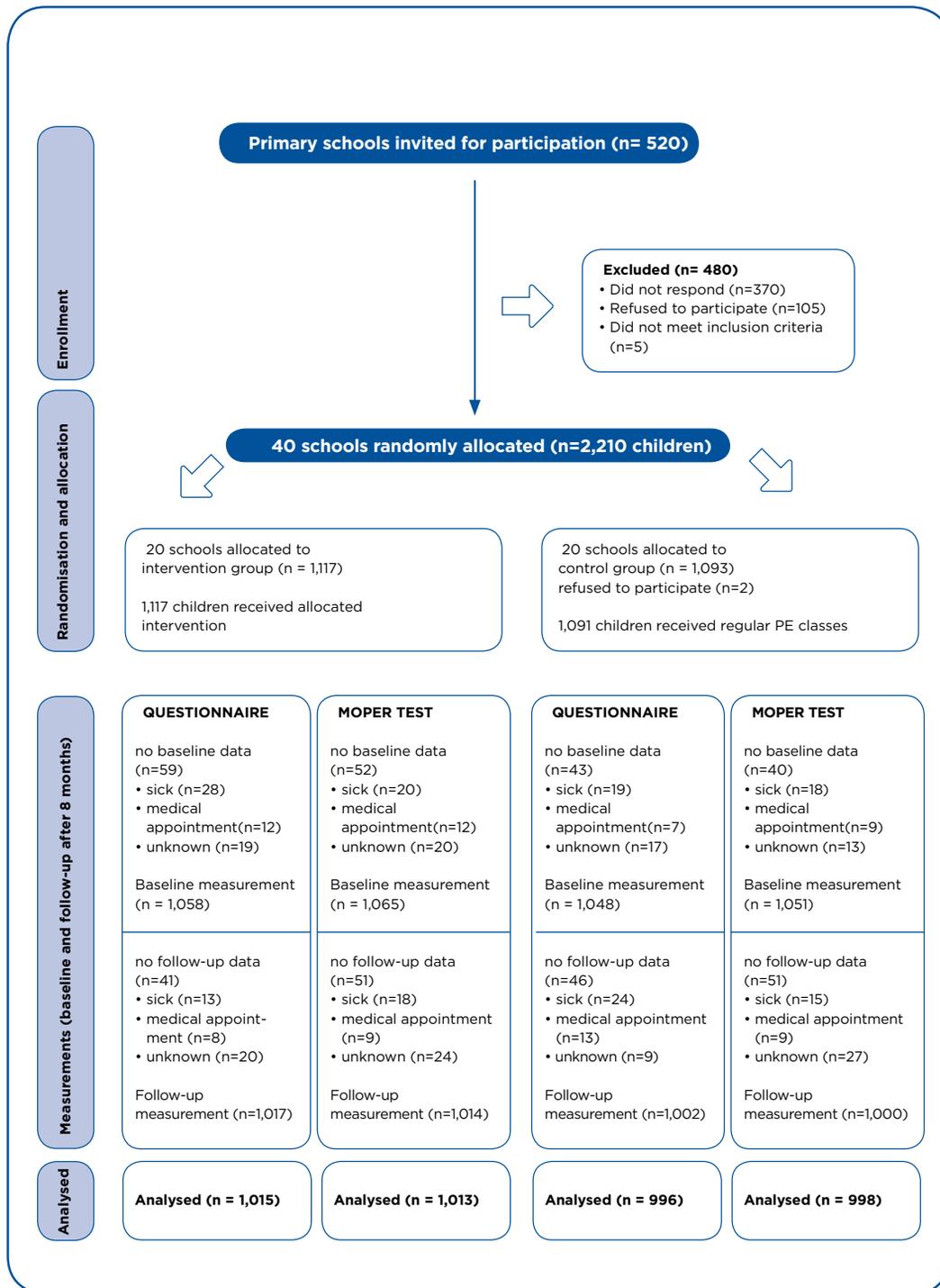
### Participants

A total of 2,208 children from 40 primary schools throughout the Netherlands participated in the study. Figure 8.2 outlines the complete flow of participants from recruitment through the last follow-up contact. Reasons for not completing the questionnaire or the MOPER test were mostly school absence due to illness or having a medical appointment. Eight questionnaires and three MOPER fitness test score forms were completed inappropriate and therefore excluded from analyses. Eventually, questionnaire data from 1,015 children in the intervention group and 996 children in the control group were analysed. Furthermore, MOPER fitness test data from 1,013 children in the intervention group and 998 children in the control group were analysed.

