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The Socioeconomic Cost of Anterior Cruciate Ligament Injuries and Lateral Ankle Sprains in Amateur Football and Basketball

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Context: Football and basketball are high-risk sports for anterior cruciate ligament (ACL) injuries and lateral ankle sprains (LASs). These injuries have a high recurrence rate and long-term consequences in terms of early onset osteoarthritis as well as lack of return to preinjury levels of activity.

Objective: To (1) prospectively record the socioeconomic costs associated with noncontact ACL injuries and LASs in amateur football and basketball and (2) to determine the association between costs and the degree of implementing preventive neuromuscular training (NMT).

Design: Cohort study.

Setting: Amateur football and basketball teams were followed up during 1 season.

Patients and Other Participants: Cohort of 3221 amateur football and basketball players.

Main Outcome Measure(s): All direct and indirect costs of sustained noncontact ACL injuries and LASs were registered until return to play and were described on a player level. The degree of implementing NMT was documented twice per season. The degree of implementing NMT during preseason and midseason was documented.

Results: The incidence proportions of ACL injuries and LASs were estimated at 0.01 and 0.03 injuries per player season, respectively. Thirty percent of the ACL injuries and 65% of the LASs represented a recurrent injury. The mean total cost per ACL injury and LAS was €6340.7 and €731.6, respectively. More than 90% of the injured players did not implement preventive NMT or implemented it inadequately.

Conclusions: The high costs of ACL injuries and LASs and the observation that preventive NMT is scarcely implemented in amateur football and basketball emphasizes an urgent need for policymakers to focus on injury prevention.

Key Words: health care cost, reinjuries, prevention, sport, injury

Key Points

- Anterior cruciate ligament injuries and lateral ankle sprains in Belgian amateur football and basketball cause a substantial socioeconomic burden, and a very large proportion of these injuries are recurrent.
- Most injured players did not implement preventive neuromuscular training during the preseason and in-season or did in an inadequate way.

Football and basketball are popular sports with a high risk for anterior cruciate ligament (ACL) injuries and lateral ankle sprains (LASs), two common noncontact injuries. Both injuries have a high recurrence rate. The pooled incidence proportion of a second ACL injury has been estimated to be up to 14%,[1] and for an LAS, it ranges from 12% to 47%.[2] Furthermore, ACL injuries and LASs have negative long-term consequences. Athletes who sustained an

ACL injury have a 4 to 6 times higher risk for developing knee osteoarthritis compared with the general population,[3] and up to 25% of athletes with an LAS develop chronic ankle instability.[4] Neuromuscular training (NMT) programs at least containing stabilization (ie, jump landing) and strengthening/plyometric exercises using feedback on proper technique are effective at reducing the risk for an ACL injury and LAS as long as these exercises are performed at least twice per week and the NMT program is performed during the preseason and in season whether supervised or unsupervised.[5–7] This is particularly important for amateur players, as they are at higher risk for sports injuries per 1000 playing hours compared with professional players, and this could result in a substantial socioeconomic burden.[8–10]

The economic burden of ACL injuries and LASs is known to be high. In 2008, the medical cost for an ACL injury in Belgium was estimated at €1358 and for an LAS at €197.[11] However, these costs are based upon retrospective data and may be underestimated.[11] Therefore, the purpose of this study is to prospectively record the socioeconomic costs associated with noncontact ACL and LAS injuries in amateur football and basketball. A secondary objective of this study is to document the degree of implementing NMT in players who sustained an ACL injury or LAS.

METHODS

In this prospective cohort study, amateur football (N = 164) and basketball (N = 164) teams were randomly selected and contacted for participation during the seasons 2014 to 2015 through 2017 to 2018. After providing written informed consent, all participating players of eligible male and female teams, competing at different levels of interregional competition in Flanders (Belgium), were prospectively followed up for 1 season (August to May). Amateur players were defined as nonprofessional players who do not receive an income from playing sports but are participating in regular competition. Information on NMT for injury prevention as well as football/basketball exposure, injuries, health care, and medication use in case of injury were prospectively collected over the course of 1 season. This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Medical Ethical Committee of the University Hospital Brussels (2015/364).

