Journal of Science and Medicine in Sport 21 (2018) 894–898

Contents lists available at ScienceDirect

Journal of Science and Medicine in Sport

journal homepage: www.elsevier.com/locate/jsams

Original research

Interrater reliability of the injury reporting of the injury surveillance system used in international athletics championships

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ARTICLE INFO

Article history:
Received 27 May 2017
Received in revised form 3 January 2018
Accepted 7 February 2018
Available online 2 March 2018

Keywords:
Injury surveillance
Methodology
Sports injury prevention
Track and field
Epidemiology
Prospective studies

ABSTRACT

Objectives: The quality of epidemiological injury data depends on the reliability of reporting to an injury surveillance system. Ascertaining whether all physicians/physiotherapists report the same information for the same injury case is of major interest to determine data validity. The aim of this study was therefore to analyse the data collection reliability through the analysis of the interrater reliability.
Design: Cross-sectional survey.
Methods: During the 2016 European Athletics Advanced Athletics Medicine Course in Amsterdam, all national medical teams were asked to complete seven virtual case reports on a standardised injury report form using the same definitions and classifications of injuries as the international athletics championships injury surveillance protocol. The completeness of data and the Fleiss' kappa coefficients for the inter-rater reliability were calculated for: sex, age, event, circumstance, location, type, assumed cause and estimated time-loss.
Results: Forty-one team physicians and physiotherapists of national medical teams participated in the study (response rate 89.1%). Data completeness was 96.9%. The Fleiss' kappa coefficients were: *almost perfect* for sex (k = 1), injury location (k = 0.991), event (k = 0.953), circumstance (k = 0.942), and age (k = 0.870), *moderate* for type (k = 0.507), *fair* for assumed cause (k = 0.394), and *poor* for estimated time-loss (k = 0.155).
Conclusions: The injury surveillance system used during international athletics championships provided reliable data for "sex", "location", "event", "circumstance", and "age". More caution should be taken for "assumed cause" and "type", and even more for "estimated time-loss". This injury surveillance system displays satisfactory data quality (reliable data and high data completeness), and thus, can be recommended as tool to collect epidemiology information on injuries during international athletics championships.

1. Introduction

Injury surveillance studies during international athletics championships are a significant part of the effort of the European Athletics (EAA)[1–4] and the International Association of Athletics Federations (IAAF)[5–9] to prevent athletes' injuries.[10,11] However, the quality of epidemiological data depends on the quality of the injury surveillance system implemented.[12–14] Edouard et al.[15] analysed the quality of the injury surveillance system used during international athletics championships,[6,7,16,17] and reported that it was useful, simple, feasible, flexible, acceptable, and with security and confidentiality, according to the Centre for Disease Control and

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https://doi.org/10.1016/j.jsams.2018.02.001
1440-2440/

Table 1
Completeness of data: number (and percentage compared to the maximal number expected) of data for each variable and case report.

	Sex	Age	Event	Circumstance	Location	Type	Cause	Time-loss	Total
Case report 1	40 (97.6)	41 (100.0)	41 (100.0)	41 (100.0)	41 (100.0)	41 (100.0)	39 (95.1)	38 (92.7)	322 (98.2)
Case report 2	40 (97.6)	35 (85.4)	41 (100.0)	41 (100.0)	41 (100.0)	41 (100.0)	40 (97.6)	37 (90.2)	316 (96.3)
Case report 3	40 (97.6)	41 (100.0)	41 (100.0)	41 (100.0)	41 (100.0)	41 (100.0)	41 (100.0)	37 (90.2)	323 (98.5)
Case report 4	40 (97.6)	41 (100.0)	41 (100.0)	41 (100.0)	41 (100.0)	41 (100.0)	38 (92.7)	38 (92.7)	321 (97.9)
Case report 5	39 (95.1)	41 (100.0)	41 (100.0)	41 (100.0)	41 (100.0)	41 (100.0)	41 (100.0)	37 (90.2)	322 (98.2)
Case report 6	38 (92.7)	35 (85.4)	41 (100.0)	41 (100.0)	41 (100.0)	41 (100.0)	36 (87.8)	37 (90.2)	310 (94.5)
Case report 7	38 (92.7)	34 (82.9)	41 (100.0)	41 (100.0)	41 (100.0)	39 (95.1)	39 (95.1)	37 (90.2)	310 (94.5)
Total	275 (95.8)	268 (93.4)	287 (100.0)	287 (100.0)	287 (100.0)	285 (99.3)	274 (95.5)	261 (90.9)	2224 (96.9)