The mean age of the children was  $10.7 \pm 0.8$  years. Intervention and control group were similar regarding age and gender. BMI in the control group ( $18.1 \pm 3.1$  kg/m<sup>2</sup>) was significantly higher than in the intervention group ( $17.7 \pm 2.7$  kg/m<sup>2</sup>). In addition, the intervention group included significantly more children from a low SES.

Table 8.1 shows the baseline and follow-up values for self-reported behaviour and determinants of behaviour towards wearing protective equipment during organised sport activities and leisure time activities and wearing appropriate footwear during physical activities.

Figure 8.2: Flow chart of schools and participants.



**Table 8.1:** Baseline and follow-up behaviour and determinants of behaviour in intervention and control group.

|  | INTERVENTION GROUP |            |            | CONTROL GROUP |            |            |
|--|--------------------|------------|------------|---------------|------------|------------|
|  | N                  | Baseline   | Follow-up  | N             | Baseline   | Follow-up  |
|  |                    | Mean ± SD  | Mean ± SD  |               | Mean ± SD  | Mean ± SD  |
| <b>Wearing protective equipment during organised sports activities</b>   |                    |            |            |               |            |            |
| <b>Behaviour (-2 ; 2) <sup>a</sup></b>   | 531                | 1.7 (0.8)  | 1.7 (0.8)  | 455           | 1.6 (1.0)  | 1.6 (0.9)  |
| <b>Attitude (-2 ; 2) <sup>a</sup></b>  | 564                | 1.6 (0.5)  | 1.6 (0.5)  | 480           | 1.6 (0.5)  | 1.6 (0.5)  |
| <b>Social norm (-2 ; 2) <sup>a</sup></b>   | 571                | 1.1 (0.9)  | 1.0 (0.8)  | 484           | 1.1 (0.9)  | 1.0 (0.9)  |
| <b>Self-efficacy (-2 ; 2) <sup>a</sup></b>   | 552                | 1.7 (0.5)  | 1.7 (0.5)  | 469           | 1.7 (0.5)  | 1.7 (0.5)  |
| <b>Intention (-2 ; 2) <sup>a</sup></b>   | 570                | 1.4 (1.2)  | 1.3 (1.3)  | 468           | 1.4 (1.2)  | 1.3 (1.3)  |
| <b>Wearing protective equipment during leisure time activities</b>   |                    |            |            |               |            |            |
| <b>Behaviour (-2 ; 2) <sup>a</sup></b>   | 605                | -0.5 (1.4) | -0.6 (1.4) | 516           | -0.5 (1.5) | -0.5 (1.5) |
| <b>Attitude (-2 ; 2) <sup>a</sup></b>  | 605                | 0.6 (1.0)  | 0.5 (0.9)  | 521           | 0.7 (0.9)  | 0.6 (0.9)  |
| <b>Social norm (-2 ; 2) <sup>a</sup></b>   | 607                | 0.1 (1.0)  | 0.1 (1.1)  | 525           | 0.2 (1.0)  | 0.1 (1.0)  |
| <b>Self-efficacy (-2 ; 2) <sup>a</sup></b>   | 598                | 0.9 (1.0)  | 0.8 (1.1)  | 520           | 1.0 (1.0)  | 0.9 (1.0)  |
| <b>Intention (-2 ; 2) <sup>a</sup></b>   | 605                | -0.0 (1.5) | -0.0 (1.5) | 526           | 0.1 (1.6)  | -0.0 (1.6) |
| <b>Wearing appropriate footwear during organized, leisure time physical activities and physical education classes.</b> |                    |            |            |               |            |            |
| <b>Behaviour (-2 ; 2) <sup>a</sup></b>   | 799                | 1.1 (0.9)  | 1.2 (0.9)  | 712           | 0.9 (1.0)  | 1.1 (1.0)  |
| <b>Attitude (-2 ; 2) <sup>a</sup></b>  | 993                | 0.9 (0.8)  | 1.0 (0.7)  | 983           | 0.8 (0.7)  | 0.8 (0.7)  |
| <b>Social norm (-2 ; 2) <sup>a</sup></b>   | 995                | 0.6 (0.9)  | 0.6 (0.9)  | 982           | 0.6 (1.0)  | 0.5 (1.0)  |
| <b>Self-efficacy (-2 ; 2) <sup>a</sup></b>   | 980                | 1.5 (0.6)  | 1.5 (0.7)  | 956           | 1.4 (0.6)  | 1.4 (0.6)  |
| <b>Intention (-2 ; 2) <sup>a</sup></b>   | 949                | 1.2 (1.0)  | 0.6 (0.7)  | 939           | 1.1 (1.0)  | 0.6 (0.7)  |