OUTCOMES

Injury

Noncontact ACL injuries and LASs sustained during one season were registered. Coaches and players were instructed to inform the researchers if a player sustained an ACL injury or an LAS. An LAS was operationally defined as an injury of the lateral ligaments of the ankle joint. In addition to the self-reporting, all coaches were contacted by email every month to verify whether 1 of their players had sustained an injury as well as to report sports exposure (ie, football or basketball) of their team's players as described by Rommers et al.[12] Exposure was reported in hours for each week. Coaches who did not respond to the email within 2 weeks were contacted by phone. In the case in which a player sustained an ACL injury or LAS, researchers first verified the nature and circumstances of the sustained injury in a standardized phone interview with the player. Only noncontact ACL injuries or LASs were included in this study defined as injuries that occurred during landing or changing direction and were not the result of direct contact at the lower limb (eg, push or pull).[13] We only collected information on medical-attention injuries leading to associated costs. A medical-attention injury was defined as an injury for which a medical doctor was consulted. It must be noted that a medical consultation is mandatory in Belgium for the athlete to get insurance coverage for injury-related costs. Each injured player received an electronic injury registration form (see Supplement) containing detailed questions about the nature of the injury, date of the injury, injury circumstances (for example, injury sustained during a game or practice while running, landing, cutting or by contact [push, pull, or tackle]), as well as localization of symptoms.

Health Care Use Costs

On the same electronic registration form, injured players were instructed to continuously collect all medical/health care visits, investigations, and treatments related to the ACL injury or LAS until they were fully recovered and returned to competition (ie, participation in an official game).[14] The research team contacted injured players by phone monthly to double-check their medical information. A similar method for collecting health care usage using an electronic diary has already been used in a previous study.[15] Direct costs and indirect costs of the sustained noncontact ACL injuries and LASs were registered. Direct costs are costs that are related to the diagnosing and treatment of a health problem (ie, medical imaging; visits to a general practitioner, sports physician, or medical specialist; surgery; hospital stay; physical therapy sessions; medical devices; cast; brace; medication; exercise equipment). Indirect costs are costs that are related to the loss of productivity due to absenteeism from paid work. The calculation of the direct costs was estimated based on the National Institute for Health and Disability Insurance.[16] The cost of medication was estimated based on the Belgian Center of Pharmaceutical Information (Belgisch Centrum voor Farmacotherapeutische Informatie).[17] Costs related to hospital stay were based upon the standard costs published in the database of Federaal Kennis Centrum voor Gezondheid.[18] All prices related to direct costs were standardized to the year 2018 (ie, cost indications of 2018 were used). Indirect costs are derived from Securex White Paper Absenteeism using the Human Capital Approach, which estimates the indirect costs based on the total duration of absenteeism from paid work (ie, flat rate per absent day).[19]

Other Variables

Before the preparation period, contact information and information about the player's age, sex, working status, sport history, and previous injuries was collected. Shortly after the preparation period and also during midseason, players completed an online survey (see Supplement). This survey contains football/basketball exposure (training frequency) and specific questions regarding the use of NMT for injury prevention. Players were asked whether they performed specific preventive exercises during training, and if so, they were asked about the content of these exercises

