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Five Years-Results of a Nationwide Database on Sudden Cardiac Events in Sports Practice in Luxembourg

5-Jahres-Ergebnisse einer landesweiten Datenbank über plötzliche kardiale Ereignisse im Sport in Luxemburg

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Summary

- **The aim of this project** was to create a national database to determine sports-related sudden cardiac event (SCE) burden in Luxembourg.
- **Systematic data collection** was carried out from 2015 until 2019 (5 years). Cases of SCE met the following criteria: (1) any major cardiac adverse event, (2) occurring during or until one hour after a sports activity (3) on national territory or outside Luxembourg by a Luxembourgish resident or sports license holder. The victim or family were contacted to inquire on the SCE by means of a standardized questionnaire.
- **In total**, 43 SCE cases were registered. The incidence was 2.6 cases/year/100000 physically active inhabitants. The 43 events occurred in 41 persons (40 males, 1 female), at an average age of 49.7 years. Seventeen events were fatal. The most concerned sports were cycling (17 cases), followed by football (5), and running (4). Twenty-four victims suffered a sudden cardiac arrest, of which 16 received cardiopulmonary resuscitation (CPR). Eight (33%) of those survived. The survival rate was highest in patients receiving immediate CPR after SCE.
- **The incidence of SCE** related to sports in Luxembourg is relatively high and mainly affects middle-aged men during cycling. Bystander CPR significantly improves the chances of survival.

Zusammenfassung

- **Ziel dieses Projekts** war die Erstellung einer nationalen Datenbank zur Bestimmung der Anzahl sportbezogener plötzlicher Herzereignisse (SCE) in Luxemburg.
- **Zur Erfassung von SCE** erfolgte von 2015 bis 2019 eine systematische Datenerhebung. Alle Fälle von SCE erfüllten die folgenden Kriterien: (1) jedes plötzliche kardiale Ereignis, (2) während oder bis eine Stunde nach einer sportlichen Aktivität (3) auf nationalem Territorium oder bei einem Luxemburger Einwohner oder Sportlizenzinhaber außerhalb Luxemburgs. Mit Hilfe eines standardisierten Fragebogens wurden die Betroffenen, beziehungsweise deren Familienangehörige zu den Umständen des SCE befragt.
- **Insgesamt** wurden in den 5 Jahren 43 Fälle von SCE registriert. Die Inzidenz lag bei 2.6 Fällen/Jahr/100000 körperlich aktive Einwohner. Die 43 Ereignisse traten bei 41 Personen (40 Männer, 1 Frau) mit einem Durchschnittsalter von 49,7 Jahren auf. Siebzehn Ereignisse verliefen tödlich. Die am stärksten betroffenen Sportarten waren Radfahren (17 Fälle), gefolgt von Fußball (5) und Laufen (4). 24 Opfer erlitten einen Herzstillstand, von denen 16 von Laien kardiopulmonal reanimiert wurden. Acht (33%) von ihnen überlebten. Die Überlebensrate war am höchsten bei Patienten, die eine sofortige Reanimation nach SCE erhielten.
- **Fälle von SCE** in Luxemburg betreffen hauptsächlich Männer im mittleren Alter und treten am häufigsten beim Radfahren auf. Sofortige Wiederbelebungsmaßnahmen begünstigen die Überlebenschancen bei Herzstillstand.

KEY WORDS:

Cardiac Arrest, SCE, CPR, Chances of Survival

SCHLÜSSELWÖRTER:

Herzstillstand, SCE, CPR, Überlebenschancen



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Introduction

Sports practice is like the Roman God Janus, it has two faces. On the one hand, regular physical activity promotes health and reduces cardiovascular risk factors (17). On the other hand, the risk of sudden cardiac events (SCE) increases during and immediately after, mainly vigorous, exercise (3). Although regular exercise reduces this risk, these sports-related cardiac events concern both untrained persons and well-trained athletes with, most of the time, no previously known cardiac diseases (3, 14). Although

cases of SCE during sports practice are globally rare, they attract a lot of attention through media coverage, especially in cases of young and seemingly healthy athletes.

