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REVIEW

Low ambient temperatures, seasonality, and testicular torsion: A scoping review

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Abstract

Introduction: Testicular torsion is a medical emergency that accounts for up to a quarter of all cases of acute scrotal syndrome and may result in organ loss if not treated within the first few hours. Although its etiology is unknown, recent evidence suggests that low environmental temperatures may be a predisposing factor for testicular torsion. This review aims to summarize the main findings in the literature regarding the relationship between ambient temperature, seasons, and testicular torsion.

Material and Methods: The search for studies was conducted in PubMed between August 16 and August 28, 2023. Of the 78 articles identified, 22 were included in the review (21 retrospective studies and one prospective study). The search was conducted following the recommendations of the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines.

Results: The main countries represented in the studies were Brazil (4), the United States (4), and Nigeria (3). Additionally, 10 articles (52.3%) evaluated both the seasonality of testicular torsion and its association with ambient temperature, while eight articles (30%) focused exclusively on seasonality and four (19%) only on temperature. Of the 18 articles on the seasonality of testicular torsion, 10 reported a statistically significant association. In contrast, of the 14 studies that investigated the relationship between ambient temperature and testicular torsion, 13 found sufficient evidence to confirm a correlation.

Conclusion: The available evidence strongly suggests that low temperatures are a predisposing factor for the development of testicular torsion, while the association with seasons presents conflicting results.

BAJAS TEMPERATURAS AMBIENTALES, ESTACIONALIDAD Y TORSIÓN TESTICULAR: REVISIÓN DE ALCANCE

Resumen

Introducción: *La torsión testicular es una urgencia médica de etiología idiopática que, al no ser tratada en las primeras horas, puede conducir a la pérdida del órgano. Recientemente se ha apoyado la teoría que las bajas temperaturas son un factor predisponente en su etiopatogenia. El propósito del presente trabajo es exponer los principales hallazgos en la literatura de la relación entre la temperatura ambiente, las estaciones del año y la torsión testicular.*

Materiales y métodos: *La búsqueda de estudios se realizó en PubMed entre los días 16 a 28 de agosto de 2023 con base en las recomendaciones de la Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR).*

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Resultados: *De un total de 78 artículos, 22 fueron incluidos (21 estudios retrospectivos, 1 prospectivo). Los principales países de estudio fueron Brasil (4), Estados Unidos de América (4) y Nigeria (3). Asimismo, 10 artículos (52.3%) investigaron la estacionalidad de la torsión testicular, y también su asociación con la temperatura ambiente; mientras que 8 (30%), solo estudiaron la estacionalidad y 4 (19%), únicamente la temperatura. De los 18 artículos sobre la estacionalidad de la torsión testicular, 10 encontraron una asociación estadísticamente significativa. Por otro lado, de 14 estudios sobre la temperatura ambiente y la torsión testicular, 13 observaron evidencia suficiente para corroborar su relación.*

Conclusión: *La evidencia disponible sugiere fuertemente que las bajas temperaturas son un factor predisponente en el desarrollo de la torsión testicular, mientras que su asociación con las estaciones tiene resultados contrastantes.*

INTRODUCTION

Acute scrotal syndrome is a medical emergency characterized by the sudden onset of scrotal pain, edema, and redness[1,2]. Among its causes, testicular torsion (TT) accounts for up to 25%[2] and is defined as spermatic cord torsion interrupting blood supply. TT is classified as intravaginal (94%) and extravaginal (6%)[3]. The incidence is approximately 1 in 4,000 boys under the age of 25, with a higher prevalence between the ages of 12 and 18[2,4,5]. Immediate intervention is crucial, as delays in diagnosis and treatment may lead to testicular loss, particularly since irreversible pathophysiological changes begin 4 to 6 hours after symptom onset[5].

TT typically occurs in the absence of identifiable risk factors, with only 4-8% of cases associated with trauma. Other factors, such as anatomical anomalies, also play a role[6]. Low environmental temperatures have been proposed as a predisposing factor for TT, possibly due to the hyperactive reflex of the cremaster muscle.

At the time of this research, no comprehensive review on the association between low temperatures and the incidence of TT had been published; therefore, the primary objective of this study was to present and analyze the current knowledge on this phenomenon using a scientifically rigorous protocol.

MATERIAL AND METHODS

Study design

The study was designed as a scoping review to identify evidence from a diverse field of research, to synthesize the existing body of knowledge and identify gaps[7]. The search was conducted following the recommendations of the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews)[8].

Search strategy and selection process

The search for eligible articles was conducted in PubMed between August 16 and August 28, 2023. The search strategy used was (testicular torsion) AND ([temperature] OR [seasonality]). The inclusion criteria for the articles were: (1) cohort or case-control studies, (2) published in Spanish or English, and (3) related to the association of TT with low temperatures or seasons. Articles that were inconsistent with the topic, written in another language, or unavailable were excluded.