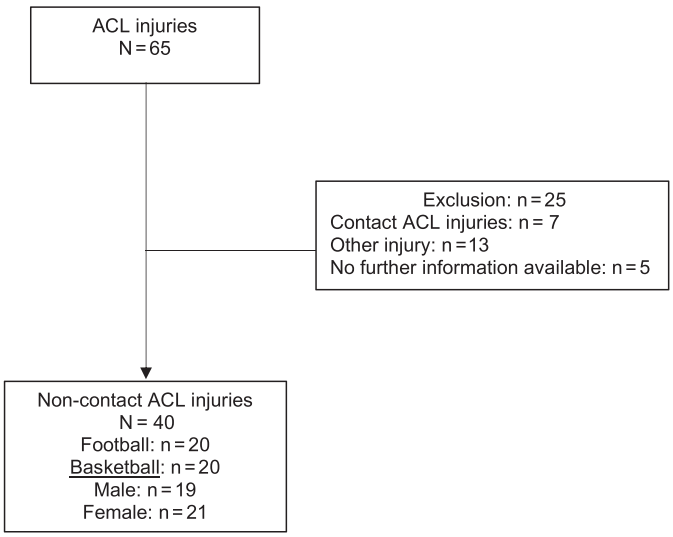

Figure 1. Flowchart of anterior cruciate ligament injuries.

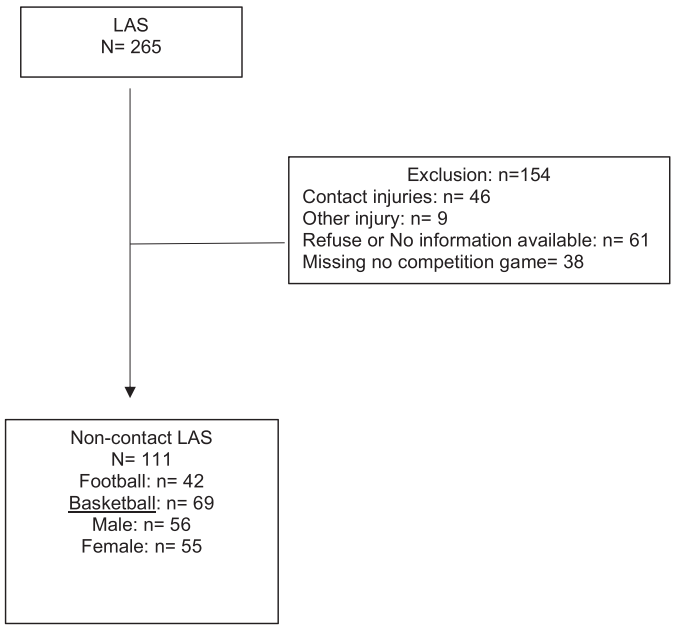

Figure 2. Flowchart of noncontact lateral ankle sprains.

(type of exercises illustrated by photos or videos, frequency of exercises, duration of exercises, feedback, etc). The test–retest reliability of the questionnaire has already been demonstrated (Cohen's kappa ranging from 0.55 to 1).[12] Based on the answers, players were then categorized into the "adequate prevention" group, "inadequate prevention" group, or "no prevention" group. The "adequate prevention" group consisted of players performing both stability/balance exercises and plyometric exercises at least twice a week in or out of training; the "inadequate prevention" group consisted of players performing these preventive exercises less than twice a week or in case the implemented program did not include both stability/balance and plyometric exercises. The "no prevention" group contained players performing no NMT at all. This categorization is supported by results of systematic reviews and meta-analyses demonstrating that the implementation of preventive programs including stability/balance exercises and plyometric exercises significantly reduces the risk for an ACL injury or LAS.[5–7,20,21]

STATISTICAL ANALYSIS

Patients' demographic characteristics were described by mean with SDs or median and interquartile range (IQR) for continuous variables, depending on their distribution or count, and percentage for categorical variables. The incidence of noncontact ACL injuries and LASs was calculated per player season with corresponding Wilson 95% CIs. Percentages, mean, and SDs of the used investigations and treatments per category were presented. Further on, the mean and SD of the direct and indirect costs per injury were calculated. We compared the costs between the index and recurrent injuries and between prevention groups (no prevention versus inadequate and adequate prevention; index versus reinjury) using the Wilcoxon signed rank test or the Kruskal-Wallis test as appropriate. With very close follow-up, we aimed to ensure high-quality data collection and avoid missing data. All analyses were performed in R (version 4.0.5).

