

# Supplementary Appendix

Supplement to:

The effectiveness of a tennis specific injury prevention programme. A randomised controlled trial.

## **APPENDIX A**

### **BLINDING AND TRIAL PROCEDURE**

Due to the nature of the intervention, participant blinding was not possible. One author (OK) was unblinded to group allocation and organised all correspondence with the participants. During the study, three authors had access to the data management system (OK, JT, HP). All other authors were blinded for group allocation. At the end of the study, the data was downloaded by one author (HP) and handed to an independent statistician (RH) who de-identified the allocation code to ensure blinded assessment of the data.

Both the intervention and control groups were informed about their allocation by e-mail. The TennisReady group was instructed to download the app on their device. The app was remotely locked to prevent the control group from accessing the program. Only players from the TennisReady group were given access. The control group was instructed to continue their warm up routine as usual.

### **INJURY REGISTRATION**

The OSTRC questionnaire includes four questions on: a) any difficulties participating in training and competition, b) to what extent the training volume was reduced, c) to what extent the performance was affected and d) to what extent symptoms or health complaints were experienced<sup>4,25</sup>. Each question has four or five response options, a numerical value of zero to four per question (higher scores indicate a higher severity). Absence of injury meant a player scored a total of zero on the first four questions. Substantial injuries were previously defined as injuries leading to moderate or severe reductions in training, volume or performance, or a total inability to participate<sup>14</sup>. One e-mail reminder per two-weekly interval was sent if no response was received within 4 days of the first e-mail.

## **APPENDIX B**

### **PREVENTION PROGRAM CONTENT**

The exercises aimed at reducing the number of ankle, knee, shoulder and elbow injuries. The app contained weekly on- and off-court programmes with instruction videos and written instructions. The on-court exercises were designed to be used as a warm-up prior to each tennis activity (game or training). The exercises consisted of cardiovascular (running based) exercises, neuromuscular (strength and coordination) exercises and tennis specific (racket-in-hand) drills which could be completed in 7-10 minutes.

The off-court exercises consisted of strength and coordination exercises. These exercises were derived, or based on, the strength and balance exercises from the on-court programme. The exercises were intended to be used as an alternative for, or as an addition to, the on-court programme. The exercise routines took about 7-10 minutes to complete.

The duration of the intervention was 12 weeks. Participants were instructed to complete the on-court or off-court exercises at least twice a week. Over the 12 weeks, the content and frequency of exercises per set gradually increased. The complete detailed content is described in the matrix below (tables s1-s4)

Table S1-4, On and off court program with and without elastic band, subdivided in cardiovascular, neuromuscular and tennis-specific exercises. The exercises are presented for each week (week 1-12). Total number of series (f.e. 2x 10), total number of repetitions (f.e. 10x) are presented

<b>Table S1 ON COURT EXERCISES WITHOUT ELASTIC BAND</b>			
	<b>week1</b>	<b>week2</b>	<b>week3</b>
<b>Cardiovascular</b>			
Circuit run: dribble, sidestep, dribble with arm swing, cross steps	2 minutes	2 minutes	2 minutes
<b>Neuromuscular</b>			
Half squat	10x	12x	14x
Skate steps	10x	12x	14x
Trunk rotation	5/side	5/side	5/side
Leg swing	5/leg	5/leg	5/leg
Cross body racket swing	10x	10x	10x
Racket drop	10x	11x	12x
Single leg knee raise	2 x 10 sec/leg	2 x 10 sec/leg	3 x 10 sec/leg
<b>Tennis Specific</b>			
Baseline T exercise	2x	2x	2x
Mini-tennis in 1 service area (fore- and backhand)	3 minutes	3 minutes	3 minutes
	<b>week4</b>	<b>week5</b>	<b>week6</b>
<b>Cardiovascular</b>			
Circuit run: dribble, skipping, side steps, dribble with arm swings, line run)	2 minutes	2 minutes	2 minutes
<b>Neuromuscular</b>			
Squat	10x	12x	14x
Lunge	5/leg	6/leg	7/leg
Figure of 8 trunk rotation	10x	10x	10x
Leg swing	5/leg	5/leg	5/leg
Cross body racket swing	10x	10x	10x
Racket drop	13x	14x	15x
Single leg tennis ball throw	10x	10x	10x
<b>Tennis specific</b>			
Service line T, return facing forwards	2x	2x	2x
Mini-tennis in 2 service areas (only slice)	3 minutes	3 minutes	3 minutes
	<b>week7</b>	<b>week8</b>	<b>week9</b>
<b>Cardiovascular</b>			
Circuit run: dribble, tripling, skipping, cross steps, tram rail side steps	2 minutes	2 minutes	2 minutes
<b>Neuromuscular</b>			
Squat jumps	10x	12x	14x
Sideways lunge	5/leg	6/leg	7/leg
Diver	2 x 10 sec/leg	2 x 10 sec/leg	3 x 10 sec/ leg
Leg swing	5/leg	5/leg	5/leg
Cross body racket swing with trunk rotation	10x	10x	10x
Racket drop with squat	10x	11x	12x
1 legged skipping	2/leg	2/leg	2/leg
<b>Tennis specific</b>			

