



Clinical research

Epidemiology and prognostic implications of syncope in young competing athletes

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KEYWORDS

Syncope;
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Aims This study was undertaken to evaluate the epidemiological features and the prognostic implications of syncope in young athletes.

Methods and results A cohort of 7568 young athletes (5132 males, 2436 females, aged 16.2 ± 2.4) underwent a pre-participation evaluation. A syncopal spell in the last 5 years was reported by 474 athletes (6.2%). Syncope was unrelated with exercise in 411 athletes (86.7%), post-exertional in 57 (12.0%) and exertional in 6 (1.3%). All episodes of non-exertional or post-exertional syncope had the typical features of neurally-mediated fainting. The 6 athletes with exertional syncope underwent further testing allowing the diagnosis of hypertrophic cardiomyopathy in one case, and of right ventricular outflow tract tachycardia in another. The remaining 4 athletes only showed a positive response to tilt-testing. All athletes were followed for 6.4 ± 3.1 years, during 48 066.6 person-years of follow-up. The recurrence rate was 20.3 per 1000 subject-years in athletes with non-exertional, and 19.2 per 1000 subject-years in athletes with post-exertional syncope. The incidence of first report of syncope was 2.2 per 1000 subject-years for non-exertional and 0.26 per 1000 subjects-years for post-exertional spells. No other adverse event was noted during follow-up.

Conclusions In young athletes, syncope occurring before the initial pre-participation screening has a neurally-mediated origin in most cases and shows a low recurrence rate. Exercise-related syncope is infrequent and is not associated with an adverse outcome in subjects without cardiovascular abnormalities. The incidence of new syncope during competitive activity is particularly low.

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Introduction

Syncope is a common symptom and is currently defined as a sudden and temporary loss of consciousness associated with a concurrent loss of postural tone, from which recovery is spontaneous and prompt.^{1,2} Although syncope is almost invariably a benign event in young adults and, in

many cases, never reaches the attention of a physician, particular concern usually exists over the evaluation of athletes suffering syncopal spells.^{3–5} In fact, syncope may represent the initial presentation of several cardiac disorders, including hypertrophic cardiomyopathy, right ventricular dysplasia, anomalous coronary artery origin, myocarditis and the long QT syndrome, which have all been recognized as possible causes of sudden death in the young athletic population.^{6,7} However, to date, there have been no large-scale surveys describing the epidemiology of syncope in young competitive athletes.⁸

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Consequently, this study was designed and undertaken to evaluate the frequency and the prognostic implications of syncope in the young athletic population.

Methods

Study sample

From January 1989 to September 2001, 7568 consecutive young competitive athletes (5132 males and 2436 females; 2862 soccer players, 1439 basketball players, 1190 volleyball players, 824 swimmers, 782 runners, 471 cyclists, with a mean age of 16.2 ± 2.4 years) underwent their first pre-participation cardiovascular evaluation at two centres for sports medicine in Rome, Italy. All subjects planned to begin organised sports programmes requiring regular training and competition. According to the Italian legislation,⁹ cardiovascular screening for competitive athletes was part of a comprehensive medical evaluation including a general clinical history taking, physical examination, orthopaedic examination, spirometry, and urinalysis. The initial cardiovascular assessment included family and personal history taking, physical examination with blood pressure measurement, basal 12-lead electrocardiography, and limited exercise testing with the Montoye step test.^{9,10} In accordance with the Italian guidelines for sports eligibility,¹¹ additional non-invasive testing, such as echocardiography, 24-h ambulatory Holter monitoring, or maximal exercise testing, were considered only for those subjects showing abnormal findings at the initial evaluation.

As a part of a specific effort to define the prevalence and prognostic implications of syncope in the athletic population, all athletes were asked about any episode of syncope which might have occurred within the 5 years preceding the first pre-participation cardiovascular evaluation. Syncope was defined as a sudden and transient loss of consciousness with inability to maintain postural tone and with spontaneous recovery.^{1,2} As syncope presenting during exercise tends to be more frequently associated with structural heart disease and with an unfavourable outcome,^{3–5} particular care was taken in order to distinguish syncopal spells occurring during exercise from those taking place either in the post-exertional state or during ordinary daily activities. As previously reported, only those syncopal spells presenting during a continuous bout of exercise and causing a sudden unintentional interruption of the activity and falling were considered to have occurred during exercise.⁵ All equivocal reports of loss of consciousness, as well as all reports of syncope due to head trauma were excluded.