Prevention (CDC) guidelines.[12,13] In addition, it had good methodological qualities, with high national medical team participation, coverage of athletes, response rates and completeness of injury data.[15]

However, other methodological aspects,[12,13] such as objectivity, sensitivity, reliability and validity, have not been analysed yet. These methodological aspects concern the injury reporting, which is an important part of the injury surveillance system. The validity of the data refers to their accuracy and reliability, and is a component of the data quality in addition to the data completeness and objectivity.[12] Accuracy and reliability can be analysed through the analysis of the interrater variability. Indeed, determining whether all physicians/physiotherapists (corresponding to the rater population of interest) report the same information for the same case of injury sustained by an athlete (corresponding to the subject population of interest) allows evaluating the reliability of the data,[18,19] and is of course of major interest to determine the quality of the injury surveillance system and the collected data, and consequently to better interpret epidemiological injury data representing the first step of the injury prevention sequence.[11]

The aim of this study was therefore to analyse the reliability of the data collection (injury reporting) through the analysis of the interrater reliability.

2. Methods

During the first Advanced Athletics Medicine Course of the European Athletics (3–4 July 2016, in Amsterdam), which took place just before the 23th European Athletics Championships in Amsterdam, all national medical teams (n = 46) were asked to participate in the study, and to complete seven virtual case reports on a standardised injury report form using the same definitions and classifications of injuries as the international athletics championships injury surveillance protocol.[6,7,16,17]

The seven virtual case reports were created by two sports medicine physicians specialized in athletics (PE and PB) based on the most common and relevant injury situation from previous studies during international championships,[1–9,20] and to provide an overview of the injury situation possibilities: (1) sprinter, sudden hamstring muscle injury, (2) jumper, sudden ankle sprain, (3) thrower, chronic shoulder tendinopathy, (4) long distance runner, lower leg muscle injury, (5) jumper, chronic Achilles tendinopathy, (6) sprinter, sudden hamstring muscle injury, and (7) decathlete, sudden ankle sprain (Appendix A in Supplementary material). After oral explanation of the aim and modalities of the study, a booklet in paper form was distributed to all participants of the medical seminar. The booklet included the aim and modalities of the study, the seven case reports, the definitions and classifications of injuries, and the standardised report form to report the data (Appendix A in Supplementary material). For each case report, the participants should complete the standardised report form information. All information (oral and booklet) was provided in English, but participants were allowed to use translation tools or the injury classification (in French, German, Russian and Spanish) used in previous studies during international championships.[1–9,20] No communication between raters was allowed. The completed report forms were collected during the same day after allowing sufficient time for participants to complete them. All participants were members of athletics national medical teams with experience in sports medicine with high-level athletes, especially during international championships, and with experience in the injury surveillance studies during international athletics championships. No ethical approval was required since the study did not involve patients.