Baseline T, return facing backwards	2x	2x	2x
Mini-tennis in tram rails (fore and backhand switch)	3 minutes	3 minutes	3 minutes
	<b>week10</b>	<b>week11</b>	<b>week12</b>
<b>Cardiovascular</b>			
Circuit run: skipping, heel raise, handball jumps, skipping with arm swings, tram rail side steps	2 minutes	2 minutes	2 minutes
<b>Neuromuscular</b>			
Lunge squat	5/leg	6/leg	7/leg
Lunge with trunk rotation	5/leg	6/leg	7/leg
Diver with arms extended	2x10 sec/leg	2x10 sec/leg	3x 10 sec/leg
Leg swing	5/leg	5/leg	5/leg
Cross body racket swing with trunk rotation	10x	10x	10x
Racket drop with squat	13x	14x	15x
Skate jumps in tram rails	10x	12x	14x
<b>Tennis Specific</b>			
Fanrun from service point, return backwards	2x	2x	2x
Mini-tennis in 2 service areas with table tennis serve	3 minutes	3 minutes	3 minutes

<b>Table S2 ON COURT WITH ELASTIC BAND</b>			
	<b>Week 1</b>	<b>Week 2</b>	<b>Week 3</b>
<b>Cardiovascular</b>			
Circuit run: dribble, sidestep, dribble with arm swing, cross steps	2 minutes	2 minutes	2 minutes
<b>Neuromuscular</b>			
Row with band	10x	12x	14x
External rotation	8/arm	10/arm	12/arm
Internal rotation	8/arm	10/arm	12/arm
I with band	10x	12x	14x
Leg swing	5/leg	5/leg	5/leg
Skate jumps in tram rails	10x	12x	14x
Sidesteps with ankle band	0 cm	5 cm	10 cm
<b>Tennis Specific</b>			
Baseline T, return facing forwards	2x	2x	2x
Mini-tennis in 1 service area (fore- and backhand)	3 minutes	3 minutes	3 minutes
	<b>Week 4</b>	<b>Week 5</b>	<b>Week 6</b>
<b>Cardiovascular</b>			
Circuit run: dribble, skipping, side steps, dribble with arm swings, line run	2 minutes	2 minutes	2 minutes
<b>Neuromuscular</b>			
Half T with band	8/arm	10/arm	12/arm
W with band	10x	12x	14x
PNF hip to shoulder	8x	10x	12x
Leg swing	5/leg	5/leg	5/leg
Diver with band	2x10 sec/leg	2x10 sec/leg	3x 10 sec/leg
Monster walk with knee band	0 cm*	5 cm	10 cm
<b>Tennis Specific</b>			
Service line T, back facing forwards	2x	2x	2x
Mini-tennis in 2 service areas (only slice)	3 minutes	3 minutes	3 minutes
	<b>Week 7</b>	<b>Week 8</b>	<b>Week 9</b>
<b>Cardiovascular</b>			
Circuit run: dribble, tripling, skipping, cross steps, tram rail side steps	2 minutes	2 minutes	2 minutes
<b>Neuromuscular</b>			
Squat with band	10x	12x	14x
Rowing with external rotation	10x	12x	14x
PNF cross body	8/arm	10/arm	12/arm
Side leg swing	5/leg	5/leg	5/leg
Diver with arms extended	2x10 sec/leg	2x10 sec/leg	3x 10 sec/leg

<b>Tennis Specific</b>			
Baseline T, return facing backwards	2x	2x	2x
Mini-tennis in tram rails (fore- en backhand switch)	3 minutes	3 minutes	3 minutes
	<b>Week 10</b>	<b>Week 11</b>	<b>Week 12</b>
<b>Cardiovascular</b>			
Circuit run: Skipping, heel raise, handball jumps, skipping with arm swings, tram rail side steps	2 minutes	2 minutes	2 minutes
<b>Neuromuscular</b>			
Squat jumps	10x	12x	14x
Rowing with T up to shoulder level	10x	12x	14x
PNF deadlift	8/arm	10/arm	12/arm
Diver with band	2x10 sec/leg	2x10 sec/leg	3x 10 sec/leg
Side leg swing	5/leg	5/leg	5/leg
<b>Tennis Specific</b>			
Fanrun	2x	2x	2x
Mini-tennis in 2 service areas with table tennis serve	3 minutes	3 minutes	3 minutes

\* indicates the number of centimetres from the end of the elastic band where the knot to tie the band together should be made in order to get the correct resistance.