<sup>a</sup> a higher score on the Likert-scale is more favourable.

#### Intervention effects on injury-preventing behaviours ( $\tau$ )

The second column of table 8.2a, 8.2b and 8.2c represents the iPlay-intervention effects on the three injury-preventing behaviours. The intervention did not significantly affect the behaviour of the children towards wearing protective equipment during organized sports activities ( $\tau = 0.05$  (95%CI=-0.04-0.14)), wearing protective equipment during leisure time activities ( $\tau = -0.01$  (95%CI=-0.21-0.19)) or wearing appropriate footwear during physical activities ( $\tau = 0.07$  (95%CI=-0.13-0.27)).

#### Intervention effects on behavioural determinants ( $\alpha$ -coefficients)

The third column of table 8.2a, 8.2b and 8.2c represents the intervention effect on behavioural determinants i.e. knowledge, attitude, social norm, self-efficacy and intention.

The iPlay-programme significantly improved knowledge about injury prevention ( $\alpha = 0.49$  (95%CI=0.20-0.78)). In addition, the iPlay-programme also significantly improved attitude

towards wearing appropriate footwear during physical activities ( $\alpha=0.10$  (95%CI=0.00–0.20)) (table 2c). Furthermore, we found a significant negative effect of the iPlay-programme on self-efficacy towards wearing protective equipment during leisure time activities ( $\alpha =-0.15$  (95%CI=-0.27 - -0.03)) (table 8.2b). The intervention did not significantly affect the other determinants.

#### Determinant effects on behaviours ( $\beta$ -coefficients)

Next we checked whether the changes in the determinants were associated with changes in the three injury-preventing behaviours ( $\beta$ -coefficients in column 4 and 5 of table 8.2a, 8.2b and 8.2c).

Improved scores on knowledge ( $\beta=0.05$  (95%CI=0.01–0.08)), attitude ( $\beta=0.28$  (95%CI=0.18–0.38)), social norm ( $\beta=0.10$  (95%CI=0.04–0.16)) and intention ( $\beta=0.09$  (95%CI=0.06–0.13)) were significantly related to wearing more often protective equipment during organised sport activities (table 8.2a, column 4).

Improved scores on knowledge ( $\beta=0.10$  (95%CI=0.03–0.16)), attitude ( $\beta=0.65$  (95%CI=0.56–0.75)), social norm ( $\beta=0.57$  (95%CI=0.49–0.66)), self-efficacy ( $\beta=0.36$  (95%CI=0.28–0.44)), and intention ( $\beta=0.44$  (95%CI=0.39–0.50)) were significantly related to wearing more often protective equipment during leisure time activities (table 8.2b, column 4).

Improved scores on attitude ( $\beta=0.28$  (95%CI=0.21–0.35)), social norm ( $\beta=0.21$  (95%CI=0.16–0.26)), self-efficacy ( $\beta=0.55$  (95%CI=0.48–0.63)), and intention ( $\beta=0.16$  (95%CI=0.10–0.23)) were significantly related to wearing more often appropriate footwear during physical activities (table 8.2c, column 4).