RESULTS

Of the 3221 players (football, 2013 players; basketball, 1208 players) included in this study and followed up for an entire season, 151 players sustained a noncontact ACL injury and/or LAS (see flowchart in Figures 1 and 2). The players' demographic characteristics are described in Table 1. Most injuries occurred during match play. The ACL injury incidence proportion was calculated at 0.01 injuries per player season (95% CI = 0.009, 0.017) (Table 2). Thirty percent of ACL injuries represented a recurrent injury. Most ACL injuries were observed at the start of the season and shortly after winter break. The LAS incidence proportion was calculated at 0.03 injuries per player season (95% CI = 0.029, 0.041), and 65% percent of LASs represented a recurrent injury. Comparable to ACL injuries, most LASs were observed during August, September, and October. The median time until return to competition for an LAS was

Table 1. Demographic Characteristics of Injured Players[a]

	Overall	ACL	LAS
n	151	40	111
Age (years)	24.1 (5.2)	24.7 (5.9)	23.7 (4.9)
Female sex	76 (50.3)	21 (52.5)	55 (49.5)
Football	62 (41.1)	20 (50.0)	42 (37.8)
Recurrent injury	84 (55.6)	12 (30.0)	72 (64.9)
Use of tape or brace	58 (38.9)	16 (42.1)	42 (37.8)
Match injury	107 (70.9)	32 (80.0)	75 (67.6)
Injury leading to related absenteeism	38 (25.5)	21 (55.3)	17 (15.3)
Injury reported to sports federation	95 (63.8)	38 (100.0)	57 (51.4)
NMT			
No	114 (75.5)	27 (67.5)	87 (78.4)
Inadequate	26 (17.2)	11 (27.5)	15 (13.5)
Adequate	11 (7.3)	2 (5.0)	9 (8.1)

Abbreviations: ACL, anterior cruciate ligament; LAS, lateral ankle sprain; n, number; NMT, neuromuscular training.
[a] Age is presented as mean (standard deviation), categorical variables as frequency (percentage).

Table 2. Incidence of ACL Injuries and LAS With 95% Wilson Confidence Interval

	Football		Basketball	
	Male	Female	Male	Female
Athletes, n	1205	808	600	608
ACL injuries, n	11	9	8	12
Incidence proportion	0.009 (0.005, 0.016)	0.011 (0.006, 0.021)	0.013 (0.007, 0.026)	0.020 (0.011, 0.034)
LAS, n	18	24	38	31
Incidence proportion	0.015 (0.009, 0.023)	0.030 (0.020, 0.044)	0.063 (0.046, 0.086)	0.051 (0.036, 0.071)

Abbreviations: ACL, anterior cruciate ligament; LAS, lateral ankle sprain; n, number.
Incidence (95% Wilson CI).

27 days (IQR: 21, 42) and 326 days (IQR: 259.2, 375.5) for an ACL injury. In the group of injured players, over 90% of the injured players did not use NMT or implemented it inadequately (Table 1).

Direct Costs and Indirect Costs

A detailed overview of the costs is presented as median and range in Table 3, stratified by injury type. These costs showed a large between-player variation. The mean total cost per ACL injury was €6340.7 (SD 3068.7). The mean direct and indirect costs per ACL injury were €3883.1 (SD 1029.6) and €2533.4 (SD 2582.7), respectively. Most medical costs of ACL injuries can be explained by medical imaging (used by 92.5%), physical therapy (used by all), a knee brace (used by 82.5%), and absenteeism from work (52.5% missed at least 1 day of work). Costs for second ACL reinjuries were not different from index ACL injuries (€6015, IQR: 3900, 8393 versus €4886, IQR: 3900, 8394; $P = .924$).