<b>Table S3 OFF COURT WITH ELASTIC BAND</b>			
	<b>Week 1</b>	<b>Week 2</b>	<b>Week 3</b>
Squat	12x	16x	20x
Lunge	8/leg	10/leg	12/leg
Diver with support	2x10 sec/leg	2x10 sec/leg	3x 10 sec/leg
Toe walk	3x	4x	5x
One legged balance	2x30 sec/leg	2x 45sec/leg	2x60sec/leg
Row with band	10x	15x	20x
Bridge on knees	3x20 sec	3x30sec	3x40 sec
External rotation with band	10x	15x	20x
	<b>Week 4</b>	<b>Week 5</b>	<b>Week 6</b>
Overhead squat	12x	16x	20x
Lunge	8/leg	10/leg	12/leg
Diver without support	2x10 sec/leg	2x10 sec/leg	3x 10 sec/leg
One legged balance exercise with knee raise	2x30 sec/leg	2x 45sec/leg	2x60sec/leg
Bow and arrow	10/arm	15/arm	20/arm
Bridge on toes	3x20 sec	3x30sec	3x40 sec
PNF hip to shoulder with band	10/arm	15/arm	20/arm
	<b>Week 7</b>	<b>Week 8</b>	<b>Week 9</b>
Squat with leg raise	6/leg	8/leg	10/leg
Diver with knee raise	5/leg	7/leg	9/leg
Row with external rotation	10x	15x	20x
Bridge with elbow raise	10/arm	15/arm	20/arm
PNF cross body with band	10/arm	15/arm	20/arm
	<b>Week 10</b>	<b>Week 11</b>	<b>Week 12</b>
Squat jumps	12x	16x	20x
Diver with band	2x10 sec/leg	2x10 sec/leg	3x 10 sec/leg
Row with T up to shoulder level	10x	15x	20x
Bridge with elbow raise and trunk rotation	10/arm	15/arm	20/arm
Deadlift PNF with band	10/arm	15/arm	20/arm

<b>Table S4 OFF COURT WITHOUT ELASTIC BAND</b>			
	<b>Week 1</b>	<b>Week 2</b>	<b>Week 3</b>
Squat	12x	16x	20x
Lunge	8/leg	10/leg	12/leg
Diver with support	2x10 sec/leg	2x10 sec/leg	3x 10 sec/leg
Toe walk	3x	4x	5x
One legged balance exercise	2x30 sec/leg	2x 45sec/leg	2x60sec/leg
Push-up against wall	10x	15x	20x
Bridge on knees	3x20 sec	3x30 sec	3x40 sec
External rotation against gravity	10x	15x	20
	<b>Week 4</b>	<b>Week 5</b>	<b>Week 6</b>
Overhead squat	12x	16x	20x
Lunge	8/leg	10/leg	12/leg
Diver without support	2x10 sec/leg	2x10 sec/leg	3x 10 sec/leg
One legged balance exercise with knee raise	2x30 sec/leg	2x 45sec/leg	2x60sec/leg
Push-up against table	10x	15x	20x
Bridge on toes	3x20 sec	3x30 sec	3x40 sec
PNF hip to shoulder with a weight (1- 1.5 Kg)	10/arm	15/arm	20/arm
	<b>Week 7</b>	<b>Week 8</b>	<b>Week 9</b>
Squat with leg raise	6/leg	8/leg	10/leg
Diver with knee raise	5/leg	7/leg	9/leg
Push up on the ground with knee support	10x	15x	20x
Bridge with elbow raise	10/arm	15/arm	20/arm
PNF cross body with weight (1- 1.5 Kg)	10/arm	15/arm	20/arm
	<b>Week 10</b>	<b>Week 11</b>	<b>Week 12</b>
Squat jump	12x	16x	20x
Diver with weight (1-1.5 Kg)	2x10 sec/leg	2x10 sec/leg	3x 10 sec/leg
Push-up	10x	15x	20x
Bridge with elbow raise and trunk rotation	10/arm	15/arm	20/arm
Deadlift PNF with weight (1-1.5 Kg)	10/arm	15/arm	20/arm

## **APPENDIX C**

### **ROBUSTNESS AND SECONDARY OUTCOME TESTING**

The robustness of the initial primary outcome analysis was tested in three sensitivity analyses. In the first analysis, missing values for the injury were redefined using a worst-case scenario. We assumed that all participants who did not respond to an injury survey had experienced an injury in the corresponding two-week period. In the second analysis, missing values for the injury were redefined using a best-case scenario. We assumed that all participants who did not respond to an injury survey had not experienced an injury in the corresponding two-week period. In the third analysis, we performed an injury prevalence analysis using only data from participants, who completed all nine injury surveys (complete data analysis).

