Effectiveness of a judo-specific injury prevention programme: a randomised controlled trial in recreational judo athletes

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ABSTRACT

Objectives To evaluate the effectiveness of a supervisor-saturated judo-specific injury prevention warm-up programme on overall injury prevalence.

Methods We conducted a two-arm, cluster randomised controlled trial; the Injury Prevention and Performance Optimization Netherlands (IPPON) study. Judo athletes aged ≥12 years were randomised by judo school to IPPON intervention or control group who performed their usual warm-up. Primary outcome was overall injury prevalence (%) over the follow-up period (16–26 weeks) measured fortnightly with the Oslo Sports and Trauma Research Centre Questionnaire. A modified intention-to-treat analysis was performed due to COVID-19, with estimates for the primary outcome obtained using generalised linear mixed models. Secondary outcomes included: prevalence of severe injuries, overall incidence, time-loss injuries, exposure, adherence and experiences of trainers and athletes.

Results 269 judo athletes (IPPON: 117, Control: 152) were included. Mean injury prevalence over 16–26 weeks was 23% (95% CI 20% to 26%) in the IPPON and 28% (95% CI 25% to 30%) in the control group. We observed no significant difference of all reported injuries (OR 0.72 in favour of the IPPON group; 95% CI 0.37 to 1.39). Secondary outcomes also demonstrated no significant differences between groups. Specifically, no significant difference of severe injuries was reported (OR 0.80 in favour of the IPPON group; 95% CI 0.36 to 1.78). All trainers and 70% of athletes perceived the IPPON intervention as successful.

Conclusion The IPPON intervention did not significantly reduce the overall and severe injury prevalence. Despite this, we suggest the IPPON intervention be considered as an useful alternative to regular judo warm-up, given the high adherence and the positive clinical experiences of trainers and athletes.

Trial registration number NTR7698.

INTRODUCTION

Judo is a popular international combat sport with an estimated 20 million active participants worldwide.1 Judo is characterised by the combination of balance, coordination, flexibility, agility, speed and strength with the aim to incapacitate their opponent. It is demanding of the neuromuscular and physical capacity of athletes. Participation in judo entails a substantial risk of injury in both elite and recreational judo.2 For elite judo athletes, up to 29% of elite judo athletes will get injured during a judo tournament.3 An epidemiological study on recreational judo athletes reported a 3-month injury incidence of 41%.4 The most common injuries in judo are sudden onset injuries of the shoulder, knee, ankle and fingers.5 6 7 The most common severe injuries are anterior cruciate ligament rupture and shoulder dislocation.7 For these injuries, the time-loss burden is 6–9 months, which negatively impacts performance.7 8

Injury prevention programmes in other sports have been proven effective in reducing injury rates for elite and recreational athletes.8 9 10 In judo, research on exercise-based prevention is limited to the description of injury prevention programmes,11 12 but the effectiveness of these programmes has never been evaluated.

In the absence of proven effective prevention strategies in judo, we developed and published the Injury Prevention and Performance Optimization Netherlands (IPPON) intervention using the guidelines of the Knowledge Transfer Scheme.
METHODS

Study design

Our study was a two-armed, cluster randomised controlled trial. We followed the Consolidated Standards of Reporting Trials Statement for reporting randomised controlled trials.17

The study protocol was registered in the Dutch trial register (NTR7698). The study was partly funded by The Dutch Organisation for Health and Research and Development (ZonMw).

Participants

Judo athletes were eligible if they were at least 12 years of age, willing to perform an exercise programme at least two times a week during the judo training and understood the Dutch language. The number of participating athletes and their baseline characteristics are presented in the results section (table 1). Judo schools, trainers and athletes were contacted between May 2019 and September 2019 through email, telephone, social media (Facebook, Instagram and Twitter), newsletters and presentations at judo events. Detailed information on the study goal, background, participation requirements, content and expectations were shared by email. The trainer registered all interested judo athletes. On registration, informed consent was obtained. For participants below the age of 16, informed consent was obtained from parents or guardians, as per the Dutch requirements of the ethical standards in the Netherlands.

