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The Epidemiological Profile of Calisthenics Athletes

Verletzungshäufigkeit in der Trendsportart Calisthenics

ORIGINALIA

ACCEPTED: August 2018

PUBLISHED ONLINE: September 2018

DOI: 10.5960/dzsm.2018.342

Kaiser S, Engeroff T, Niederer D, Wurm H, Vogt L, Banzer W. The epidemiological profile of calisthenics athletes. Dtsch Z Sportmed. 2018; 69: 299-304.

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Summary

› **Introduction:** Calisthenics is a conditioning workout characterized by bodyweight exercises at bar and floor. Comparable to gymnastics or crossfit workouts, calisthenics demands a great amount of strength, coordination and flexibility. To date, no studies have examined injury rates among calisthenics participants.

› **Methods:** Utilizing a cross-sectional design, data were collected using an online-survey. The questionnaire was developed based on two validated assessment tools for sports and overuse injuries: a) the Oslo Sports Trauma Research Centre (OSTRC) Overuse Injury Questionnaire and b) the OSTRC Questionnaire in Health Problems. Data on training-specific aspects or location and type of injury-characteristics were assessed via standardized assessment tools.

› **Results:** In our sample (156 males and 28 females), 124 injuries from 72 people and 1.288 injuries per 1000 hours of training were reported. More than 70% of these injuries occurred at the upper extremity and were reported as muscle or tendon injury. Around 60% of all injuries led to a time-loss of training, ranging from one to 220 days (CI: [29.01; 51.27]).

› **Discussion:** Our sample showed a lower injury rate than sports with similar demands. Physicians, athletes, and trainers should be familiar with calisthenics-specific types of exercises and the related risk of injuries to build a basis for good treatment of injuries and a sufficient prevention strategy.

SCHLÜSSELWÖRTER:
Calisthenics, Turnen, Sportverletzung, Verletzungsrate, Trendsport

Zusammenfassung

› **Einleitung:** Die Sportart Calisthenics ist eine neue Sportart, der immer mehr Menschen nachgehen. Durch turnerische und akrobatische Elemente wird dem Athleten ein hohes Maß an Körperbeherrschung, Kraft und Beweglichkeit abverlangt. Eine Verletzung kann zu erheblichen Einschränkungen bis hin zu kompletten Ausfällen sowohl in Training und Wettkampf als auch in Alltag und Beruf führen. Es gibt zum jetzigen Zeitpunkt keine publizierte Untersuchung, die Art und Prävalenz von Verletzungen und damit einhergehenden Ausfallzeiten im Calisthenics systematisch untersucht.

› **Methoden:** Mittels eines validierten Fragebogens (Oslo Sports Trauma Research Centre (OSTRC)) (Clarsen 2013) wurden angepasst an die Sportart persönliche Angaben zu erlittenen Verletzungen erhoben. Ergänzt durch personenbezogene Daten (z. B.: Alter, Geschlecht, Körpergewicht, Körpergröße) wurden zusätzlich trainingsspezifische Informationen (z. B.: Dauer und Intensität einer Trainingseinheit, Trainingserfahrung) erfasst. Insgesamt 184 Sportler (m=156, w=28, 25±6 Jahre) haben über soziale Netzwerke durch sog. „Calisthenics-Gruppen" an der online Befragung teilgenommen.

› **Ergebnisse:** Es wurden 124 Verletzungen erfasst. Expositionszeitbezogen ergibt sich eine Inzidenz von 1,288 Verletzungen pro 1000 Trainingsstunden. Verletzungen wurden überwiegend an der oberen Extremität (73%) lokalisiert und als Muskel- oder Sehnenverletzung beschrieben. Mehr als 65% führten zu einem Trainingsausfall von einem bis 220 Tagen (CI: [29.01; 51.27]).

› **Diskussion:** Im Vergleich zu anderen Trendsportarten wie CrossFit oder ähnlichen kraftbezogenen Sportarten wie Gewichtheben ist die Verletzungsrate beim Calisthenics geringer. Zukünftige Studien sollten Informationen zum Verletzungsmechanismus sowie objektive Daten zum Schweregrad der Verletzung erheben.

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Introduction

Calisthenics, initiated by local groups in the US and east Europe at the beginning of the 21th century, is practised in over 70 countries as a conditioning workout of increasing interest among physically active young populations. It is characterized by bar- and floor-exercises with focus on bodyweight movements. Those workouts are executed mostly alone or in small groups on specific calisthenics trails, playgrounds or comparable areas with appropriate obstacles.