For the secondary outcomes, incidence were calculated as the number of participants reporting new injuries divided by their total number of hours of exposure, all multiplied by 1000. Location specific prevalence and substantial injury prevalence was compared between the study groups using similar GEE models to the primary outcome.

For each injury, time loss was calculated as the sum of the number of days the players had indicated not being able to participate in tennis. Differences in overall and location specific incidence between the study groups were compared using generalized linear model with a Poisson distribution and a log link function.

To analyse the effect of adherence, the high adherence TennisReady group was compared respectively to the low adherence TennisReady and control group. A GEE model was used to analyse overall injury prevalence between groups.

All analyses were performed using IBM® SPSS® 24 (IBM corp. New York, USA). Graphic and descriptive adherence analysis was performed using Microsoft excel 2010 (Microsoft corp., Redmond, Washington, USA). A standard operating procedure was available to logically recode and clean the data. All analyses were performed by an independent statistician. A  $p < 0.05$  was considered statistically significant for all analyses. After final statistical analysis, disclosure and reviewing of the blinded results, the authors reached consensus on the interpretation of the results. After unblinding, no changes were applied to the interpretation of the results.

### **ADHERENCE AND DESCRIPTION OF THE ADHERENCE ALGORITHM**

At two weeks interval, adherence to the TennisReady was evaluated for four exercise categories: unsupervised practice, supervised practice, matches and off-court programme. For these four

categories, adherence was rated in four classes for each category: never (score 0), sometimes (score 1) almost always (score 2) always (score 3).

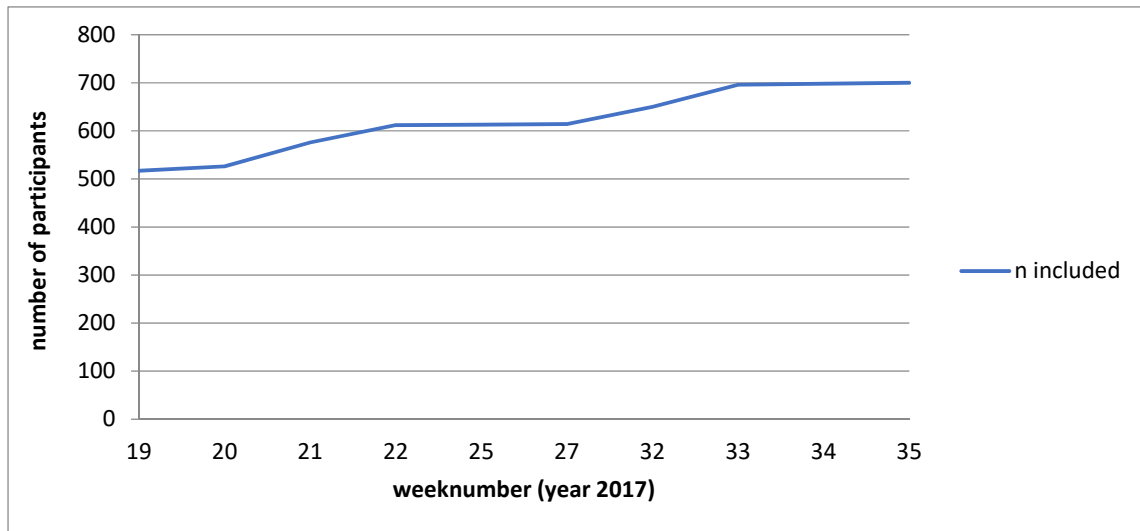
An algorithm was defined to indicate whether a participant was considered as low or high adherence at each survey instance. This algorithm corrected for exposure per category (i.e. exposure or no exposure) and if the participant had scored sufficient tennis categories with at least a high adherence (defined as always or almost always adherent).

A participant was considered to be high adherent per survey instance if he/she had scored high adherent in one category if he/she only had one category to which he/she was exposed. In case of two categories with exposure, 1/2 high adherence was considered necessary. In case of three categories with exposure, 2/3 with high was considered necessary. If a participant had no tennis exposure in the past two weeks, a high adherence score for the off court program still enabled an overall high adherence score for the participant at that survey instance.

An additional survey at the end of the trial registered retrospectively the mean number of tennis and mean number of TennisReady sessions per week in four categories: (1) none (2) less than one (3) less than two (4) two or more.

**APPENDIX D**  
**SUPPLEMENTARY TABLES AND FIGURES**

**Figure S1:** inclusions over time



**Figure S2.** response rate over time