Since the intervention targeted multiple determinants simultaneously, the effects of the determinants on injury-preventing behaviour change were also assessed in a multiple-mediator model to account for multicollinearity (table 8.2a, 8.2b and 8.2c, column 5).

Improved scores on attitude ( $\beta=0.15$  (95%CI=0.02–0.27)), intention ( $\beta=0.09$  (95%CI=0.04–0.13)) and knowledge ( $\beta=0.03$  (95%CI=-0.00–0.06)) were significantly related to wearing more often protective equipment during organised sport activities, although this latter association was borderline significant (table 8.2a, column 5).

Improved scores on attitude ( $\beta=0.26$  (95%CI=0.14–0.38)), social norm ( $\beta=0.25$  (95%CI=0.15–0.34)), self-efficacy ( $\beta=0.11$  (95%CI=0.03–0.19)), and intention ( $\beta=0.27$  (95%CI=0.21–0.34)) were significantly related to wearing more often protective equipment during leisure time activities (table 8.2b, column 5).

Improved scores on attitude ( $\beta=0.08$  (95%CI=0.00–0.16)), social norm ( $\beta=0.01$  (95%CI=0.04–0.16)), self-efficacy ( $\beta=0.46$  (95%CI=0.38–0.55)) were significantly related to wearing more often appropriate footwear during physical activities (table 2c, column 5).

**Table 8.2a:** Wearing protective equipment during organised sports activities group.

|  | Effect on behaviour (τ) (95%CI) | Effect on determinants of behaviour (α) (95%CI) | Effect of determinants of behaviour on behaviour (β) (95%CI) |                         | Mediated effect (α*β) (95%CI) |                         |
|--|---------------------------------|---|--|-------------------------|-------------------------------|-------------------------|
|  |                                 |   | Single-mediator model  | Multiple-mediator model | Single-mediator model         | Multiple-mediator model |
| <b>Protective equipment organised sports</b> | 0.05<br>(-0.04 - 0.14)          |   |  |                         |                               |                         |
| <b>Knowledge (-2 ; 2) <sup>a</sup></b>       |                                 | 0.49<br>(0.20 - 0.78) *                         | 0.05<br>(0.01 - 0.08) *                                      | 0.03<br>(-0.00 - 0.06)  | 0.02<br>(0.02 - 0.03) *       | 0.02<br>(0.01 - 0.02) * |
| <b>Attitude (-2 ; 2) <sup>a</sup></b>        |                                 | -0.01<br>(-0.08 - 0.06)                         | 0.28<br>(0.18 - 0.38) *                                      | 0.15<br>(0.02 - 0.27) * | -0.00<br>(-0.02 - 0.02)       | -0.00<br>(-0.01 - 0.01) |
| <b>Social norm (-2 ; 2) <sup>a</sup></b>     |                                 | -0.01<br>(-0.11 - 0.09)                         | 0.10<br>(0.04 - 0.16) *                                      | 0.06<br>(-0.01 - 0.13)  | -0.00<br>(-0.01 - 0.01)       | 0.00<br>(-0.01 - 0.01)  |
| <b>Self-efficacy (-2 ; 2) <sup>a</sup></b>   |                                 | -0.01<br>(-0.07 - 0.05)                         | 0.10<br>(-0.01 - 0.21)                                       | 0.04<br>(-0.09 - 0.17)  | -0.00<br>(-0.01 - 0.01)       | 0.00<br>(-0.00 - 0.00)  |
| <b>Intention (-2 ; 2) <sup>a</sup></b>       |                                 | -0.14<br>(-0.40 - 0.13)                         | 0.09<br>(0.06 - 0.13) *                                      | 0.09<br>(0.04 - 0.13) * | -0.01<br>(-0.04 - 0.01)       | -0.01<br>(-0.03 - 0.01) |

<sup>a</sup> a higher score on the Likert-scale is more favourable

\* significant effect (p<0.05)