A thorough description of all syncopal spells and all available clinical and laboratory data concerning the presumptive aetiology of the episodes were obtained in all cases. Moreover, all available witnesses (parents, other athletes, trainers) were interviewed, in order to collect all possible information about the specific circumstances and the athlete's appearance and behaviour during and immediately after the episodes. No subjects were receiving medications of any kind. Besides, all athletes denied the assumption of any kind of illegal or recreational drug.

Clinical management and follow-up

After completion of the initial evaluation, all athletes reporting syncopal episodes underwent counselling regarding the possible diagnosis and probable pathophysiology of their spells. Those subjects showing clinically relevant cardiovascular abnormalities were disqualified from competitive athletic activity.

All subjects considered eligible for competitive athletic activity after the clinical work-up were reassured and counselled on recognizing pre-syncopal prodromes. Moreover, they were urged to take appropriate postural manoeuvres when pre-syncopal in order to avoid traumatic injuries. No specific pharmacological treatment was started in any case. All subjects were asked to notify any syncope recurrence immediately.

Epidemiological measures

The following measures of syncope frequency in the study populations were used:¹²

1. Five-year period prevalence, that is the proportion of individuals reporting at least one syncopal spell within the 5 years preceding the initial pre-participation cardiovascular screening.
2. Overall incidence rate, also known as incidence density, which represents a measure of new occurrences of syncope over a period of time.
3. Overall recurrence rate, which represents a measure of the recurrences of syncope in those subjects who reported to have had at least one syncopal spell before the first pre-participation screening.

Statistical analysis

Mean (\pm standard deviation) and median values were calculated for continuous variables, while frequencies were measured for categorical variables. Differences between groups were analysed by two-tailed, unpaired Student t-test for continuous variables and by χ^2 or Fisher's exact test for categorical variables as appropriate.

In athletes who reported to have had at least one syncopal episode before the first pre-participation cardiovascular screening, the cumulative risk of recurrence of syncope during follow-up was estimated by means of the Kaplan–Meier method. Survival curves of subgroups were then formally compared using the log-rank test. Moreover, in the same group of athletes reporting syncope before the initial pre-participation evaluation, multivariate analysis was performed using the Cox proportional hazard method to identify risk factors for time-related recurrence of syncope during follow-up. The assumption of proportionality for the Cox model was tested through visual inspection, and no violation of proportional hazards was found. Variables entered into the analysis included age, gender, type of sports activity (soccer, basketball, volleyball, swimming, running, cycling), type of syncope (exertional, post-exertional, non-exertional) and absolute number of syncopal spells before the initial evaluation.

Data analysis was performed using the SPSS statistical software package (SPSS 11.0, Chicago, Illinois). A *p*-value <0.05 was considered statistically significant.

Results

Prevalence of syncope

During the first pre-participation cardiovascular screening 474/7568 athletes (296 males and 178 females) reported to have had at least one syncopal episode within the preceding 5 years, thereby giving an overall five-year period prevalence of syncope of 6.2% in the study sample. Athletes reporting syncopal spells were