The mean total cost per LAS was €731.6 (SD 989.8). The mean direct and indirect costs per LAS were €396.9 (SD 321.9) and €334.7 (SD 883.7), respectively. Most direct medical costs for LASs can be explained by medical imaging (53% had medical imaging), an ankle brace (54% received a brace), and absenteeism from work (15.3% missed at least 1 day of work). Costs for a second LAS were not significantly different from the index LAS (€426, IQR: 117, 858 versus €376, IQR: 146, 818; $P = .593$). No significant differences in costs between the prevention groups (no prevention versus inadequate prevention versus adequate prevention) were found (see Figure 3E and 3F; LAS, $P = .390$; ACL, $P = .924$). For neither direct costs (see Figure 3A and 3B; LAS, $P = .974$; ACL, $P = .933$) nor indirect costs did we find a significant difference (see Figure 3C and 3D; LAS, $P = .059$; ACL, $P = .896$).

DISCUSSION

An important finding of our study is that the total cost of an ACL injury and LAS, estimated at €6340 and €731.59, respectively, are considerably higher when compared with earlier published Belgian cost data. Second, a high percentage of the sustained injuries is recurrent, and even more important, most of the injured players do not (adequately) implement NMT.

Incidence Proportion

In our study, most injuries occurred during the game and were sustained during the first part of the season (August to October), which is in accordance with previous studies.[13,22] Therefore, to obtain a possible effect in the early phase of the season in preventing ACL injuries, the National Athletic Trainers' Association recommends that sport teams should already start NMT in the preseason.[5]

The incidence proportion of ACL injuries in our study was 1.5% (female) and 1.1% (male) per player season, respectively. In other studies reporting sports injuries in amateur athletes, the incidence proportion of ACL injuries in female athletes ranged from 0.4% to 1.4% and in male athletes from 0.6% to 3%.[23–25] The incidence proportion of ACL injuries may vary because of differences in studied populations or differences in type of injuries (contact and noncontact). In a recent meta-analysis, the incidence proportion of second ACL injuries in studies rated as studies with a low risk of bias may vary from 10% to 32%,[26] which is comparable to the recurrence rate observed in our study (30%).

Results of a systematic review indicate that basketball is a high-risk sport for LASs, and this is confirmed by our results.[27] Indeed, in our study, particular basketball players have a higher risk for sustaining a noncontact LAS when compared with football players. So maybe basketball teams may need to implement preventive NMT even more than football teams.

With respect to LAS injuries, a systematic review revealed that, in amateur athletes, the incidence proportion of these injuries ranges from 4% to 30% per player season.[28] The incidence proportion of LAS injuries in our study (3%) is comparable to previous studies reporting 4% and 5%, respectively,[29,30] but is considerably lower than the highest observed incidence proportion of 30%.[31] However, these authors also included other types of injuries, such as medial ankle sprains, unspecified injuries, tibiofibular injuries, or others, that may have affected the observed difference in injury proportion. Also, in their study, it is unclear what percentage of LASs were classified as noncontact injuries, as most reported ankle sprains represented contact injuries.

Socioeconomic Burden

From a socioeconomic point of view, it is important to prevent injuries resulting in costs, absence from sport competition, and absenteeism from work. In our study, the mean direct cost for treating an ACL injury (€3383) or LAS injury (€397) was considerably higher compared with the costs presented in the study of Cumps et al, being €1358 (ACL 2018 Belgian price: €1577.1) and €197 (LAS 2018 Belgian price: €228.8), respectively.[11] As well for