Trial procedure

Participants entered the trial from the commencement of the judo season on 1 September 2019. The intervention and control groups were informed of their allocation by the coordinating researcher (ALvG). More details on participants’ allocation is described below in the section on ‘data collection, randomisation and blinding’. The IPPON group was instructed to use the trainer-supervised intervention via the instruction book (online supplemental appendix A), instruction videos18 and handout photo and description cards (online supplemental appendix B). The coordinating researcher (ALvG), who had 23 years of judo experience, verbally explained the intervention to the trainers and answered any of their questions. The trainers then provided the exercises to the judo athletes through trainer-supervised training sessions. To facilitate implementation, the coordinating researcher was available throughout the trial procedure to answer questions and provide explanation as required for the trainers and athletes. Fidelity controls to monitor the performance of the exercises could no longer be performed due to the COVID-19 induced lockdowns. The control group was instructed to continue their regular judo warm-up and practice.

Data collection, randomisation and blinding

Data was collected through an online survey and data management programme (CastorEDC, CastorEDC, CIWIT B.V., Amsterdam, The Netherlands). All eligible athletes were registered in this data management programme (CastorEDC). Cluster randomisation was performed by a computer-generated permuted 1:1 block scheme (CastorEDC) with random block sizes of two or four. The definition of a cluster was one judo school. Blinding of the participants was not possible due to the nature of the intervention. The coordinating researcher (ALvG) was unblinded to group allocation and organised all correspondence to the participants. All other study personnel were blinded for group allocation.

Baseline measurements

The baseline survey (online supplemental appendix C) was sent at the start of the study. Baseline characteristics included; gender, age, body mass, height, belt colour (kyu or dan degree), judo experience (years), training exposure (hours of training per week), competition participation (yes/no) and previous injuries.

Injury definition and registration

The injury survey was sent every fortnight to register injuries on a regular basis without inundating participants with surveys.19 The injury survey registered all injuries including detail on; locations, type and time loss through the Oslo Sports and Trauma Research Centre (OSTRC) Questionnaire20 21 (online supplemental appendix D). The OSTRC Questionnaire has previously been validated and translated to the Dutch language.21 An injury

Table 1 Baseline characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Category</th>
<th>IPPON group (n=117)</th>
<th>Control group (n=152)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender, n (%)</td>
<td>Male</td>
<td>69 (59)</td>
<td>94 (62)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>48 (41)</td>
<td>58 (38)</td>
</tr>
<tr>
<td>Age, years (IQR)</td>
<td></td>
<td>14 (13–17)</td>
<td>15 (13–21)</td>
</tr>
<tr>
<td>Anthropometric characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body mass, kg (SD)</td>
<td></td>
<td>57.0 (15)</td>
<td>61.0 (15)</td>
</tr>
<tr>
<td>Height, cm (SD)</td>
<td></td>
<td>166.5 (11)</td>
<td>168.9 (11)</td>
</tr>
<tr>
<td>Judo-specific characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belt colour, n (%)</td>
<td>White (sixth kyu)</td>
<td>1 (1)</td>
<td>2 (1)</td>
</tr>
<tr>
<td></td>
<td>Yellow (fifth kyu)</td>
<td>0 (0)</td>
<td>4 (2)</td>
</tr>
<tr>
<td></td>
<td>Orange (fourth kyu)</td>
<td>8 (6)</td>
<td>4 (3)</td>
</tr>
<tr>
<td></td>
<td>Green (third kyu)</td>
<td>14 (12)</td>
<td>16 (11)</td>
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<tr>
<td></td>
<td>Blue (second kyu)</td>
<td>33 (29)</td>
<td>31 (21)</td>
</tr>
<tr>
<td></td>
<td>Brown (first kyu)</td>
<td>46 (40)</td>
<td>56 (37)</td>
</tr>
<tr>
<td></td>
<td>Black (first dan)</td>
<td>9 (4)</td>
<td>30 (20)</td>
</tr>
<tr>
<td>Judo experience, years (IQR)</td>
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<td>8 (6–10)</td>
<td>8 (6–12)</td>
</tr>
<tr>
<td>Training exposure/week, hours (IQR)</td>
<td></td>
<td>4 (3–6)</td>
<td>4 (3–6)</td>
</tr>
<tr>
<td>Competition participation, n (%)</td>
<td></td>
<td>81 (69)</td>
<td>110 (72)</td>
</tr>
<tr>
<td>Injury characteristics</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Previous injury, n (%)</td>
<td></td>
<td>50 (43)</td>
<td>65 (43)</td>
</tr>
<tr>
<td>IQR=lower limit 25% and upper limit 75%</td>
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</tbody>
</table>
| IPPON, Injury Prevention and Performance Optimization Netherlands; IQR, interquartile range; n, exact numbers.
was defined as any answer above the minimal value on one of the first four questions of the OSTRC Questionnaire and when it did not concern an illness.\textsuperscript{25} Time loss was defined as the number of days that athletes were unable to participate in judo activities in the previous 14 days with the assumption that they should train judo every day. A severe injury was defined as an injury that led to moderate or severe reduction of training (OSTRC question 2) or inability to train (OSTRC question 3). Time to return to play was defined as the time from injury onset until return to full and unrestricted judo training.