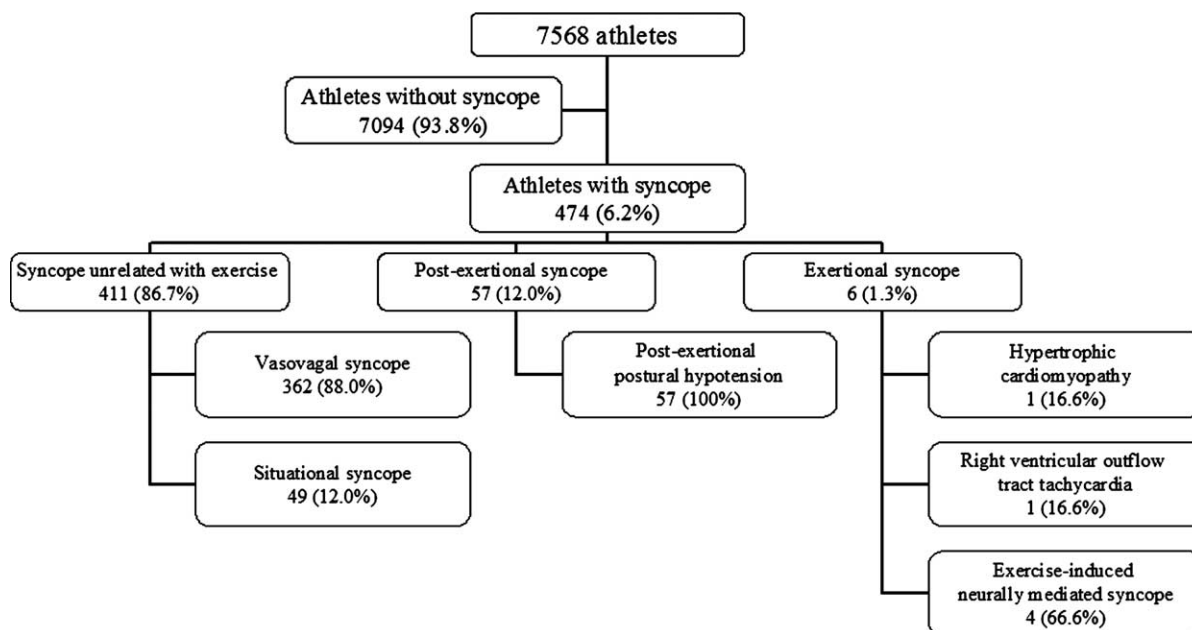


Fig. 1 Results of the diagnostic work-up in the study population.

similar for age to the rest of the study population (16.3 ± 2.7 versus 16.1 ± 2.9), while the mean number of syncopal episodes per athlete within the 5 years preceding the evaluation was 1.3 ± 0.7 (median 1 episode). In 36/474 cases (7.5%) syncope had been associated with minor traumatic injuries (bruises, small cuts and soft tissue injuries). The overall five-year period prevalence was found to be higher in female athletes than in male athletes (7.3% versus 5.7%, $p = 0.01$). Besides, the mean number of syncopal spells in personal history was also higher in female athletes than in male athletes (1.7 ± 0.9 versus 1.1 ± 0.4 , $p < 0.0001$).

In 411/474 cases (86.7%, 261 males and 150 females), syncope was reported as unrelated with exercise and occurring during ordinary daily activities. In 57/474 cases (12.0%, 30 males and 27 females) the episodes were post-exertional and usually occurred soon after cessation of exercise, while in only 6/474 athletes (1.3%, 5 males and 1 female) at least one syncopal spell had occurred during exercise.

Diagnostic work-up

The results of the diagnostic work-up are shown in Fig. 1. In all athletes reporting syncopal episodes during ordinary daily activities, clinical history was consistent with either vasovagal (362/411, 88.0%) or situational syncope (49/411, 12.0%).^{1,2} Vasovagal syncope was considered the likely diagnosis when the episodes were associated with typical precipitating events (fear, pain, instrumentation, emotional distress, prolonged standing in warm places, unpleasant sight or smell) and typical prodromal symptoms (nausea, dizziness, visual blurring, epigastric

discomfort, diaphoresis, weakness). Situational syncope was diagnosed when the spells had occurred during or immediately after urination, defecation, cough or swallowing. No episodes with tonic-clonic jerks or tongue biting were reported. Besides, in all of these cases no significant abnormality was disclosed by physical examination, 12-lead electrocardiography, and limited exercise testing. Eventually, all of these athletes were allowed to continue their training and competitive activity.

In the athletes reporting post-exercise syncope, clinical history was invariably consistent with post-exertional postural hypotension,³ as all of the episodes had occurred after prolonged bouts of vigorous effort, often in a hot and humid environment, and were heralded by typical prodromal symptoms (nausea, dizziness, weakness). Moreover, also in these subjects, physical examination, 12-lead electrocardiography, and limited exercise testing did not reveal any significant abnormality and the athletes were allowed to continue their training and competitive activity.