In a review on retrospective studies (8), the incidence rate calculations of sudden cardiac death related to sports activity in athletes varied from 0.1/100000 to 33/100000, where studies with higher methodological quality reported incidence rates from 1.3/100000 to 2.5/100000. These widely varying

estimates are due to differences in the methodology used, including case identification, inclusion criteria and definition of population denominators, ranging from college athletes to male athletes between 18 and 40 years, to the whole population.

Information on SCE related to sports practice in Luxembourg is scarce and anecdotal. There was no systematic data collection (e.g., a registry) or survey on SCE in Luxembourg, be they sports-related or not. This contrasts with many other European countries.

Aware of the current lack of systematic information on sports-related SCE, the aim was to develop a systematic data collection methodology and to determine the sports-related SCE burden in Luxembourg. More specifically, the purpose was to characterize the circumstances of sports-related SCE and, if possible, to identify its incidence for different sports in Luxembourg.

Methods

The present study was designed as a prospective cohort study. To identify cases of SCE, a systematic data collection was carried out from 2015 to 2019 (5 years). A dedicated website featuring an online questionnaire was set up, by which observed sports-related SCE cases could be declared by the general population (1). A second data source were the public media, both print and electronic, that were scanned for eligible cases on a regular basis. Third, the national cardiology institute as well as the cardiac reeducation centers informed their patients about the study and upon participation agreement relayed the contact to us. Finally, direct witnesses and other publicly available information concerning SCE cases reported to us were considered. A similar methodology was used in two recent studies in France (6, 13).

All cases of SCE had to meet the following criteria: 1) any major cardiac adverse event; 2) occurring during or until maximal one hour after a sports activity; 3) on national territory or outside Luxembourg by a Luxembourgish resident or sports license holder. Events due to trauma – except if fulfilling the definition of a commotio cordis (no cases found in the survey) – were excluded.

Sport activities considered for this study were all forms of physical activities which, through casual or organized participation, aimed to use, maintain, improve, or compare physical skills and ability. Sports activities are hence limited to activities that are solely done for the sake of sport without any further purpose (e.g., transportation, production of goods, etc.). Sport activities could be competitive or non-competitive. In the framework of the present study, all Luxembourg-based sport activities practiced by both residents and non-residents of Luxembourg were included, i.e., those performed on Luxembourgish territory (even if they include a border-crossing). Furthermore, sport activities performed abroad by Luxembourgish residents

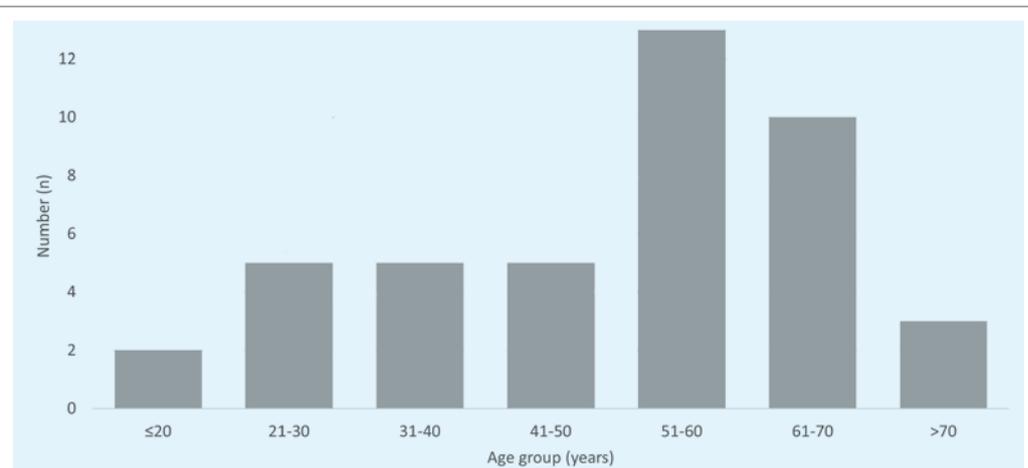


Figure 1

Cases of SCE (n=43) by age group.

or license holders within a Luxembourgish sport organization (federation or club) were considered (e.g., training camps or competitions abroad).