**Table 8.2b:** Wearing protective equipment during leisure time activities

|   | Effect on behaviour (τ) (95%CI) | Effect on determinants of behaviour (α) (95%CI) | Effect of determinants of behaviour on behaviour (β) (95%CI) |                         | Mediated effect (α*β) (95%CI) |                         |
|---|---------------------------------|---|--|-------------------------|-------------------------------|-------------------------|
|   |                                 |   | Single-mediator model  | Multiple-mediator model | Single-mediator model         | Multiple-mediator model |
| <b>Protective equipment leisure time activities</b> | -0.01<br>(-0.21 - 0.19)         |   |  |                         |                               |                         |
| <b>Knowledge (-2 ; 2) <sup>a</sup></b>              |                                 | 0.49<br>(0.20 - 0.78) *                         | 0.10<br>(0.03 - 0.16) *                                      | 0.03<br>(-0.02 - 0.08)  | 0.05<br>(0.04 - 0.06) *       | 0.01<br>(0.01 - 0.02) * |
| <b>Attitude (-2 ; 2) <sup>a</sup></b>               |                                 | -0.04<br>(-0.16 - 0.09)                         | 0.65<br>(0.56 - 0.75) *                                      | 0.26<br>(0.14 - 0.38) * | -0.02 (-0.10 - 0.06)          | -0.01<br>(-0.04 - 0.02) |
| <b>Social norm (-2 ; 2) <sup>a</sup></b>            |                                 | -0.02<br>(-0.14 - 0.11)                         | 0.57<br>(0.49 - 0.66) *                                      | 0.25<br>(0.15 - 0.34) * | -0.01<br>(-0.08 - 0.06)       | -0.00<br>(-0.03 - 0.03) |
| <b>Self-efficacy (-2 ; 2) <sup>a</sup></b>          |                                 | -0.15<br>(-0.27 - -0.03) *                      | 0.36<br>(0.28 - 0.44) *                                      | 0.11<br>(0.03 - 0.19) * | -0.06<br>(-0.10 - -0.01) *    | -0.02<br>(-0.04 - 0.00) |
| <b>Intention (-2 ; 2) <sup>a</sup></b>              |                                 | 0.12<br>(-0.08 - 0.32)                          | 0.44<br>(0.39 - 0.50) *                                      | 0.27<br>(0.21 - 0.34) * | 0.05<br>(-0.04 - 0.14)        | 0.03<br>(-0.02 - 0.09)  |

<sup>a</sup> a higher score on the Likert-scale is more favourable

\* significant effect (p<0.05)

**Table 8.2c:** Wearing appropriate footwear during organized, leisure time physical activities and physical education classes.

|  | Effect on behaviour ( $\tau$ ) (95%CI) | Effect on determinants of behaviour ( $\alpha$ ) (95%CI) | Effect of determinants of behaviour on behaviour ( $\beta$ ) (95%CI) |                         | Mediated effect ( $\alpha\beta$ ) (95%CI) |                         |
|--|--|--|--|-------------------------|---|-------------------------|
|  |  |  | Single-mediator model  | Multiple-mediator model | Single-mediator model                     | Multiple-mediator model |
| <b>Appropriate footwear during physical activities</b> | 0.07<br>(-0.13 - 0.27)                 |  |  |                         |   |                         |
| <b>Knowledge (-2 ; 2) <sup>a</sup></b>                 |  | 0.49<br>(0.20 - 0.78) *                                  | 0.03<br>(-0.01 - 0.06)   | 0.00<br>(-0.03 - 0.03)  | 0.01<br>(0.01 - 0.02) *                   | 0.00<br>(-0.00 - 0.00)  |
| <b>Attitude (-2 ; 2) <sup>a</sup></b>                  |  | 0.10<br>(0.00 - 0.20) *                                  | 0.28<br>(0.21 - 0.35) *  | 0.08<br>(0.00 - 0.16) * | 0.03<br>(0.00 - 0.06) *                   | 0.01<br>(-0.00 - 0.02)  |
| <b>Social norm (-2 ; 2) <sup>a</sup></b>               |  | 0.13<br>(-0.02 - 0.28)                                   | 0.21<br>(0.16 - 0.26) *  | 0.01<br>(0.04 - 0.16) * | 0.03<br>(-0.00 - 0.06)                    | 0.01<br>(-0.00 - 0.03)  |
| <b>Self-efficacy (-2 ; 2) <sup>a</sup></b>             |  | 0.04<br>(-0.04 - 0.12)                                   | 0.55<br>(0.48 - 0.63) *  | 0.46<br>(0.38 - 0.55) * | 0.02<br>(-0.03 - 0.07)                    | 0.02<br>(-0.02 - 0.06)  |
| <b>Intention (-2 ; 2) <sup>a</sup></b>                 |  | 0.06<br>(-0.01 - 0.14)                                   | 0.16<br>(0.10 - 0.23) *  | 0.05<br>(-0.01 - 0.12)  | 0.01<br>(-0.00 - 0.02)                    | 0.00<br>(-0.00 - 0.01)  |