According to the diagnostic protocol currently employed at our institution,⁵ the 6 athletes reporting syncopal spells during exercise underwent an extensive cardiovascular evaluation, including Doppler-echocardiography, 24-h ambulatory electrocardiographic monitoring, exercise testing, cardiac electrophysiological study and head-up tilt-testing. The echocardiographic examination revealed the presence of a high degree of left ventricular hypertrophy (wall thickness >16 mm) with an unusual and heterogeneous distribution in one male athlete, thereby allowing the diagnosis of hypertrophic cardiomyopathy.¹⁰ In another male athlete, 24-h ambulatory electrocardiographic monitoring showed the occurrence of frequent monomorphic premature

ventricular beats and several episodes (8/24 h) of non-sustained ventricular tachycardia. In this case the cardiac electrophysiological study allowed the induction of a sustained monomorphic ventricular tachycardia originating from the outflow tract of the right ventricle. Both of these subjects were permanently disqualified from competitive sports activity. As to the remaining 4 athletes, the only abnormality detected during the diagnostic work-up was represented by a positive response to head-up tilt testing (i.e., development of syncope in association with hypotension and/or bradycardia). These 4 athletes were allowed to continue competitive activity and their long-term outcome has already been reported in a recent paper from our group.⁵

Overall, syncope was associated with major cardiovascular abnormalities requiring disqualification in only 2 out of 474 cases (0.4%).

Follow-up

Follow-up data were obtained from office visits, telephone interviews, or written questionnaires and were available for all subjects. No athlete was lost to follow-up. The study population was followed for an average of 6.4 ± 3.1 years (median 6.2 years, interquartile range 3.2–9.5) during 48066.6 person-years of follow-up. During the follow-up period 148/7568 (1.9%) subjects discontinued training and competitive activities.

Recurrence of syncope

During the follow-up period, 58/411 athletes with previous non-exertional syncope showed at least one recurrence of syncope (mean time to first recurrence of syncope 6.3 ± 2.9 years; median time to first recurrence of syncope 7.1 years). The overall recurrence rate in these patients was 20.3 per 1000 subject-years. Moreover, 6 athletes showed a second recurrence of syncope during the follow-up period. In 9 cases the recurrence of syncope was associated with minor syncope-related traumatic injuries.

Nine out of the 57 athletes with previous post-exertional syncope also showed at least one recurrence of syncope (mean time to first recurrence of syncope 6.1 ± 3.1 years; median time to first recurrence of syncope 6.8 years). In this group, the estimated overall recurrence rate was 19.2 per 1000 subject-years.

The Kaplan–Meier actuarial estimates of first recurrence of syncope after 3, 6, and 12 years were 2.6%, 7.0%, and 35.1% in athletes with non-exertional syncope and 3.1%, 3.1% and 23.6% in athletes with post-exertional syncope respectively (log-rank $p = 0.9$), as shown in Fig. 2.

In athletes who reported to have had syncope before the first pre-participation screening, the absolute number of syncopal spells before the initial evaluation was found to be the only independent predictor of syncope recurrence during follow-up (risk ratio 1.87; 95% CI 1.21–2.34 $p = 0.013$). No other characteristic, including age, gender, type of sports activity or type of syncope predicted syncopal recurrences.

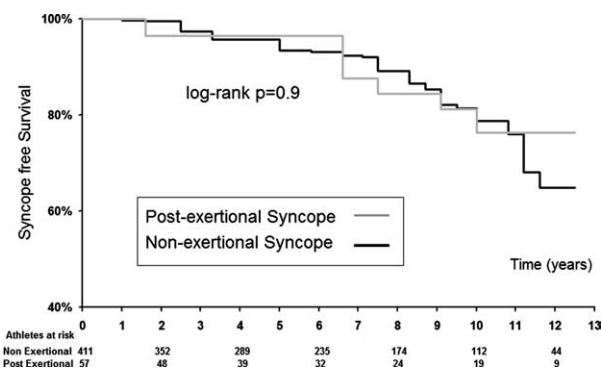


Fig. 2 Kaplan–Meier estimates of first recurrence of syncope in athletes with non-exertional and post-exertional syncope.

Incidence of first report of syncope

Among the 7094 athletes who did not report any syncopal spell during the first pre-participation cardiovascular screening 94 showed a non-exertional syncopal episode during the follow-up period. The overall incidence rate of first report of non-exertional syncope was then calculated as 2.2 per 1000 subject-years. In all of these athletes, the clinical history was consistent with either vasovagal or situational syncope,^{1,2} while the scheduled annual cardiovascular evaluation did not reveal any significant abnormality.