Table 3. Overview of the Costs Per Injury

	ACL (n = 40)			LAS (n = 111)		
	n (%)	Use[a] (min, max)	Cost[a] (SD)	n (%)	Use[a] (min, max)	Cost (SD)
Consultations						
General practitioner	28 (73.7)	1.5 (1, 5)	36 (29)	62 (55.9)	1.3 (1, 4)	31 (15)
Sports physician	9 (23.7)	1.7 (1, 3)	40 (17)	15 (13.5)	1.1 (1, 2)	27 (8)
Orthopedic surgeon	37 (97.4)	3.9 (1, 10)	94 (59)	14 (12.6)	1.8 (1, 4)	43 (19)
Emergency room	20 (52.6)	1.0 (1, 1)	41 (0)	41 (0)	1.0 (1, 1)	41 (0)
Medical imaging						
X-ray	19 (50.0)	1.6 (1, 4)	32 (22)	49 (44.1)	1.1 (1, 2)	15 (3)
CT scan	4 (10.5)	1.2 (1, 1)	51 (0)	2 (1.8)	1.0 (1, 1)	51 (0)
MRI scan	35 (92.1)	1.2 (1, 3)	61 (27)	8 (7.2)	1.0 (1, 1)	52 (0)
Ultrasound	2 (5.3)	1.0 (1, 1)	28 (0)	19 (17.1)	1.1 (1, 2)	30 (6)
Arthroscopy	2 (5.3)	1.0 (1, 1)	59 (0)	1 (0.9)	1.0 (1, 1)	59 (0)
Medical imaging reading	37 (97.4)	2.1 (1, 6)	53 (39)	59 (53.2)	1.4 (1, 4)	37 (16)
Medical interventions						
Cast	2 (5.3)	1.0 (1, 1)	68 (0)	9 (8.1)	1.0 (1, 1)	59 (0)
Use of plaster room	1 (2.6)	1.0 (1, 1)	30 (0)	9 (8.1)	1.0 (1, 1)	30 (0)
ACL reconstructive surgery	37 (97.4)	1.1 (1, 3)	450 (160)			
Menisectomy	2 (5.4)	1.0 (1, 1)	260 (0)			
Meniscal suture	7 (18.9)	1.0 (1, 1)	279 (0)			
Surgery scar tissue	1 (2.7)	1.0 (1, 1)	70			
Physical therapy visits	40 (100.0)	28.5 (13, 42)	607 (157)	66 (59.5)	9.2 (1, 19)	207 (110)
Drugs						
Analgetics	35 (92.1)	1.1 (1, 2)	3 (1)	21 (18.9)	1.0 (1, 1)	3 (0)
Antithrombotics	32 (88.9)	2.1 (1, 4)	62 (24)			
NSAIDs	29 (78.4)	1.2 (1, 3)	7 (3)	23 (20.7)	1.0 (1, 1)	6 (0)
Anti-inflammatory				16 (14.4)	1.0 (1, 1)	9 (0)
Therapeutic material						
Brace	31 (81.6)	1.0 (1, 2)	794 (138)	60 (54.1)	1.0 (1, 2)	98 (17)
Tape				32 (28.8)	2.1 (1, 8)	17 (16)
Crutches	34 (89.5)	1.1 (1, 2)	13 (3)	23 (20.7)	1.0 (1, 1)	12 (0)
Airex	2 (5.4)	1.0 (1, 1)	60 (0)	3 (2.7)	1.0 (1, 1)	60 (0)
Elastic exercise band	4 (10.8)	1.3 (1, 2)	6 (2)			
Individual costs	11 (30.6)		130 (135)	11 (9.9)		12 (9)
Hospitalization days	37 (97.4)	2.0 (1, 4)	808 (286)			
Total direct cost			3883 (1030)			397 (322)
Indirect costs						
Absenteeism from paid work	21 (56.8)	15.6 (1, 24)	4464 (1721)	17 (15.3)	7.7 (2, 15)	2185 (1035)
Total indirect cost			2533 (2583)			335 (884)
Total cost			6341 (3069)			732 (990)

Abbreviations: ACL, anterior cruciate ligament; CT, computed tomography; LAS, lateral ankle sprain; max, maximum; min, minimum; MRI, magnetic resonance imaging; n, number; NSAIDs, nonsteroidal anti-inflammatory drugs.
Use, number of usages.
[a] Presented as mean.