<sup>a</sup> a higher score on the Likert-scale is more favourable

\* significant effect ( $p < 0.05$ )

### Mediation ( $\alpha\beta$ -coefficients)

Respectively, column 6 and 7 of table 8.2a, 8.2b and 8.2c represent the single and multiple mediated effects.

The single-mediator model showed that the intervention effect of the iPlay-programme on changes in wearing protective equipment during organized sport activities was mediated by knowledge ( $\alpha\beta=0.02$  (95%CI=0.02-0.03)). Thus, the improvement in knowledge partly explained the change in wearing protective equipment during organized sport activities (table 8.2a, column 6). However, the effects were small. The intervention effect on wearing protective equipment during leisure time activities was also mediated by knowledge ( $\alpha\beta=0.05$  (95%CI=0.04-0.06)). The single-mediator model revealed also a statistically significant suppression effect of self-efficacy on changes in wearing protective equipment during leisure time activities ( $\alpha\beta=-0.06$  (95%CI=-0.10 - -0.01)) (table 8.2b, column 6). Unfortunately, the iPlay-programme had a negative effect on self-efficacy for wearing protective equipment during leisure time activities. In the multiple-mediator model, this suppressive effect was no longer significant (table 8.2b, column 7).

The intervention effect of the iPlay-programme on wearing appropriate footwear during physical activities was mediated by knowledge ( $\alpha\beta=0.01$  (95%CI=0.01-0.02)) and attitude ( $\alpha\beta=0.03$  (95%CI=0.00-0.06)) (table 8.2c, column 6). No significant mediated effects were found in the multiple-mediator model.

### Neuromotor fitness

Table 8.3 and 8.4 present the results regarding the MOPER fitness test items for boys and girls, respectively. Separate analyses were conducted for boys and girls, as gender was found to be an effect modifier. There was a trend towards improvement on almost all MOPER fitness test items in boys and girls in favour of the intervention group. In boys, no significant intervention effect on the MOPER fitness test items was found. In girls, a significant beneficial intervention effect on the 10x5 m run was found.