During the follow-up period 11/7094 athletes showed a post-exertional syncopal episode, giving an overall incidence rate of 0.26 per 1000 subjects-years. In these athletes, clinical history was consistent with post-exertional postural hypotension³ and the cardiovascular evaluation remained negative.

Only 1 athlete reported a syncopal spell during exercise 28 months after the first pre-participation cardiovascular screening. This athlete underwent an extensive cardiovascular evaluation, which revealed only a positive response to head-up tilt testing.

Cardiovascular outcome

Cardiovascular outcome was benign in the whole study sample, with no differences between athletes with or without prior syncope. In fact, no major adverse cardiovascular event of any kind was noted during the follow-up period in the study population. In particular, the 472 athletes with syncope before the first pre-participation screening and without any cardiac abnormality continued their training during the follow-up period and did not experience any major cardiac event. Moreover, the scheduled yearly cardiovascular evaluation did not reveal the appearance of any significant abnormality in any case.

Discussion

Athletes with syncope represent a particular clinical challenge as the potential causes of their spells can

range from affections with a benign prognosis, such as the common vasovagal faint, to severe cardiac diseases.^{3,6} Although data exist regarding the frequency of syncope in the general population,¹³ only scanty information is currently available as to the epidemiology of such particular symptom complex in the young athlete.⁸ Actually, to the best of our knowledge, this is the first clinical investigation describing the main characteristics of syncope in a large cohort of young competing athletes.

Overall, our data confirm that in young athletes, as in the general population, syncope has a neurally-mediated origin in most cases. Besides, exercise-related syncopal spells are infrequent (14% of all episodes), and in the great majority of cases are due to post-exertional postural hypotension.

Once more, the results of this study underline that the history surrounding a syncopal episode is of paramount importance, as it may provide a general direction to the clinical evaluation and possibly also yield a final diagnosis in the athlete.^{1,2} Moreover, our findings further suggest that particular attention should be reserved to syncope actually occurring during exercise. In fact, even if only a minority of all syncopal episodes takes place during exertion (1.3% of all spells and 0.08% of the whole study sample), in such instance an extensive cardiovascular evaluation is warranted and may indeed disclose a major unexpected cardiac affection.^{8,14,15} Accordingly, our data confirm the long-held anecdotal observations indicating that syncope occurring before the finish line of a competition is a much more ominous event than that occurring after the finish line.¹⁵

The long-term follow-up of our athletic cohort has also allowed the description of other relevant features of syncope in a homogeneous population of young athletes. In fact, in our series the incidence of first report of syncope was particularly low and similar to the reported incidence of syncope in the general population of young age.¹³ Moreover, during the follow-up period, all athletes who reported syncope in the first pre-participation screening continued their training and competitions, while showing a benign outcome. In fact, all athletes with syncope had a low recurrence rate and no major adverse events in a follow-up period of more than 6 years. This observation can be explained by the absence of any clinical or electrocardiographic evidence of cardiac dysfunction in our series of athletes with syncope. In fact, in the absence of heart disease, syncope in young individuals is almost invariably a benign condition, either in athletes or in the sedentary population.^{1,2}

Limitations of the study

This study considered only young athletes with a mean age of 16 years. Consequently, the results of this investigation cannot be applied to adult athletes. Besides, another limitation of this study is represented by the absence of a control group of age and sex-matched sedentary subjects, which precludes a direct comparison between athletes and the general population.

Conclusions

The results of this investigation support the concept that syncope is rather common in young athletes and has a neurally-mediated origin in most cases. Besides, as already outlined by some authorities,¹⁶ syncopal spells seem to have similar clinical and prognostic features in young athletes and in age-matched sedentary subjects.

In general, a careful clinical evaluation should be performed in all cases, with considerable attention paid to the historic characteristics. In fact, this study further confirms that syncopal spells actually occurring during exercise tend to be more ominous than those in the post-exertional state or during ordinary daily activities. Furthermore, during the initial physical examination, the cardiovascular system should be closely evaluated, while an electrocardiogram is mandatory in all cases and requires close scrutiny. Any abnormality emerging during such a first order evaluation should then prompt a second-line laboratory cardiovascular assessment.

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