The variables used for the analyses were the same as previous studies during international athletics championships[1–9,15,20]: sex (female or male), age, event, circumstance (training or competition), location, type and assumed cause of injury as well as estimated time-loss. The codes and classification of the variables followed the consensus statement for epidemiological studies in Athletics (track and field).[17] Assumed cause of injury were analysed in two ways: (i) using a dichotomous classification into two categories: traumatic vs. overuse, and (ii) using the classification of causes from the consensus statement.[17] Analysis of estimated time-loss were performed in two ways: (i) using a dichotomous classification into two categories: no time loss vs. time-loss injury, and (ii) using the classification of time-loss from the consensus statement.[17] The analysis of non-participation and missing data were first performed through the calculation of the rate of participation and the completeness of data, respectively, as reported by Edouard et al.[15] Our present study followed the guidelines for reporting reliability and agreement studies.[18] The level of measurement of the variables were categorised as nominal/categorical.[18,19] The Fleiss' kappa coefficient was calculated to determine the interrater reliability for each case report and each variable.[18,19] According to Landis and Koch,[21] the kappa values were interpreted as: $\leq$0 = poor, 0.01–0.20 = slight, 0.21–0.40 = fair, 0.41–0.60 = moderate, 0.61–0.80 = substantial, and 0.81–1 = almost perfect. The overall percentage agreement was used to evaluate the interrater agreement for each variable. All data were processed using Excel or R (http://www.R-project.org).

3. Results

Out of the 46 team physicians and physiotherapists of national medical teams participating in the 2016 European Athletics Advanced Athletics Medicine Course, 41 (89.1%) accepted to participate in this study and returned the standardised report form with information completed for the seven case reports. There were 21 (51.2%) physicians and 18 (43.9%) physiotherapists; information was missing for 2 (4.9%).

The completeness of data was 96.9% (2224 data of 2296), ranging from 80.3 to 100% according to the participants, 90.9 to 100% according to the variables, and 94.5 to 98.2% according to the case reports (Table 1). The 72 missing data were for estimated time-loss (n = 26; 36.1%), age (n = 19; 26.4%), sex (n = 12; 16.7%), assumed cause (n = 13; 18.1%) and type (n = 2; 2.8%); no missing information occurred for event, circumstances and location.

For the interrater reliability analysis, the Fleiss' kappa coefficients were *substantial* or *almost perfect* for all case reports (Table 2). In addition, the Fleiss' kappa coefficients were: *almost perfect* for sex, location, event, circumstance, and age, *moderate* for assumed cause (with dichotomous classification) and type, *fair* for assumed cause (with all classification) and estimated time-loss (with dichotomous classification), and *poor* for estimated time-loss (with all classification). The Fleiss' kappa coefficients and the overall percentage agreement for each variable are reported in Table 3. There were no differences in the reporting between physicians and physiotherapists.

4. Discussion

The main findings of the present study were that (1) the injury surveillance system used during international athletics championships provides reliable data, (2) "sex", "location", "event", "circumstance", and "age" seems to be reliable information, (3) caution should be taken for "assumed cause" and "type", and even more for "estimated time-loss" given their high interrater variability. In addition, and in agreement with previous studies,[1–9,15,20] the injury surveillance system seems acceptable given the high response rate and the high data completeness.

This present study extends the results of a previous study on the methodological quality of injury surveillance system,[15] and provides additional information specifically on its injury reporting component, supporting the quality of the injury surveillance system used during international athletics championships. The injury surveillance system has been evaluated as useful, simple, feasible, flexible, and acceptable with high data quality.[15] The present results report that the system is reliable between raters, with caution for certain variables (i.e. type, assumed cause and especially estimated time-loss), suggesting reliability of injury collection data methods.

"Sex", "location", "event", "circumstance", and "age" seem to be reliable information, these data can represent a strong and valid basis of the injury epidemiology knowledge. This could be explained by the fact that these variables can be determined easily without complex examination and sports medicine background, and mainly just by asking athlete.

For "assumed cause" and "type", the interrater reliability was moderate, suggesting caution in the interpretation of these data. The determination of injury type corresponds to the determination of the injured/involved tissue that needs, at least, a specific physical examination, some experience in sports medicine and, sometimes, other examinations such as imaging. This could explain the present reported variability because the participants had to perform the diagnosis of the injury type only based on a virtual case report without possibility of a physical examination; it is therefore an assumption. We presume that the injury type reliability may be better classified in a real situation. Determining the cause of injuries is difficult to determine since it might involve knowing the mechanism of injury (not always known by the athlete), predisposing risk factors, and/or a history of symptoms or changes in injured tissue. Moreover, the difficulty is higher for virtual case reports since no additional information is available. In addition, the classification of cause[17] could also be complex or not enough adapted to the in-championships situation.