Up to date it is organized by world- and nationwide federations like the World Street Workout and Calisthenics Federation (WSWCF). With increasing rates of participation and unusual locations it is important to gather background information about the target group to evaluate the injury rates and patterns in this population.

Calisthenics involve ballistic movements which demand a great amount of strength, physical ›

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Table 1

Participants characteristics. Demographics, participation in Calisthenics training and the number of training sessions per week as well as the duration and intensity.

	M±SD	MINIMUM	MAXIMUM
Age [Years]	25±6	18	47
Height [meter]	1.78±0.07	1.60	1.96
Weight [kiligramm]	74±12	58	94
Participation in Calisthenics [days]	672±563	32	5905
Training days per week [days]	4.4±1.4	2	7
Duration / training session [minutes]	81.2±33.7	20	210
Intensity / training session [Borg scale 6-20]	16±2	12	20
Warm-up-time / training session [minutes]	12±7	0	45

control and flexibility during sports-specific movements. Sports with exposure of high impacts during exercises are more likely to lead to an injury on the loaded extremity (1). Correspondingly motion-like sports like gymnastics show a high incidence for bone, joint and ligament injuries of the upper extremities within both training and competition (16). During 1000 hours of training exposition, approximately 9 injuries occur. Compared to gymnastics and other athletic disciplines, epidemiologic aspects of injuries in Calisthenics are still unknown.

To date, no studies have examined injury rates among calisthenics participants or factors that may contribute to injury rates. Thus, the purposes of this study are: a) to consequently determine the type, incidence and time distribution of injuries occurring during Calisthenics and b) to identify potential risk factors based on anthropometric and training related variables.

Methods

Study Design

Utilizing a cross-sectional design, data were collected over a three months period using an online survey platform. The study followed the recommendations for good clinical practice in the conduct and reporting of survey research (10). The cross-sectional study was approved by the local ethic commission (2015-234).

The Survey

The questionnaire was developed based on two validated assessment tools for sports and overuse injuries: a) the Oslo Sports Trauma Research Centre (OSTRC) Overuse Injury Questionnaire (3) and b) the OSTRC Questionnaire in Health Problems (4). Data on training specific aspects or location and type of injury was assessed via standardized assessment tools (9, 16).

The primarily developed questionnaire was subsequently screened for redundant and incomprehensible information and questions. The resulting pilot version of the questionnaire was process-validated by four active Calisthenics athletes, with the goal to include sample representatives. Their comments were finally implemented into the final version. This final version is provided in supplement material (online) and consists of a sociodemographic and anthropometric part as well as training characteristics using single- and multiple choice-questions as well as free text questions. The main part contained questions on injury epidemiology. Scoring was done according to five-step ordinal-Likert scale. People were asked to give only information about Calisthenics related injuries.

Questionnaires were processed for analysis if they were not duplicates (in the sense of questionnaires filled in more than once by the same person) and if they contained information for research question answering, i.e. information on the frequency of injuries.

Participants

Participants were recruited via social media platforms. All 11 available calisthenics-specific interest groups were used for recruitment. A total of around 12 000 account holders in German language based interest groups were informed about the survey. The link, together with a short explanation, was posted twice: Firstly at the beginning of the survey and secondly as a reminder eight weeks later. Participant inclusion criteria were to a) actively engaged in Calisthenics (in form of being a member in one of the Calisthenics groups) and b) being 18 years or older. All participants provided online informed consent prior to study enrolment; data was stored anonymously.

Statistical Analyses

Data were processed using Microsoft Excel 2013 (Microsoft Corporation, USA), and for statistical analysis IBM SPSS Statistics Version 24 (IBM Corporation, USA). To assess the risk of non-responder bias, a wave analysis was performed (13). Contingency table tests were calculated (Chi^2 or exact Fisher, depending on expected cell distribution) for the importance rating comparing the initially 10% of received data to the latest 10% of responders.

After descriptive demographics displaying, the obtained data was analysed either qualitatively or quantitatively in dependence of scaling and abiding by underlying assumptions for parametric/non-parametric testing. Potential associations of anthropometric, sociodemographic and/or training data with injury incidence were assessed exploratively using correlation analysis (Spearman´s Rho) and Chi-Square-Tests. All statistical tests were two-sided and p-values less than .05 were considered to be statistically significant.

Results

Participants

A total of 200 people took part on the online survey, 92% (184 questionnaires (from 156 male and from 28 female participnats)) were included into analysis. Overall completion rate was 79% (n=158 questionnaires). Contingency analyses showed no differences between early and late responders in terms of injury incidence (p=.48; Chi^2=.51).