**Intervention**

The IPPON intervention is an injury prevention programme designed specifically to reduce injuries in judo athletes.\textsuperscript{16} The KTS\textsuperscript{15} was used for the systematic development of the programme. The five steps of the bottom-up development process have been described in full detail before\textsuperscript{16} and summarised in online supplemental appendix E. The intervention was available through instructional videos,\textsuperscript{18} and an instructional book with photos and explanation of all exercises including key points of correct performance of the exercises. There were also hand-held photo cards with descriptions for the trainers to use on the tatami (judo training ground). The trainer-supervised IPPON intervention mainly focuses on preventing musculoskeletal injuries of the shoulder, knee, and ankle. This is based on previous epidemiological studies\textsuperscript{2} and follows the steps of the Van Mechelen\textsuperscript{23} and Translating Research into Injury Prevention Practice (TRIPP) models.\textsuperscript{24} The IPPON intervention consists of 36 exercises divided into (1) flexibility and agility, (2) balance and coordination and (3) strength and stability. Each category consisted of 12 exercises with 3 levels of difficulty. Athletes performed 4 exercises per category and thus 12 exercises at the start of the training at least two times per week. Prior to the intervention exercises, athletes completed running exercises and falling techniques. Athletes in the control group were instructed to continue their usual warm-up and regular judo practice as warm-up prior to training or competition is standard routine in judo. The duration of the IPPON intervention was aligned with the average duration of the usual warm-up in the control groups. Although, not measured in the study procedure, the approximate duration of warm-up was 15 min in both groups.

**Outcome measures**

**Primary outcome**

The primary outcome was the overall injury prevalence (%) over 16–26 weeks of follow-up, measured with the OSTRC Questionnaire at 2-week intervals. The overall injury prevalence (%) and associated 95% CIs were calculated as the total number of athletes reporting an injury divided by the total number of returned surveys over 16 to 26 weeks of follow-up.\textsuperscript{25}

**Secondary outcomes**

Secondary outcomes were: (1) the prevalence of severe injuries; (2) incidence rate defined as the total number of new injuries per 1000 hours of training and competition exposure during follow-up; (3) location-specific injury prevalence (%) of total injuries; (4) time loss; (5) sudden and gradual onset injury recurrence rates were calculated and defined as injuries of the same type and on the same side sustained within 2 months after full and unrestricted return to judo training. All primary and secondary outcome measures were corrected for potential confounders: previous injuries within 6 months, participation in competition, judo experience in years, age, body mass and height. These confounders were included as per expert opinion (judo experts from the Knowledge Transfer Group, formed for the development of the IPPON intervention) as no risk factors have previously been identified (online supplemental appendix F).

**Exposure, adherence and experience**

Exposure, self-reported adherence and experience evaluation were monitored through online questionnaires sent with CastorEDC (online supplemental appendices G and H). Exposure was recorded at the individual athlete level in both the IPPON and control groups. The IPPON group athletes and trainers also recorded weekly adherence to the programme. We calculated the adherence percentage by dividing the overall number of reported IPPON sessions by the total number of prescribed IPPON sessions (two sessions per week). Trainers and athletes recorded their experience through a standardised questionnaire at the end of the intervention period. Trainers and athletes in the intervention group were asked if they were satisfied with the IPPON intervention using a five-level Likert scale: disagree entirely, disagree, neutral, agree and agree entirely.

**Sample size**

For the sample size calculation, we considered a reduction of 40% in injury prevalence as clinically relevant.\textsuperscript{26} For this 40% reduction in the prevalence from 0.41\textsuperscript{4} to 0.25, with an α of 0.05 and β of 0.80 and adjustment for cluster correlations (estimated intraclass correlation of 0.05), a sample of 15 clusters was needed assuming 15 athletes per cluster. Correcting for an estimated dropout rate of 30%, the minimum sample size was set at 20 clusters. This corresponded to an approximate total of 300 athletes divided across the study groups.