The procedure for the final selection of articles for analysis was as follows: First, all results from the search strategy were compiled into a single file, and duplicates were removed. Next, the title and abstract of each article were screened according to the selection criteria. Then, of the remaining articles assessed for eligibility, those whose full text was in a different language and could not be accessed, even after contacting the authors via email or ResearchGate, were excluded. Finally, the remaining studies were included in the review.

Analyses

The variables extracted from each article are listed in Table 1, following the PRISMA-Scr guidelines[8]. The variables were selected to provide a comprehensive overview and to identify the limitations of the existing knowledge. Among the publication details (author, year, country, and title), the country where the research was conducted was considered particularly important due to its direct correlation with the area's temperature. The study design, data collection methods, and statistical analysis provide information on the methodology, while the main results address the initial question regarding the relationship between temperature and/or seasonality and TT. Data extraction and compilation into tables were performed by the first author over a period of three months and content completeness was assessed at four time points.

RESULTS

Description of the article selection process

A total of 78 studies were retrieved, of which 44 were excluded for being irrelevant to the topic. Of the remaining 34, five were excluded because they were in a language other than Spanish or English, four were excluded based on the type of article, and another three were removed due to lack of availability, leaving 22 articles to be included in the review (Figure 1). Table 2 provides the information extracted according to the PRISMA-ScR guidelines[8].

TABLE 1. Information extracted from the studies.

Type of information	Description
Related to publication	Author, year, country, and title
Study design	Type of study design used (e.g., retrospective, prospective) and main objective (association of TT with low temperatures and/or seasons)
Data collection methods	Meteorological data collection instruments and enrollment procedures
Statistical analysis	Statistical methods for quantitative and qualitative information
Main results	Presence of association and magnitude of effect

TT: testicular torsion.

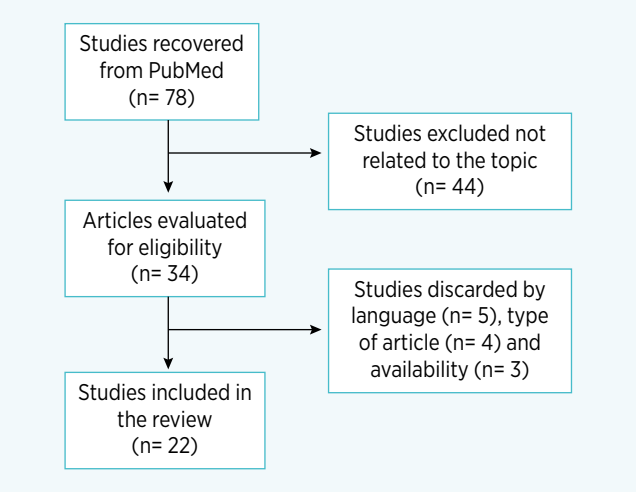

FIGURE 1. Flowchart of item search and selection.

TABLE 2. Characteristics of selected studies.

#	Author	Year	Title	Method of data collection	Country	Study design and statistical analysis	Main results
1	Al-Hunayan et al.	2004	Testicular torsion: a perspective from the Middle East	75 patients with a presumptive diagnosis of TT, conducted between January 1999 and December 2002; 63 patients (mean age 18.3 [11-45 years]) were confirmed by Doppler study or nuclear scan	Kuwait	A prospective study comparing the number of new cases during the year's four seasons. Statistical analysis was not performed	The mean number of new cases of TT was higher in the colder seasons than in the warmer seasons (in summer, the mean number of new cases per month was 4; in fall, 6; in winter, 6.7; and in spring, 5.5); the mean temperatures for each season were (spring, 13 to 30°C; summer, 40 to 50°C; fall, 15 to 32°C] winter, 5 to 17°C)
2	Cabral Días Filho et al.	2018	Immediate and delayed effects of atmospheric temperature in the incidence of testicular torsion	218 patients with a single diagnosis of intravaginal TT confirmed by surgery in January 2012-January 2015, with a mean age of 15.8 (range, 14.1-18.5) years Records of mean daily ambient temperature and its minimum and maximum values were obtained from the World Meteorological Organization repository of weather stations	Brazil	Retrospective cohort study with nonparametric analysis (Wilcoxon test) and distributed lag nonlinear regression	Mean ambient temperatures of days with TT cases were lower than those without TT (20.9 vs. 21.4°C, p= 0.0002) Distributed lag nonlinear regression showed an increased risk of TT with low temperatures on the day of exposure (RR= 24 (95% CI: 2.2-266.83) at 15.6°C to 2.01 (95% CI: 1.03-3.99) at 19.4°C
3	Chiu et al.	2012	Seasonality of Testicular Torsion: A 10-Year Nationwide Population-Based Study	1,782 TT hospitalizations were retrieved from the National Health Insurance Research Database (NHIRD) between January 2000 and December 2009 Monthly mean ambient temperature records were obtained from the Taiwan Central Weather Bureau (CWB). In Taiwan, the seasons are spring (March-May), summer (June-August), fall (September-November),and winter (December-February)	Taiwan	This retrospective study used the Spearman correlation to explore the association between temperature and TT incidence, and the ARIMA method for statistical analysis to assess the seasonality of incidence	Monthly TT incidence negatively correlated with ambient temperature (r= -0.351, p< 0.01), and a similar seasonality pattern was observed across years using the ARIMA method