Sports-related SCE are defined as all cardiac arrests or deaths, myocardial infarctions and acute coronary syndromes occurring during or because of sports activities, as defined above.

In a second stage, the reported cases were cross-checked for eligibility and uniqueness. Nevertheless, it was possible that the eligibility and uniqueness of a case could not be unambiguously established at this stage. If the victim was identified and his/her contact details were available, a contact was made with him/her or, in case of decease, the family. If the victim could not be identified a priori, a contact was made with the emergency medical services. If the case was known, the physician in charge was asked to make the first contact with the victim or a relative (6, 13).

During this first contact, the study objectives were explained. In case of acceptance of participation, a full written study description was provided, and a written informed consent was signed. Study participation entailed answering a questionnaire in the presence and with the assistance of a research collaborator, as well as granting the permission to retrieve potentially unknown medical information from the appropriate medical services (emergency medical services, cardiologist, etc.). This information was retrieved by asking a staff member, who had access to the concerned medical file to complete the questionnaire. The results were introduced anonymously in the national database.

Incidence estimations were calculated based on the estimates of physically active population in the Grand-Duchy of Luxembourg. The results of the Special Eurobarometer public opinion survey on sport and physical activity in the 28 EU Member States during the study period estimates Luxembourg to have a 56% active population (7, 18).

All statistical analyses were performed using STATA/SE version 15 (StataCorp, College Station, USA).

Results

In total, 43 SCE cases were registered over the 5-year period. A clear male predominance was observed, with 40 men (98% - with 2 men counting 2 separate SCE cases each) and 1 woman.

The median age was 53 years with an average age of 49.7 (SD: 17.0 years). The youngest recorded case had 17 years and the oldest 80. The incidence was 2.6 cases/year/100000 active inhabitants. >