**COVID-19 pandemic adjustment**

Due to the COVID-19 pandemic, all indoor and group sports participation was cancelled during the lockdown period from 16 March to 1 July 2020. The lockdown influenced the study in two ways. First, the participants could not continue with the IPPON intervention or warm-up as usual. Second, participants were not exposed to judo training or competition. Therefore, judo schools started with the intervention at different time points. There was a varying period until the lockdown in which the athletes performed the intervention and were exposed to judo (online supplemental appendix I). Therefore, we modified the outcome analysis by taking into account the variance in exposure by including all athletes for as long as they had access to indoor judo training until 16 March 2020. Additionally, we added two sensitivity analysis scenarios, one over 16 weeks and the second analysis over 26 weeks.

**Statistical analysis**

Modified intention-to-treat principles were performed to analyse the primary and secondary outcome measures. Participants were considered available for the primary outcome analysis if the baseline survey and at least one follow-up survey had been completed. Estimates for the injury prevalence over the whole period were obtained using generalised linear mixed-effect models with the intervention period as a covariate variable to compare both groups. Additional mixed-effect model analyses were performed to correct for potential confounders. Statistical significance was set at p<0.05. All analyses were performed using SPSS software V.26.0. The statistical analysis has been described in detail in online supplemental appendix J.
The statistical analysis and presentation are consistent with the Checklist for statistical Assessment of Medical Papers (CHAMP) statement.27

Equity, diversity and inclusion statement
Our study included recreational judo athletes of all genders, ethnicities, socioeconomic levels and inclusion in marginalised groups. Data collection methods were set up to include participants from all regions of the Netherlands including disadvantaged and rural areas. Our research team consisted of three women and nine men who have ranks varying from professor to first-time researchers. The author’s disciplines cover the full spectrum from highly qualified specialists (orthopaedic surgeon, sports physician, human movement scientist) to people with extensive practical knowledge (judo athletes and trainers). In our analysis, we have not distinguished between gender, ethnicity and socioeconomic status. In the research process, we have treated all participants and team members equally, meaning that values and opinions were met with sincere appreciation.

RESULTS

Participants
Between 1 May and 1 September 2019, 371 athletes from 24 judo schools met the inclusion criteria and were cluster randomised to the IPPON (n=190 athletes, 12 judo schools) or control group (n=181 athletes, 12 judo schools). One judo school (50 athletes) withdrew from participation after randomisation. Overall, 52 (16%) participants (IPPON group=23 and control group=29) did not complete a follow-up survey and were excluded from the analysis. A total of 269 (84%) participants (IPPON group: 117 and control group: 152) were included in the modified intention-to-treat analysis of the primary and secondary outcomes. Figure 1 shows a flow chart of the included study participants. Baseline characteristics are presented in table 1. Detailed information of the participating judo athletes per follow-up moment can be found in figures 2 and 3.

Primary outcome
Overall injury prevalence
In the modified intention-to-treat analysis, the overall injury prevalence was 23% (95% CI 20% to 27%) in the IPPON group vs 28% (95% CI 25% to 31%) in the control group. We observed no significant difference of all reported injuries (OR 0.72 in favour of the IPPON group, 95% CI 0.37 to 1.39, adjusted p value 0.33). Figure 2 illustrates the 2-weekly injury prevalence over 26 weeks.

Sensitivity analyses
The 16-week and 26-week sensitivity analyses showed similar primary outcome results (table 2). The primary analysis outcome did not change the best-case and worst-case analysis outcomes (table 2).

Secondary outcomes
Severe injuries
The severe injury prevalence was 14% (95% CI 12% to 17%) in the IPPON group vs 18% (95% CI 16% to 22%) in the control group. We observed no significant difference of the reported severe injuries (OR 0.80 in favour of the IPPON group, 95% CI 0.36 to 1.78, adjusted p value 0.58). Figure 3 illustrates the 2-weekly severe injury prevalence over 26 weeks.