**Table 8.3:** Intervention effects on MOPER fitness test scores for boys.

| BOYS  | Intervention group   |                       | Control group        |                       | Adjusted <sup>a</sup> difference between groups |
|---|----------------------|-----------------------|----------------------|-----------------------|---|
|   | Baseline (mean ± SD) | Follow-up (mean ± SD) | Baseline (mean ± SD) | Follow-up (mean ± SD) | Beta (95%CI)                                    |
| <b>Bent-arm hang (sec) Median (25-75 IQR)</b> | 10 (4 - 20)          | 10 (4 - 20)           | 8 (3 - 18)           | 10 (4 - 21)           | 0.39 † (-1.35 ; 2.14)                           |
| <b>10x5 run (sec)</b>                         | 19.5 ± 1.5           | 19.1 ± 1.5            | 19.5 ± 1.6           | 19.2 ± 1.5            | -0.09 † (-1.35 ; 0.18)                          |
| <b>Leg lift (sec)</b>                         | 16.6 ± 1.3           | 17.4 ± 5.9            | 17.6 ± 1.4           | 17.2 ± 1.4            | -0.40 † (-1.62 ; 0.81)                          |
| <b>Plate tapping (sec)</b>                    | 15.1 ± 2.0           | 13.5 ± 1.6            | 15.0 ± 1.9           | 13.7 ± 1.8            | -0.24 † (-0.53 ; 0.06)                          |
| <b>Sit and reach (cm)</b>                     | 26 ± 6               | 26 ± 7                | 26 ± 7               | 26 ± 7                | 0.22 † (-0.39 ; 0.83)                           |
| <b>Arm pull (kg/kg weight)</b>                | 68 ± 7               | 73 ± 9                | 70 ± 3               | 73 ± 8                | -1.21 (-7.42 ; 5.00)                            |
| <b>Standing high jump (cm)</b>                | 38 ± 6               | 39 ± 7                | 38 ± 7               | 39 ± 7                | -0.12 (-1.20 ; 0.97)                            |
| <b>Flamingo (attempts)</b>                    | 8 ± 3                | 8 ± 3                 | 8 ± 3                | 8 ± 3                 | -0.17 † (-0.69 ; 0.35)                          |

<sup>a</sup> adjusted for baseline value, SES and BMI.

† changes in favour of the intervention group

**Table 8.4:** Intervention effects on MOPER fitness test scores for girls.

| GIRLS   | Intervention group   |                       | Control group        |                       | Adjusted <sup>a</sup> difference between groups |
|---|----------------------|-----------------------|----------------------|-----------------------|---|
|   | Baseline (mean ± SD) | Follow-up (mean ± SD) | Baseline (mean ± SD) | Follow-up (mean ± SD) | Beta (95%CI)                                    |
| <b>Bent-arm hang (sec) Median (25-75 IQR)</b> | 6 (3 - 13)           | 8 (3 - 15)            | 6 (2 - 13)           | 6 (2 - 12)            | 2.08 † (-0.34 ; 3.83)                           |
| <b>10x5 run (sec)</b>                         | 20.0 ± 1.5           | 19.3 ± 1.6            | 20.0 ± 1.6           | 19.7 ± 1.5            | -0.33 † (-0.50 ; -0.16)*                        |
| <b>Leg lift (sec)</b>                         | 16.7 ± 1.3           | 16.4 ± 1.3            | 17.3 ± 1.4           | 16.9 ± 1.4            | -0.80 † (-1.83 ; 0.23)                          |
| <b>Plate tapping (sec)</b>                    | 14.7 ± 1.8           | 13.4 ± 1.8            | 14.8 ± 1.9           | 13.5 ± 1.7            | -0.17 † (-0.47 ; 0.14)                          |
| <b>Sit and reach (cm)</b>                     | 30 ± 6               | 30 ± 7                | 30 ± 6               | 30 ± 7                | 0.47 † (-0.39 ; 1.32)                           |
| <b>Arm pull (kg/kg weight)</b>                | 61 ± 4               | 67 ± 5                | 62 ± 2               | 64 ± 6                | 3.44 † (-1.64 ; 8.51)                           |
| <b>Standing high jump (cm)</b>                | 37 ± 6               | 38 ± 7                | 36 ± 7               | 36 ± 7                | 0.82 † (-0.47 ; 2.10)                           |
| <b>Flamingo (attempts)</b>                    | 8 ± 3                | 7 ± 3                 | 8 ± 3                | 7 ± 3                 | 0.09 (-0.27 ; 0.46)                             |

<sup>a</sup> adjusted for baseline value, SES and BMI.

† changes in favour of the intervention group

\*significant difference between intervention and control group

## Discussion

This manuscript describes the effects of the iPlay-programme on injury-preventing behaviour, the targeted behavioural determinants and neuromotor fitness. Furthermore, we examined the underlying hypothetical model.

The iPlay-programme did not improve behaviour towards wearing protective equipment and appropriate footwear during physical activities despite the fact that the iPlay-programme significantly changed knowledge about injury prevention and attitude towards wearing appropriate footwear during physical activities. The negative intervention-effect on self-efficacy towards wearing protective equipment during leisure time activities that was found can be possibly explained by the fact that children perceived more barriers after the intervention, decreasing their self-efficacy<sup>10</sup>.