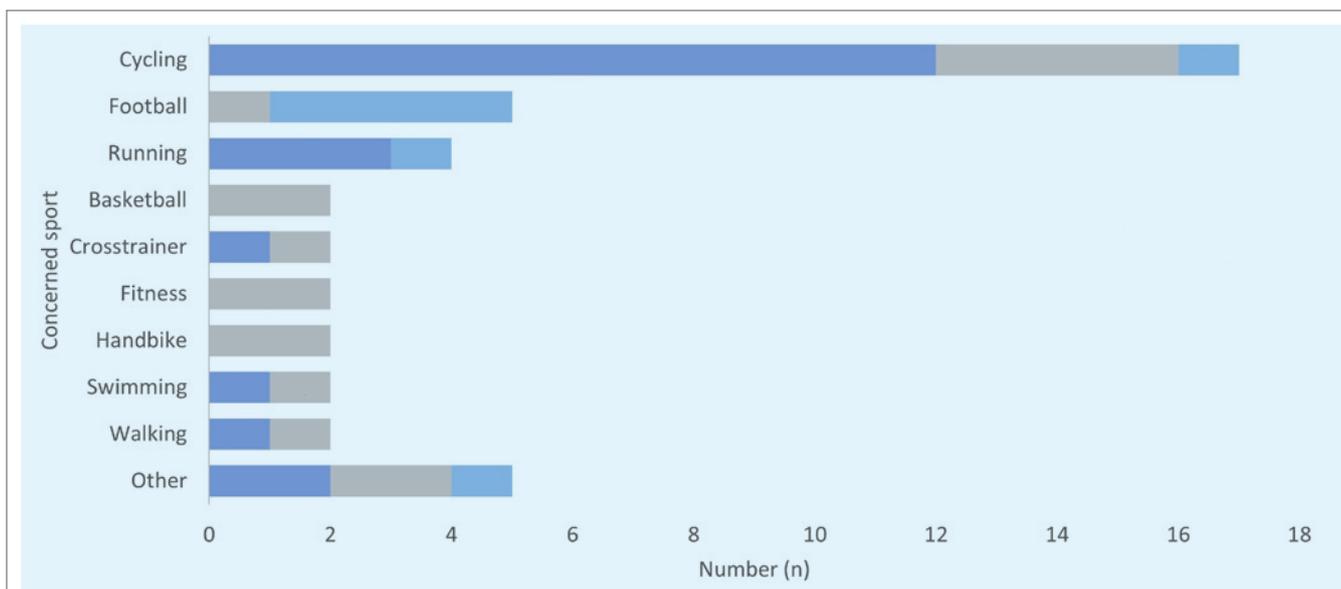


Figure 2

Cases of SCE (n=43) by concerned sports and their purpose (dark blue: recreational sport; light blue: competition; grey: structured training).

26% of the cases occurred in the morning, 35% in the afternoon and 30% after 6 p.m. (missing information for 9%).

Twenty cases occurred in public spaces, 19 in a gym and 4 at home. In total, 17 events were fatal. The most concerned sport activities were cycling (17 cases), followed by football (5) and running (4). 44% of the cases in Luxembourg occurred during a leisure activity, 39% during structured training and 17% in a competition context.

Of the 43 victims, 35 had been regularly active with more than one activity per week, while three victims were physically active 1-4 times per month. Only 2 victims never practiced sport before (1 missing information).

Thirty victims had no history of heart disease at the time of their incident. For 9 persons, it was not the first cardiac incident, while for 4 cases this information could not be verified.

Twenty-one cases of SCE were caused by coronary artery disease (including one coronary spasm at the age of 17 years; mean age 49.6 years with extremes 17-77 years), 2 were related to myocarditis (33 and 51 years) and 1 due to a hypertrophic cardiomyopathy (44 years). For 19 cases the origin could not be verified or was missing.

In 24 of the 43 cases, the victims suffered a sudden cardiac arrest, of which 16 (67%) received cardiopulmonary resuscitation by bystanders and 2 benefited from semi-automatic defibrillators. Eight persons (33%), of which 7 received resuscitation started by bystanders and 1 benefited from a defibrillator, survived the arrest (1 missing information about CPR).

Discussion

The incidence in our population study of 2.6 cases per 100 000 active inhabitants seems higher than in other international studies, where the incidence of SCE in sports in the general population ranged between 0.12 to 1.20 per 100 000 inhabitants (5, 13, 19). Although, one study in 3 regions in France found higher incidence rates with 6.5 per 100 000 (6). Caution is always warranted with statistics in small populations as in countries like Luxembourg. But it must also be considered that the definition of the population studied (the denominator), as well as the definition of the cases listed (the numerator), vary greatly between the different surveys. Some studies were only looking

at a certain age group or on an active population in contrast to the general population. Knowing that the active population may account for 50-70% of the total population, the incidence may double when using a different denominator. When studying professional football players in Norway (4) or teenagers of the football academy in UK (11), incidences were even as high as 63 resp 6.8 per 100 000. Furthermore, the numerator depends on the definition of sports-related SCE, where no standard definition exists in the scientific literature. Likewise, the abbreviation SCE or MACE can refer to different outcomes, as it may stand for "major adverse cardiac events" (9) as well as for "major adverse cardiovascular events", in which case it includes stroke as an endpoint (20). This problem has already been discussed in recent studies (10), but a universally accepted definition has not yet been introduced. Also, most of the studies only report incidences of sudden deaths related to sports practice, whereas in our study, all cases of major cardiac problems are considered. If, on the other hand, only sport-related sudden deaths were considered, the annual incidence rate in our study would merely be 1.04 per 100 000 active inhabitants, which would align our incidence rate to that of the other studies.