ACL injuries as for LAS, the large difference is caused by a higher number of medical consultations, more physical therapy visits, more medical imaging, and a higher use of braces by the injured players.

The mean total cost for treating an LAS in our study (€731.6) clearly exceeds cost data of LASs in the Netherlands, estimated at being €418 (2018 Belgian price: €466.1) and €446 (2018 Belgian price: €538.8), respectively.[15,32] Particularly, the direct costs are responsible for this difference, explained by an increased use of medical imaging, physical therapy visits, and the use of an ankle brace for treating an LAS injury.

Preventive Neuromuscular Training

As already mentioned, a substantial part of the observed injuries in our study were recurrent. Particularly with respect to second LAS injuries, the Dutch guideline of Vuurberg et al[33] and a recent meta-analysis of Wagemans et al[34] indicates that exercise-based rehabilitation, merely being balance training, can significantly reduce the reinjury risk. Moreover, injury-prevention programs are cost-effective.[35] However, only 7% of the injured players implemented adequate NMT during the preseason or in season (ie, jump-landing exercises and strengthening exercises performed at least twice a week), and this is in line with the general population in the cohort.[12] This implementation gap is remarkable as, in our study, 30% of the ACL injuries and 65% of the LASs represented recurrent injuries. Results of an earlier study indicated that the most important barriers of players (N = 1253) and coaches (N = 140) for implementing NMT in football were "a lack of knowledge which exercises to perform" (players and coaches), "the belief that stretching is sufficient for preventing injuries" (players and coaches), "having no time to implement NMT during training" (coaches), and "I don't need exercises"