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TABLE 2 *(Cont.).* Characteristics of selected studies.

#	Author	Year	Title	Method of data collection	Country	Study design and statistical analysis	Main results
4	Chen et al.	2013	Diurnal temperature change is associated with testicular torsion: a nationwide, population-based study in Taiwan	65 patient records (mean age 16.2 years (range, 1 to 53) hospitalized for TT and surgically treated older than one year were obtained from the Taiwan Health Insurance Longitudinal Database 2000 between January 1996 and December 2008 Climatic information (mean, maximum, and minimum ambient temperature) was obtained from the Taiwan CWB	Taiwan	A retrospective study using the Kruskal-Wallis H test to analyze seasonal climatic variation and the Mann-Whitney U test to compare seasonal variation	The order of highest to lowest incidence by season was winter (31.1%), spring (26.2%), fall (23%), and summer (19.7%) ($p > 0.05$). Regarding the relationship with daily temperature change (DTC) (difference between maximum and minimum), a DTC > 6°C was the turning point in the increase of TT incidence ($p = 0.05$)
5	Cost et al.	2011	Pediatric testicular torsion: demographics of national orchiopexy versus orchiectomy rates	2,876 patients diagnosed with TT older than one year (mean age 11.9 years) were retrieved from the US Pediatric Health Information System database between 2003 and 2009 The object of the association was the seasons of the year in which the presentation occurred (spring [March-May]; summer [June-August]; fall [September-November]; winter [December-February]	United States	A retrospective cohort study using the X^2 test to investigate the role of seasonal variations	Of the total number of cases, 792 (27.5%), 827 (28.8%), 616 (21.4%), and 641 (22.3%) occurred in winter, spring, summer, and fall, respectively ($p > 0.05$)
6	Driscoll et al.	1983	Cold weather and testicular torsion	134 patients had TT confirmed by surgery from 1973-1983 The distribution of months of the year by season was spring (March-May), summer (June-August), fall (September-November), and winter (December-February)	Scotland	A retrospective study using the X^2 test to analyze the role of seasons	The distribution of cases by season was spring (28.3%), summer (18.6%), fall (26.1%), and winter (26.8%) ($p > 0.1$)
7	Ekici et al.	2018	Relationship of Low Temperature with Testicular Torsion	30 patients diagnosed with TT (mean age 14 [range, 10.8-17.0]), identified through the hospital system and surgery notes from June 2005 to December 2014 Groups of patients were studied according to the season of presentation: spring (March-May), summer (June-August), fall (September-November), and winter (December-February). Mean ambient temperature was obtained from online records of the state meteorological service	Turkey	A retrospective study using the X^2 test to compare more than two groups and Spearman's test for correlation analysis	The distribution of the 30 TT cases by season was spring (23.3%), summer (13.3%), fall (16.6%), and winter (46.6%) ($p = 0.0126$) In the seasonal periods, the recorded temperatures were: winter, 1.4°C (-2.3, 5.2); spring, 9.5°C (6.7, 12.1); summer, 22°C (19, 26.8); fall, 1.3 (8.1, 13.5). There was a strong negative correlation between ambient temperature and TT cases ($r = -1.0$, $p = 0.033$)
8	Gomes et al.	2015	Cold weather is a predisposing factor for testicular torsion in a tropical country. A retrospective study	64 patients with a surgically confirmed diagnosis of TT (mean age 16 years [1.0-30.0]) were included; their clinical information was obtained from hospital records from April 2006 to March 2011 Symptom onset was tabulated according to month and season (spring, October to December; summer, January to March; fall, April to June; winter, July to September). Mean and minimum ambient temperatures were obtained from the Brazilian National Institute of Meteorology records	Brazil	A retrospective study using the X^2 test was conducted to investigate the role of seasonal variation	The distribution of TT cases by season was spring (11%), summer (16%), fall (34%), and winter (39%). Thus, 73% of the cases occurred during the colder months (fall and winter), while 27% occurred during the warmer months (spring and summer) ($p < 0.001$) Eighty-three percent of the cases occurred when the minimum temperature was below 17.3°C, and only 17% when it was higher ($p < 0.001$)

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TABLE 2 *(Cont.).* Characteristics of selected studies.