Several explanations can be suggested for the minimal effects of the iPlay-programme on behaviour and determinants of behaviour. First, the self-reported measurements might not have been sufficiently sensitive to detect changes in behaviour and determinants of behaviour. Injury preventing behaviour and the determinants were measured using an invalidated and self-reported questionnaire. Self-report measures have numerous limitations such as social desirability (integration bias) and recall bias. In addition, constructs such as intention and behaviour were measured with only one question. Possibly, having one question as an index of behaviour and intention is not adequate enough.

A second explanation can be that the intervention methods or strategies used in this intervention (active learning, providing cues and scenario-based risk information and active processing of information) were not effective. Possibly, other methods or strategies to improve attitude, social norm, self-efficacy and intention should be used.

A third explanation for the lack of effect on wearing protective equipment and its determinants is possibly explained by the fact that at baseline almost all children indicated that they were already wearing protective equipment during organized sports activities. Improvement of this particular behaviour was therefore difficult.

A last possible explanation for the lack of effect of the intervention could be that the iPlay-programme was not adequately implemented, which has led to a lack of impact on behaviour and its determinants. However, a positive effect on knowledge about injury prevention suggests that the programme was at least partly implemented.

A second overall conclusion based on the results presented in this manuscript is that improved scores on knowledge, attitude, social norm, self-efficacy and intention were significantly related to changes in injury-preventing behaviours. These results confirm the hypothetical model that behaviour is determined by intention, attitude, social norm and self-efficacy<sup>27,28</sup>.

Unfortunately, the iPlay-programme was not capable to improve social norm, self-efficacy and intention. Improvements of the iPlay-programme should focus on strategies to increase

scores on those determinants.

A third conclusion of this study is that the intervention effect on injury-preventing behaviour was mediated by changes in knowledge and attitude. However, the intervention effect was too small to lead to actual behaviour change.

Finally we can conclude that almost all MOPER fitness test items showed small improvements in favour of the intervention group. Although not significant, the effects of the iPlay-programme appear promising.

### Comparison with previous research

To our knowledge, the iPlay-programme is the first school-based injury prevention program for children aged 10-12 years aimed at decreasing physical activity-related injuries by improving injury-preventing behaviour and neuromotor fitness. Backx (1991)<sup>29</sup> conducted a school-based intervention aimed at preventing physical activity-related injuries in adolescents aged 12-20 years. This was a smaller uncontrolled study including 471 adolescents from one secondary school that showed positive effects on knowledge and attitude. Our study, including more than 2,200 primary school children, showed consistent findings regarding knowledge and attitude.

### Strengths and limitations of the iPlay-study

The strength of our study is the large sample size. The iPlay-programme has been evaluated in a randomised controlled trial including 40 primary schools with more than 2,200 children. During the study high follow-up rates were achieved in both the intervention and control group. The study population - children from different primary schools in urban and suburban areas throughout the Netherlands - was a representation of the Dutch population. Furthermore, the iPlay-programme is designed to be a workable and time-efficient program that fits into the regular school curriculum.

A limitation of the study is that - besides that there were no valid measures available for our behavioural measures - the participants and research-assistants were not blinded. Blinding of participants and research-assistants is important to prevent bias but difficult in community based studies.

### Conclusion

The iPlay-intervention aimed at the prevention of physical activity-related injuries in primary school children by improving injury-preventing behaviour and neuromotor fitness. This manuscript showed that the iPlay-programme was not able to significantly improve injury-preventing behaviour. The effect of the intervention-program on behaviour appeared to be significantly mediated by knowledge and attitude. However, the effect of the iPlay-programme on knowledge and attitude was not strong enough to change injury-preventing behaviour. Furthermore, we found that changes in attitude, social norm, self-efficacy, and intention were

significantly related to changes in injury-preventing behaviour. Finally, iPlay resulted in small non-significant improvements in neuromotor fitness in favour of the intervention group.

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