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SUMMARY

Sports participation – a cornerstone of public health

Current levels of physical inactivity are a major public health issue. Physical inactivity impacts health detrimentally and also results in a substantial economic burden to society. Promoting sufficient levels of physical activity is, therefore, crucial for the public health agenda. Sports provides a powerful avenue for the promotion and maintenance of sufficient levels of physical activity worldwide. Accordingly, the promotion of sports participation is a current global effort and should be seen as an investment in the present and in the future.

Sports-related injuries hamper sports participation

The benefits of sports participation are well documented. However, sports participation also entails a risk of injuries. Participants can be discouraged to continue with sports due to the negative experiences related to injuries. Apart from the burden on the individual's health, sports injuries also hamper the athletic success of individuals and teams. The prevention of sports injuries is, therefore, of great importance for public health and should be a priority for protecting athletes' health and maximising athletic performance.

This thesis aims to facilitate the prevention of sports-related injuries

Given the detrimental impact of injuries on sports participation, health, and athletic success, the prevention of sports injuries is an important goal worldwide. Active injury prevention research contributes to safe sports participation for people throughout their lifespan. Accordingly, the main objective of this thesis is to facilitate, from a practical perspective, research on the prevention of sports injuries and actual injury prevention on the field.

Chapter 2. Measuring the extent of sports injuries

Monitoring sports injuries is crucial to commence preventative efforts. Chapter 2 of this thesis presents a review of relevant concepts for monitoring sports injuries and the practical application of such concepts. Sports injuries need to be monitored regarding their occurrence (e.g. incidence, prevalence) and severity, as these descriptors are fundamental when establishing the extent of the injury problem. However, there is no 'one-size-fits-all' approach to define a recordable injury within a study or injury-monitoring system, or how the severity of injuries should be measured. Consequently, there is no 'one-size-fits-all' monitoring system for sports injuries. Chapter 2 can, as such, serve as a primer for those interested in the monitoring of sports injuries and hence establish a focus for preventative efforts.

Chapter 3. The perspective of end-users towards online sport-health monitoring

Chapter 3 describes the acceptability and perceptions of end-users (i.e. elite judo, swimming, volleyball athletes, and their team staff members) towards an online sport-health monitoring system built based on the concepts described in chapter 2. The mean athlete response rate to the health monitoring follow-ups over one season was 50% (standard deviation [SD] 23), 61% (SD 27), and 56% (SD 25) for judo, swimming, and volleyball, respectively. The mean prevalence of injury measured repeatedly over the season was 26% (95% confidence interval [95% CI] 0–59), 19% (95% CI 0–65) and 36% (95% CI 0–77) for judo, swimming, and volleyball, respectively. Athletes stated that they had expected to receive feedback on their inputs into the system. This feedback would have motivated them to keep responding to the follow-ups, which might have led to higher response rates. The reports from the system to the athletes' authorised staff facilitated the communication between the trainer and medical department. Staff members stated that they were able to monitor their athletes' health based on these reports and, consequently, intervene earlier to prevent minor health complaints from becoming severe health problems. Chapter 3 shows that such an online system can be used complementary to regular strategies for the monitoring of elite athletes' health. The feasibility of a personalised athlete feedback is currently

under investigation and will potentially increase the adherence of athletes to such an online system.

Chapter 4. Monitoring injuries in elite field hockey

Chapter 4 presents the output of an online sport-health monitoring system used over one season in terms of injury incidence, prevalence, and severity of injuries in elite field hockey players. Players sustained 3.5 (95% CI 2.5–4.5) acute injuries per 1,000 hours of training and 12.3 (95% CI 7.6–17.0) per 1,000 hours of competition. The mean prevalence of injury, measured repeatedly over the season, was 29% (95% CI 3–55) for all, 9% (95% CI 0–20) for acute, and 14% (95% CI 0–36) for overuse injuries. The median score for the severity of injuries was 28 out of 100 (25%–75% interquartile range [IQR] 16–42) for all injuries, 35 (IQR 23–53) for acute, and 21 (IQR 16–31) for overuse injuries. Thirty percent of the injuries experienced by field hockey players hampered training/competition participation and/or performance. These injuries affected 52% of the injured players. Chapter 4 shows that, although acute injuries are common in elite field hockey, overuse injuries pose a comparable problem in this sport. Since injuries are a burden on elite field hockey players' health and may hamper performance and availability for training/competing, prevention is of great importance.