The variable "estimated time-loss" had the lowest interrater reliability. In addition, it was the information with the lowest data completeness, which is in agreement with the fact that raters had difficulties to estimate the consequence of injury on the athletics practice. Estimating the time of absence of an injury represents one of the tasks of the medical staffs. The first question of injured athlete is often: "when can I go back to sports?",[22] and time-loss from

Table 2
Interrater reliability of the injury reporting of the injury surveillance system analysed using the Fleiss' kappa coefficient and the overall percentage agreement, using the complete classification of the consensus statement[17] (using the dichotomous classification into brackets) for each case report.

	Case report 1		Case report 2		Case report 3		Case report 4		Case report 5		Case report 6		Case report 7	
Number of raters	36		29		36		35		36		25		24	
Fleiss' Kappa coefficient	0.807	(0.916)	0.780	(0.944)	0.777	(0.794)	0.819	(0.860)	0.828	(0.890)	0.719	(0.834)	0.733	(0.820)
Interpretation[21]	Substantial (Almost perfect)		Substantial (Almost perfect)		Substantial (Substantial)		Almost perfect (Almost perfect)		Almost perfect (Almost perfect)		Substantial (Almost perfect)		Substantial (Almost perfect)	
Overall percentage agreement (%)	50	(62.5)	50.0	(75.0)	37.5	(37.5)	62.5	(62.5)	37.5	(37.5)	37.5	(37.5)	37.5	(50.0)

Table 3
Interrater reliability of the injury reporting of the injury surveillance system analysed using the Fleiss' kappa coefficient and the overall percentage agreement for each variable.

	Sex	Age	Event	Circumstance	Location	Type	Cause (traumatic vs. overuse)	Cause (classification[17])	Time-loss (no time loss vs. time-loss injury)	Time-loss (5 categories[17])
Number of raters	31	27	41	41	41	39	32	32	35	35
Fleiss' Kappa coefficient	1.000	0.870	0.953	0.942	0.991	0.507	0.595	0.394	0.289	0.155
Interpretation[21]	Almost perfect	Almost perfect	Almost perfect	Almost perfect	Almost perfect	Moderate	Moderate	Fair	Fair	Poor
Overall percentage agreement (%)	100	14.3	85.7	71.4	85.7	0	28.6	0	28.6	0

Number of raters corresponds to the total number of participants after excluding missing data for Fleiss' kappa coefficient calculation.

sport may influence the success in international championships.[23] Our present finding is in agreement with current scientific knowledge reporting that predicting the time of absence or time to return to sport is a challenging and difficult task.[24,25] A recent systematic review[24] reports that there is currently no strong evidence that clinical evaluation in the first days after injury provides a valuable prognosis for the time to return to sports in the specific context of an acute hamstring injury. In addition, in acute hamstring injury, Jacobsen et al.[25] reported in a prospective cohort study that the 95% confident interval associated with the predicted time to return to sport based on the initial clinical examination was approximately plus/minus 20–25 days and explained only 59% of the variance in the time to return to sport. Thus, currently and to our knowledge, it seems that the initial examination is insufficient to determine the duration of the exact absence from sport. This is in agreement with our present findings, and confirms that caution should be taken with estimated duration of absence provided in injury surveillance studies during championships. Following athletes with time-loss injuries until their return to sport, and if needed after the championship period, would provide more accurate information. In addition, this raises the question of the definition/concept of the time-loss (i.e. in this study: "number of days that the athlete will not be able to undertake his/her normal training program or will not be able to compete"); raters could have a different perception of the definition (i.e. total stop or partial stop with adaptation of training to the injured body part).[17] This could be improved in injury surveillance protocols and injury consensus statements.