The majority of participants reported to having performed other sports prior to Calisthenics: 48.99% were engaged in team sports, 28.41% in individual sports and 47.73% in fitness training at a gym (double bentries supposable). Gymnastics as a prior sport was specified by 19.30% of participants. Sports next to Calisthenics at this time were, according to data from participants, fitness training at a gym (45.45%), individual sports (12.50%) or team sports (10.80%). Presently 13.64% additionally practise gymnastics. Mentioned training-related aspects like participation in Calisthenics training and the number of training sessions per week as well as the duration and intensity of one training session, are shown in table 1.

Most of the people reported to train at playgrounds (n=71; 40.34%), at special calisthenics-parcours (n=67; 38.07%), at movement parcours in recreation areas (n=32; 18.18%) or

Table 2

Calisthenics-related injuries. Number, location and incidence.

MAIN GROUPING	INCIDENCE (N)	INCIDENCE (%)	CATEGORY	INCIDENCE (N)	INCIDENCE (%)
Head and Neck	4	3,13	Head and neck	4	3,13
Trunk	14	11,2	Cervical Spine	1	0,81
			Thoracal Spine	3	2,32
			Lumbar Spine	1	0,81
			Upper Trunk	9	7,26
Upper limb	94	77,44	Shoulder	52	41,94
			Upper arm	7	5,65
			Ellbow	9	7,27
			Forearm	5	4,03
			Hand and Wrist	21	18,56
Lower limb	12	9,58	Thight	1	0,81
			Knee	6	4,84
			Lower leg	2	1,61
			Ankle and foot	3	2,32
All	**124**	**100**		**124**	**100**

in a gym (68; 38.64%; double entries supposable). A considerable part answered to train at home (n=33; 18.75%) or without any equipment in parks and/or forests (n=14; 7.95%; double entries supposable). The majority of people train without a trainer (n=110 vs. 46 who train with a trainer), in a group (n=53) or together with friends (n=72).

Injury Incidence

A total of 124 Calisthenics-related injuries were reported from 72 participants. Within this, 38 participants reported one experienced, 21 participants two and 9 participants three injuries. Four or more of reported injuries occurred at three respectively one participant.

In our sample 1.288 injuries per 1000 hours of training were reported. More than ¾ of these injuries occurred at the upper extremity (table 2). Within this, a major part has been located by participants at the shoulder, wrist and hand. The majority of participants reported a muscle injury or a tendon injury following Calisthenics (table 3). Injuries like dislocation, fracture or concussion turn up rarely.

Injury Consequences

A total of 54 participants reported that a minimum of one of their experienced injuries were connected to a time-loss of training. 65.52% of all injuries (80/124) lead to a time-loss of training, ranging from one to 220 days (CI: [29.01; 51.27]). Eight participants reported a total of 10 injuries leading to a time-loss at work (median=12 days; range: 2-60 days).

Chi squared test revealed that comparably younger people get injured more often than older people (Median=24 years; n=40 (young, injured) vs n=32 (old, injured); $p < .01$). No significant difference was found in injury incidence between participants exercising with or without a trainer ($p > .05$). Furthermore, no significant correlation between injury rate and time of participation in Calisthenics ($r=.005$, $p > .05$), training hours per week ($r=-.025$, $p > .05$), self-reported intensity of training ($CC=-.011$, $p > .05$) or time spent for warm up ($CC=.026$, $p > .05$) was noted.

Discussion

This is the first systematic study investigating types, incidences and time distributions of injuries occurring during calisthenics.

Calisthenics is a sport of increasing interest especially of younger population, because of it´s dynamic character to improve their physical conditioning. It is in contrast to conventional training methods, including weight training and other fitness-studio activities (14).

Compared to sports with similar demands, our sample showed a lower injury rate per 1000 hours of training. In gymnastics participants, an injury rate of 9.37 (women) or 8.78 (men), respectively, was found per 1000 h exposition time (16). CrossFit athletes, focussing on successive ballistic motions such as power lifting, Olympic lifting and gymnastics, display a higher risk in getting injured (3.1 injuries per 1000 hours) in CrossFit (8) compared to our Calisthenics participants. Professional ballet dancers need comparable physical control like in calisthenics. At this population, an injury incidence of 1.38 – 1.87/1000 hours training occurs. These injuries are to a large extent chronic (6). This risk is, again, higher than the one found in our study.