A clear male predominance has been recorded in our results (only 1 women and 40 men), although the proportion of males in the Luxembourg population during the observation period was 50.2% (18). These results are in line with many other studies, where the male population seems to be at much higher risk of cardiac events. The observed sex differences may be speculated to be the result of variation in sport participation rates and preferred exercise intensities between men and women. However, this is unlikely to explain these vast differences. An intrinsic gender related risk profile may play a major role which still needs to be investigated further (12, 13).

The two studies from France with a similar methodology and population to our study concluded that sports-related sudden death in the general population is more frequent than they initially suspected, especially in middle-aged men (6, 13). This trend has also been observed with our data, where 72% of the cases were counted in >40-year-old victims.

SCE in young remain relatively rare with 12 cases <40-year-old from which 5 were sudden cardiac arrests and 2 were fatal. Similar findings were reported in recent studies, where sudden

death of the young competitive athlete concerned 5% of the total number of sudden deaths (12).

Our data showed that SCE occur most frequently in recreational activities or in training settings, whereas only 7 cases were in competition. On the one hand, the time exposure for athletes to competition is much lower than that of training sessions, and on the other hand, there is a high number of physically active people who do not pursue competitions. Thus, these figures were to be expected, although an increased effort and an increased risk in competition are likely (3).

Cycling and running respectively football are the most popular activities in leisure respectively competition sport in Luxembourg (2), with thus an elevated number of people at risk of SCE compared to less practiced sports - especially since a large proportion of cases occur in older population, where endurance type sports are more practiced than team sports. Similarly, in a college population in the USA, sudden cardiac deaths occur most frequently in basketball and American football (14). Furthermore, those sports demand a high cardiovascular response due to both a high dynamic (endurance) and high static (power) demand and may thus be more prone to SCE (15).

Most cases of SCE were diagnosed to be caused by coronary artery disease, while only one has been diagnosed as hypertrophic cardiomyopathy. Like in Italy, it has been a legal requirement in Luxembourg for 13 years that all licensed athletes over 15 years of age must undergo a resting electrocardiogram evaluated by a physician trained in sports cardiology when receiving their first sports license, as well as at 20 and 30 years of age. By this measure, it can be assumed that the probability of hypertrophic cardiomyopathy as the cause of an SCE is significantly reduced, at least in licensed athletes (16).

It must be highlighted that the ratio of survival in patients receiving bystander CPR when having a cardiac arrest was nearly 50%, whereas all the cases of cardiac arrests not benefiting from bystander CPR were fatal. This clearly emphasizes the importance of immediate CPR by bystanders to increase the chance of survival.

We acknowledge that the present study has several limitations. First, we cannot guarantee that our data has been exhaustive as there is not yet a systematic data collection from emergency services on SCE in sports in Luxembourg. Second, the present results often remain without a precise diagnosis as the contact was made via the victims or their families rather than physicians or emergency services, especially in fatal outcomes. In this context, access to these results and diagnoses remain a challenge and are therefore incompletely recorded in the study database.

Table 1

Outcome of first aid after sudden cardiac arrest (n=24; data as n (%); First-aid = semi-automatic defibrillator with/without cardiac massage).

FIRST AID AFTER SUDDEN CARDIAC ARREST	VICTIMS	SURVIVORS	NON-SURVIVORS
First aid	18 (75)	8 (33)	10 (42)
No first aid	6 (25)	0 (0)	6 (25)

In conclusion, the incidence of SCE in our survey is relatively high compared to other international studies, but because of the heterogeneity of methodologies in the different international studies, caution is warranted when interpreting the results. SCE most often occur in men over 40 years and are most prominent in popular sports in Luxembourg.

Our data confirm that immediate CPR plays a major role in the survival incidence of cardiac arrests, prompting for a continued CPR education of the population including the deployment of external defibrillators. ■

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Ethical approval was provided by the National Ethics Committee for Research (Ref: 201503/02 Version 1.2) and the National Data Protection Commission (Ref: R000084/T010294).

Conflict of Interest

The authors have no conflict of interest.

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