Incidence per 1000 hours
The overall injury incidence was 34 per 1000 hours of judo exposure (95% CI 30 to 38) in the IPPON group vs 40 per 1000 exposure hours (95% CI 37 to 43) in the control group. We observed no significant difference of all new reported injuries (OR 0.95, 95% CI 0.48 to 1.87, adjusted p value 0.87). Online

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**Figure 1** Flow chart of the study procedure. IPPON, Injury Prevention and Performance Optimization Netherlands.

**Figure 2** Overall injury prevalence and 95% CI in the Injury Prevention and Performance Optimization Netherlands (IPPON) and control group at 2 weeks’ interval over 26 weeks. The absolute number and percentages (%) of the participating judo athletes are presented in brackets. The decreasing number and percentages from 16 to 26 weeks reflect the influence of the COVID-19 lockdown on the participating judo athletes.

**Figure 3** Severe injury prevalence and 95% CI in the Injury Prevention and Performance Optimization Netherlands (IPPON) and the control group at 2 weeks’ intervals over 26 weeks. The absolute number and percentages (%) of the participating judo athletes are presented in brackets. The decreasing number and percentages from 16 to 26 weeks reflect the influence of the COVID-19 lockdown on the participating judo athletes.
supplemental appendix K illustrates the 2-weekly injury inci-
dence over 26 weeks.

Location-specific prevalence
Figure 4 illustrates the location-specific prevalences in percentages.

Time loss
The mean time loss per injury was 2.6 days (95% CI 1.6 to 3.5) in the IPPON group vs 3.2 days (95% CI 2.1 to 4.2) in the control group. We observed no significant difference between groups for time-loss injuries (adjusted p value 0.664).

Sudden onset and gradual onset injury recurrence rates
Overall, 6% (95% CI 4% to 7%) recurrent injuries were registered in the IPPON group, 4% sudden onset injuries and 2% gradual onset injuries. In the control group, 5% (95% CI 4% to 7%) recurrent injuries were registered, 3% sudden onset and 2% gradual onset injuries.

Response rates
The mean overall response rate was 52%. The response rate decreased from 75% at baseline to 32% during the 26-week follow-up period. The response rates are presented in online supplemental appendix L.

Exposure
5.5 hours per follow-up moment of 2 weeks per participant (95% CI 5.3 to 5.7) were recorded in the IPPON group vs 5.8 hours per follow-up moment of 2 weeks per participant (95% CI 5.6 to 6.0) were recorded in the control group. We found no difference between groups. Online supplemental appendix M illustrates the 2-weekly hours of judo exposure over 26 weeks.

Adherence
In the IPPON group, the self-reported athlete adherence was 75%. When judo athletes performed the IPPON intervention, 85% of the judo athletes did all exercises completely as prescribed. The self-reported trainer adherence was 78%.

Experience
In the IPPON group 55% (6) of the trainers and 32% (48) of the athletes completed the evaluation survey. All trainers and 70% of the athletes considered the IPPON intervention successful, although some did not see the direct impact on injuries and performance. Trainers and athletes found the exercises of the IPPON intervention useful (trainers 4: 33%, 5: 67% and athletes 2: 2%, 3: 41%, 4: 55%, 5: 2%), a valuable addition to their regular training (trainers 3: 33%, 4: 67% and athletes 3: 39%, 4: 49%, 5: 12%) and will use the programme in the future (trainers 3: 33%, 4: 33%, 5: 33% and athletes 2: 10%, 3: 45%, 4: 40%, 5: 5%). Trainers will recommend other trainers use the IPPON intervention (3: 17%, 4: 50%, 5: 33%).

DISCUSSION
In our modified intention to treat analysis, the judo-specific IPPON injury prevention programme’s differences in injury prevalences were not statistically significant. However, the best-estimated differences, positive clinical experiences of athletes and all trainers, and the ease of implementation, all indicate that the IPPON intervention may be a useful alternative to the regular warm-up in judo.