Limitations of the present study include the virtual aspect of the case reports. They did not reflect all the possible injury situations (representativeness). The formulation of the case reports could have biased the results, for example some information were provided to the raters in a simpler way than on the field (e.g. age). The country was not analysed contrary to the study from Edouard et al.,[15] since in such data collection it corresponds to the country of the national medical team. The two last case reports had the lowest completeness rate, this could have biased the results, and this could be explained by the fact that the raters were no longer motivated or did not have enough time. The reliability was limited to the inter-rater reliability, intra-rater reliability should be evaluated in future studies. Since measurement setting and statistical approach were fully described, the different sources of variability of reliability estimates should be limited.[18]

Such analyses of injury surveillance system quality appear of fundamental interest as injury surveillance provides important data to help us understand injury risk, and thus, develop injury prevention strategies and evaluate their effects.[11,15] It is therefore self-evident that the pertinence of prevention strategies is highly dependent on the quality of the injury surveillance. To fully evaluate the present injury surveillance system, the sensitivity, positive predictive value, representativeness, validity, stability and sustainability needs to be evaluated.[12,13] However, to evaluate sensitivity, positive predictive value, representativeness, and validity, a gold standard for comparison is needed which, however, currently and to our knowledge, does not exist. The stability refers to the practical aspects of the injury surveillance system (i.e., the ability to collect, manage, and provide data properly without failure and the ability to be operational when it is needed).[12] The sustainability refers to the fact that the system works "with the minimum of effort and is easy to maintain and update, so that it continues to serve its purposes well after it has been established".[13] We assume that the injury surveillance system is stable and sustainable because: (1) it is used since 2007 during almost all World and European Championships, (2) its implementation was easy and rapid when needed, (3) there was always a high level of participation and data completeness,[15] (4) there were low costs of management, and (5) no failure was in the system reported.

As perspectives, the intra-rater reliability should be evaluated through test–retest evaluation. The quality of injury surveillance system and of course the data could be even more improved by improving the clarity of paper or electronic report forms, the quality of training and supervision of persons who complete these surveillance forms, and the care exercised in data management.[12] The present study analysed the injury surveillance system used during international athletics championships which is based on the International Olympic Committee injury surveillance system for multi-sport events.[16] Since both systems are very similar, we assume that the present results can be extended to other studies using such system, e.g. during the Olympic Games[26–29] and the Fédération Internationale de Natation (FINA) World Championships.[30]

5. Conclusion

The injury surveillance system used during international athletics championships provided reliable data for "sex", "location", "event", "circumstance", and "age", more caution should be taken for "assumed cause" and "type", and even more for "estimated time-loss". This injury surveillance system has been evaluated as useful, simple, feasible, flexible, acceptable, stable with high data quality (reliable data and high data completeness), and thus, can be recommended as tool to collect the epidemiological data on injuries during international athletics championships.

Practical implications

- Given their high interrater reliability information on "sex", "location", "event", "circumstance" and "age" can be considered as reliable data from epidemiological studies during international athletics championships.
- Given their low interrater reliability regarding "assumed cause" and "type", and even more for "estimated time-loss", this information should be interpreted with caution.
- The injury surveillance system used during international athletics championships has been evaluated as useful, simple, feasible, flexible, acceptable, stable with high data quality (valid data and high data completeness), and thus, is thus can be recommended as tool to collect epidemiological data on injuries during international championships.

Funding

The Advanced Athletics Medicine Course of the European Athletics (3–4 July 2016, in Amsterdam) was funded by the European Athletics (www.european-athletics.org), which has contributed to perform the present interrater reliability study.

Ethics approval

Not applicable.

Acknowledgements

The authors would like to thank the team physicians and physiotherapists for their participation and for volunteering their time to complete the virtual case reports, and the European Athletics for allowing this study.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jsams.2018.02.001.

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