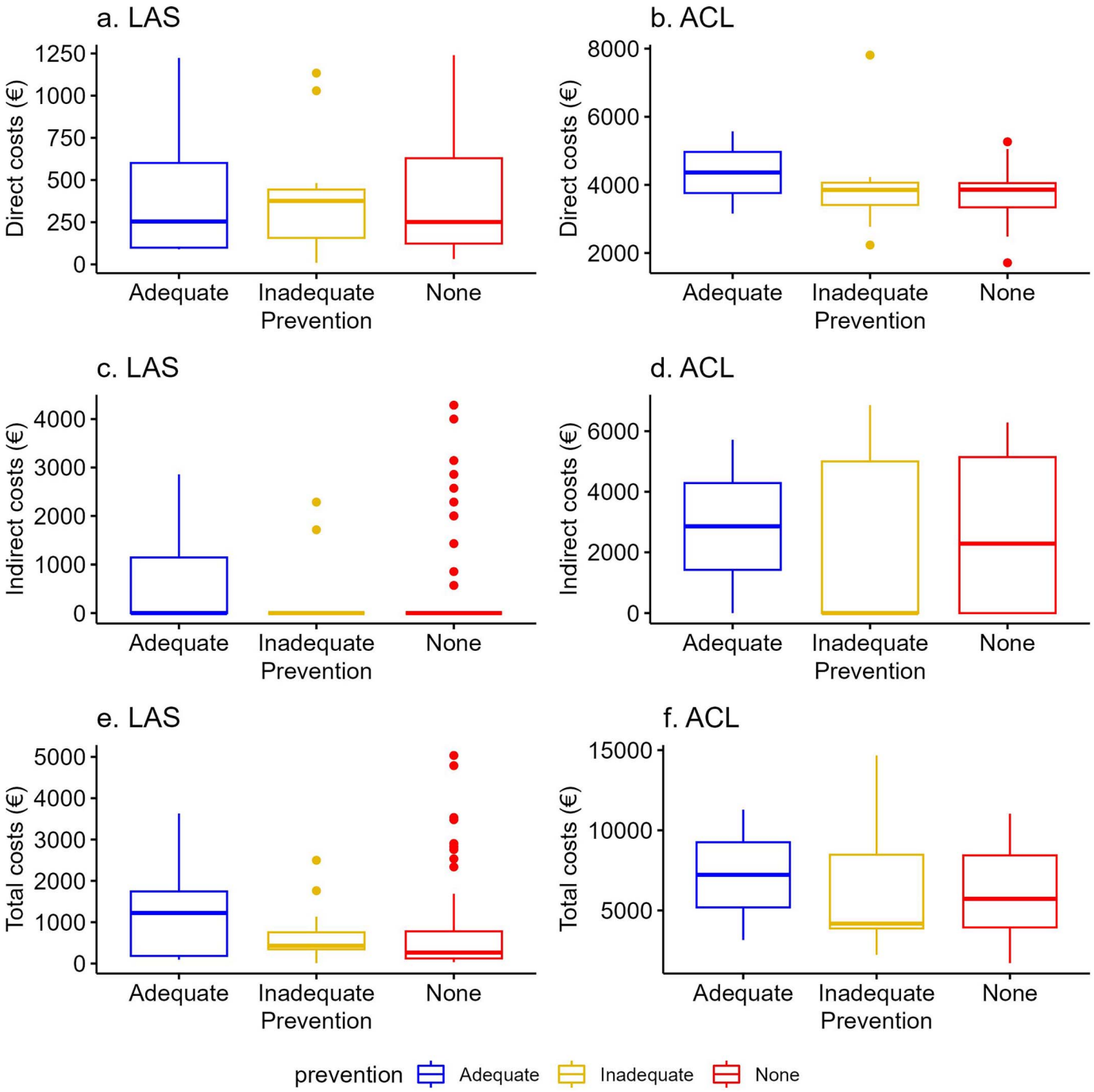

Figure 3. Direct (A, B), indirect (C, D), and total costs (E, F) by prevention group, stratified by injury (anterior cruciate ligament: A, C, E; lateral ankle sprains: B, D, F).

(players).[12] Therefore, the awareness and knowledge of the benefits and content of NMT, especially with respect to the prevention of recurrent injuries, needs to be increased in both players and coaches. If we extrapolate the calculated costs in our study to all competitive amateur football and basketball players in Belgium with the injury incidence of our study, the annual total cost of ACL injuries and LASs would be approximately €7.5 million. Costs may probably be underestimated, as our study mainly consists of students, resulting in much lower indirect costs. From both a medical and a socioeconomic point of view, the responsible authorities should, therefore, undertake more action and focus their future policies on preventing these injuries.

Strengths and Limitations

Our study is the first study prospectively investigating the socioeconomic cost of noncontact ACL injuries and LASs in Belgian amateur athletes, including a large and representative sample. We also investigated the association between the costs of injuries and the degree of implementing NMT, thereby increasing the clinical and societal significance of the results of our study. However, it is also

important to acknowledge the limitations of our study. Despite our rigorous follow-up of athletes, it is possible that certain injuries and medical interventions may have been overlooked or that medical use has been underreported (potential missing data), leading to an underestimation of the estimated socioeconomic costs. Additionally, we did not differentiate between ipsilateral or contralateral ACL reinjuries, and although we employed clear criteria to classify the registered injuries as noncontact, we could not independently verify the exact nature of these injuries. Furthermore, we did not factor in indirect costs incurred by injured students or travel expenses related to medical appointments as part of the nonmedical costs, signaling a potential underestimation of the overall expenses.

CONCLUSIONS

In Belgian amateur football and basketball, the mean total cost per ACL injury and LAS are estimated at €6340 and €731, respectively, which are substantially higher than previously published Belgian data. Importantly, 30% of the ACL injuries and 65% of the LASs were recurrent. More than 90% of the injured players do not implement NMT at all or implemented it in inadequate way. Therefore, there is an urgent need for policymakers to focus on injury prevention in amateur sports such as football and basketball.

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FINANCIAL DISCLOSURE

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