Comparable to gymnastics (2), the most injured part of the body seems to be the upper extremity, in particular the shoulder. Calisthenics is often performed at bars or rings which mostly involving the upper extremity. The resulting impact on structures surrounding the shoulder as well as the elbow and wrist may explain the comparably high incidence and the related time-loss in training-time (as the shoulder injury itself constrains shoulder movements and the shoulder involving as one major body structure included in Calisthenics). This may be the main reason why almost 2/3 of all injuries lead to a time-loss in training. Some of the injuries even caused a time-loss of work. As the shoulder is described to be stressed with high impacts in Calisthenics, this association is of importance concerning prevention and medical care. Shoulder injuries usually occur depending on the sport-specific stress profile in certain constellations and may cause various consequences (5). Some studies furthermore report injuries at a weight-bearing joint at a ›

Table 3

Frequency distribution of the reported injuries.

CATEGORY	INCIDENCE (N)	INCIDENCE (%)
Abrasion	7	6,09
Blister	2	1,74
Bruise	5	4,35
Dislocation	2	1,74
Fracture	3	2,61
Impingement	1	0,87
Joint problem	3	2,61
Ligament injuries	5	4,35
Sprain	2	1,74
Muscle Injury	30	26,09
Tendon Injury	51	44,35
Concussion	1	0,87
Other (pain, overuse, tennis ellbow)	3	2,61
All	115	100

younger age to be a risk factor for osteoarthritis 25 years later (11). This may prohibit further exercising of this and other sports. A positive impact on cardiovascular and musculoskeletal health through physical activity will consequently be lacking (17). A recently published systematic review on musculoskeletal injuries in dancers showed a decrease of the overall injury incidence of 2.46 / 1000hrs to 0.84 / 1000hrs due to the impact of special-educated medical care provision (12). One may speculate that, if a professionalization of prevention and medical care is reachable in Calisthenics, such a profound decrease is supposable, likewise. Although expensive and time consuming, supervision at gyms / trails and an emphasis on instruction before Calisthenics is a potential factor to decrease injury rates (15).

Calisthenics is a sport of increasing interest, not only but especially in the younger population. This might be due to its dynamic character which is in contrast to other-fitness-related training methods, including weight training and other fitness-center activities (14). Comparably younger people get injuries more often than older people. No impact of training hours per week and duration of training on this finding occurred. Further studies should explore if this might be a result of more complex exercises and/or a higher risk taking behaviour in younger athletes. Furthermore, younger people might get involved more often in Calisthenics specific "challenges" or "battles" to compare their level of fitness with others.

Despite the potential relevance of professionalization in Calisthenics, no impact of supervised training, time spent to warm up and experience (time spent for calisthenics) on injury rate was found. People in the role of a trainer often have more experience and may practice exercises on a higher level. Today there´s no special trainer license obtainable. It might be an aspect of prevention if trainer not only conveys the correct performing of exercises, but also creates awareness of possible injuries and the associated prevention strategies. The need to perform sports movements and gestures correctly, thus minimizing the possibility of injuries, must be emphasized because this is a complex workout routine that is performed while the participant experiences muscle fatigue (14). Knowledge about injury prevention and handling might reduce consequential damage by a good first aid. Additionally there might be a high variability in time spent and (suggested) warmup strategies. The latter calls for further research. Handling calisthenics, it might be of importance to make a special warm up to make sure that all structures are well prepared for these high loads of exercises.

We conducted the survey in accordance with proposed guidelines and revealed no systematic response bias. However, this survey got some limitations. All given answers were from self-reports and there was no validation of injuries by a physician or other health professional. People who do not access to social media Calisthenic groups were not able to take part at the survey: One may speculate that most of the people joining a trend sport will be organised online. People who have experienced some kind of injury may feel more inclined to participate in this survey. Within comparable designs, more than 80% of participants were able to give valid information about experienced sports injuries during a 12 months period (7). Although the risk for a selection bias is, following our non-responder bias wave analysis, a certain risk for a selection bias is still given. Still, there might be a recall bias because of the retrospective nature of this survey. People with subjectively less assessed problems might not be aware of this as an injury and continue training.

Conclusion

Our study was the first of this kind and correspondingly a pilot study. Although many similarities to gymnastics were shown, we confirmed that Calisthenics seems to be characterized by a lower injury risk. A future prospective study might give a more exact insight on injuries in Calisthenics. By differentiating between acute and chronic injuries, between acute and overload injuries, as well as between first incidences and recurrences, more detailed information about the kind and the mechanism of the injury would be provided. Physicians, athletes, and, in particular, trainers, should be familiar with Calisthenics-specific types of exercises and the related risk of injuries. This may be a basis for a good treatment of injuries and a sufficient prevention strategy, through targeted council and a creation of a specific training program.

Conflict of Interest
The authors have no conflict of interest.

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