Is it potentially clinically relevant?
A priori, we defined a 40% injury reduction as clinically relevant given the results of other prevention studies. The predefined injury reduction of 40% was not achieved but fell within the ranges of the 95% CIs. Therefore, a superior effect of the warm-up programme cannot be completely excluded. Our best-estimated difference of 18% in injury prevalence might be considered in retrospect as a potentially clinically relevant effect considering the following reasons. The COVID-19 pandemic impacted this study, requiring amendments to our protocol by which potential benefit was no longer measured. More importantly, the IPPON intervention is the first systematically
developed intervention in judo. Since this warm-up programme has been systematically designed with judo practice through a bottom-up approach, the exercises are recognisable for judo trainers and athletes. The extra effort is minimal, as performing a warm-up is a standard routine in judo. Trainers and athletes reinforce this implementation perspective. These reasons have contributed to a high adherence because all trainers and most of the athletes perceived the programme as successful. Due to the favourable experience of the participating trainers and athletes and the minimal extra effort for implementation, we consider the best-estimated difference of 18% in injury prevalence likely to be clinically relevant. We, therefore, suggest to consider the IPPON intervention as a useful alternative to regular warm-up in judo.

Comparison with other studies
This is the first randomised controlled trial evaluating an injury prevention programme in judo or any other combat sport, preventing comparison with other prevention studies. For non-combat sports, injury prevention programmes have frequently been reported as effective. These results were often found for team sports under trainer-based supervision. The trainer-supervised FIFA11+ programme showed a decrease in injuries of 50% among male football players and 35% among female football players. The trainer-supervised VolleyVegig programme showed a reduction in injuries of 21% among recreational adult volleyball players. While judo training sessions are supervised, it is an individual combat sport. To our knowledge, an injury prevention programme has not significantly reduced injuries in individual sports.

Lower power than aimed for
There are three main reasons causing this study to have a lower power than aimed for a priori.

First, our data revealed an overall injury prevalence rate of 2.5%. This percentage is lower than our predefined estimate of 41% in our sample size calculation. With a lower injury prevalence, a larger sample size is required to detect an injury reduction. There is a decreasing trend in injury prevalence over time for both groups. The mere presence of the study might have decreased injury prevalence. It could be that trainers and athletes who signed up for the training. As a result, the participating group could be less representative of the judo society in general.

Second, the response rates decreased to approximately 30% in both groups. We corrected these missing values in a best-case and a worst-case scenario analysis, which showed no differences. Studies that achieved higher response rates (e.g., 87%) proved successful in injury reduction. Studies with a comparable or lower response rate than ours also showed no differences.

Third, given the COVID-19 restrictions, the intervention period was forcibly shortened at most judo schools. The potential effect of the intervention over a full and unrestricted season remains unknown, but could benefit the results given the learning effect of the warm-up programme. It could be that a period of 6 months of registration is relatively short to find a statistical significant effect as there might be a training effect of the warm-up programme. In other studies with proven effective programmes, the injury registration period was 1 year.

Strengths and limitations
We are the first to publish a wide-scale cluster randomised controlled trial for injury prevention in judo. An important strength of the IPPON intervention is the systematically bottom-up development through the KTS methodology. We combined theory and practice using trainers/coaches and athletes. The strength of this study is the high adherence to the IPPON intervention compared with other warm-up prevention programmes. The trainer-supervised intervention reflects daily practice, which reinforces external validity. Our study also has limitations. This cluster-randomised controlled trial was substantially affected by the COVID-19 pandemic, requiring amendments to our protocol. Due to the COVID-19 restrictions, we could no longer perform the end visits at judo schools to monitor the quality of the exercises, as described as fidelity control in our protocol. Although trainer adherence was high, we could not ensure the quality of the exercises within the warm-up programme. While the exercises were specifically selected for judo, the protocol was powered to examine the effect on all injuries to capture potential indirect effects. Consequently, a detailed analysis could only be performed on all injuries, rather than on location-specific subtypes. Furthermore, the response rates decreased over time, which resulted in substantial missing data (online supplemental appendix I). All data was collected with self-reported information. The younger athletes were instructed to complete the questionnaires together with their parents or trainers to limit response bias. Our sample population consisted of athletes from the Netherlands only, which is a high-income country. This should be considered when generalising the results to an international context.

Recommendations for future directions
We suggest evaluating the warm-up programme throughout one complete and unrestricted season with a larger sample size in future studies. Registration for a longer period provides more injury data and a possible visible effect near the end of the intervention period. We also suggest measuring whether the IPPON intervention could improve performance. We planned on measuring the effect of the IPPON programme on performance measurements. Unfortunately, due to the COVID-19 pandemic, we could not complete the follow-up measurements.

CONCLUSION
We suggest to consider the IPPON intervention as a useful alternative to the regular warm-up in judo as no significant difference was found between these conditions and given the high adherence and the positive clinical experiences of trainers and athletes.

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