Chapter 5. Descriptive evidence on field hockey injuries

Chapter 5 portrays a systematic review of studies on field hockey injuries in order to establish the extent of the injury problem in terms of rate and severity. Most injuries in field hockey affect the lower limb. Common injury types are contusions/hematomas and abrasions. Contact injuries are common in field hockey, but non-contact injuries are also a cause for concern. Such common injury characteristics may contribute to focussed injury prevention efforts. However, substantial heterogeneity among definitions and methods employed in the different studies hampered conclusive findings on the extent of the injury problem in field hockey, which is considered the first step towards effective prevention. Therefore, injury prevention efforts in field hockey will benefit from a consensus on the methodology of injury surveillance. While

no specific consensus is currently available for monitoring field hockey injuries, future studies may use widely-accepted consensus available for other sports, such as football (soccer). In addition, future studies on field hockey injuries are encouraged to adhere to the reporting guidelines from the Enhancing the Quality and Transparency of Health Research (EQUATOR) Network to facilitate the assessment of the generalizability, strengths, and limitations of their findings.

Chapter 6. Effectiveness of the Warming-up Hockey program to prevent injuries

Chapter 6 comprises a quasi-experiment to evaluate the effectiveness of a structured exercise-based injury prevention program (i.e. the Warming-up Hockey program) regarding its potential to reduce injuries in youth field hockey players (aged 10–17 years). The program was developed by the Dutch Consumer Safety Institute (VeiligheidNL) in partnership with the Dutch Royal Hockey Association (KNHB). The exposure to the program was associated with a 36% lower injury rate (hazard ratio [HR] = 0.64 [95% CI 0.38–1.07]). The rate of lower limb injuries was 46% lower (HR = 0.54 [95% CI 0.29–1.02]) in the group following the Warming-up Hockey program. These results can be considered meaningful for practitioners given the statistically significant reduction of acute injuries (HR = 0.55 [95% CI 0.31–0.96]) and of injuries leading to 1–3 days of playing time-loss (HR = 0.52 [95% CI 0.27–0.98]). In addition, the group exposed to the program had a statistically significant reduction of 8.42 (95% CI 4.37–12.47) days of playing time-loss per 1,000 player-hours of field hockey (i.e. injury burden). Overall, it was concluded that the Warming-up Hockey program was effective in reducing the rate and burden of injuries in youth field hockey players.

Chapter 7. Considerations and interpretation of injury prevention studies

Chapter 7 is aimed to be a resource for stakeholders interested in understanding and interpreting common study designs, outcome measures, and statistics used in studies evaluating the effect of injury prevention strategies in sports, such as the one portrayed in chapter 6. As shown in chapter 2, there is no ‘one-size-fits-all’ approach regarding definitions and methodologies to assess the extent of the sports injury problem in terms

of occurrence and severity. Consequently, there is no single approach that should always be followed to ensure valid assessment of the effect of preventative strategies in sports. The preferred study design and methods derive from both the research question and the context of the investigation. Injury frequency and rates should not be the sole outcome of injury prevention studies. Other relevant outcomes to be considered are injury severity, burden of injury on athletes' sport participation, and/or compliance/adherence to preventative strategies. Therefore, sports injury prevention studies should provide a clear definition and a valid assessment of injury, sport exposure, injury severity, and compliance/adherence to preventative measures. Given the different definitions, methodologies, and settings used to assess the effect of preventative strategies in sports, stakeholders should consider the context of study findings to determine whether such strategies are applicable to their own practice.

Conclusions

Simple online technology enables monitoring of athletes' health and aids efforts regarding the prevention and management of sports injuries. Systematic monitoring of athlete health is of practical value for athletes and their team staff and provides valid data for research. End-users should be educated on the importance of athlete health monitoring and, together with researchers, should be actively involved in the design and implementation of a sport-health monitoring system.

Heterogeneity exists in definitions and methods applied to measure the extent of the injury problem in sports. Although such heterogeneity hampers conclusive findings on the magnitude of the problem in specific sports, it should not impede the engagement of stakeholders to protect athletes' health by the attempt of preventing sports injuries. Structured warm-up programs are valuable for the prevention of sports injuries. A specific warm-up program for youth field hockey showed positive results for the reduction of injury rates and burden of injuries players' sport participation in a real-world sporting context.