#	Author	Year	Title	Method of data collection	Country	Study design and statistical analysis	Main results
9	Gutiérrez-García et al.	2010	Importancia del tiempo en el manejo de la torsión testicular	37 records of patients diagnosed with TT between 2002 and 2006 were retrieved from the hospital database The seasons of the year in Mexico are spring (March-May), summer (June-August), fall (September-November), and winter (December-February)	Mexico	This retrospective study divided the patients into two groups: Group A, which received medical care within 6 hours (n= 15), and Group B, which received medical care after 6 hours (n= 22)	Both groups had a predominance of TT cases in the fall and winter months (group A, 73%; group B, 77%)
10	Grushevsky et al.	2011	The seasonality of testicular torsion	768 patients (mean age 15.5 years [range, 11.7-20.8]) seen in the ED for TT between January 1996 and December 2009 The study seasons were summer (June-August) and winter (December-February). The method of obtaining ambient temperature was not specified	United States	A retrospective study in which the number of visits due to TT in winter and summer were compared using the Student's t-test. The Pearson correlation coefficient was also determined between the mean monthly visits due to TT and temperature	The probability of developing TT was 39% (95% CI, 24-57%) higher in winter than in summer. Similarly, there was a negative correlation between TT visits and mean monthly ambient temperature (R= 0.54; p= 0.01), with approximately 30% of patients who came for consultation with a monthly temperature below 3°C
11	Karakan et al.	2015	Seasonal preponderance in testicular torsion: is it a myth?	56 patients (mean age 18.8 ± 0.73) with a diagnosis of TT, confirmed by physical examination and scrotal Doppler ultrasound findings, were admitted to the emergency department from 2005-2014 The database of the General Meteorological Directory of the Republic of Turkey was used to determine the mean temperature at the time of diagnosis and the seasons of spring (March-May), summer (June-August), fall (September-November), and winter (December-February)	Turkey	A retrospective study was conducted in which X^2, Mann-Whitney U, and Wilcoxon tests were used for statistical analysis	The distribution of the 56 TT cases by season was spring (32.1%), summer (16%), fall (25%), and winter (26.7%) (p= 0.392) In contrast, the ambient temperature on admission was below 15°C in 71.4% of cases and above 15°C in 28.6% (p= 0.002)
12	Korkes et al.	2012	Testicular torsion and weather conditions: analysis of 21,289 cases in Brazil	21,289 hospital admissions for surgical treatment of TT were obtained from the Brazilian Public Health Information System database (DATASUS) in 1992-2010 Patients were classified based on month of diagnosis, year, and region. Of the five main areas of Brazil, the South has lower temperatures and more variations than the North	Brazil	A retrospective study was conducted in which the X^2 test and ANOVA were used to compare groups	The corrected TT rate for the total population of each region remained similar in all areas studied (p= 0.38), and the temperature variation between regions was more significant between the North and South (3.1°C vs. 6.5°C; p< 0.0001) There was a significant increase in the number of TT in colder months (p= 0.002) and a substantial difference between incidence in warmer and colder months in both southern (OR= 1.4; p< 0.0001) and northern (OR= 1.1; p< 0.001) regions

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TABLE 2 *(Cont.).* Characteristics of selected studies.

#	Author	Year	Title	Method of data collection	Country	Study design and statistical analysis	Main results
13	Lyronis et al.	2009	Acute scrotum - etiology, clinical presentation and seasonal variation	140 patients with acute scrotum syndrome, of whom 35 had TT confirmed by physical examination and scrotal Doppler ultrasonography (mean age 5.66 ± 3.33 years) between January 1989 and December 2006 Cases were divided by age group and by season of symptom onset (spring, March-May; summer, June-August; autumn, September-November; winter, December-February)	Greece	Retrospective study in which clinical presentations and seasonal variations in the causes of acute scrotal syndrome were analyzed. X^2 test and ANOVA were used for statistical analysis	The distribution of TT cases by season was spring 14.2%, summer 12.5%, fall 34.2%, and winter 40% ($p< 0.047$)
14	Mabogunje	1986	Testicular torsion and low relative humidity in a tropical country	131 patients diagnosed with TT (80% in the age group 11-25 years) from 1972-1984 The monthly mean daily temperature was obtained from the Agricultural Research Institute, Zaria records. The seasons in Nigeria are usually divided into the hot and humid months (March-October) and the harmattan months (a dry trade wind in which humidity and temperature drop, November-February)	Nigeria	Retrospective study in which Edward's test was used to observe seasonality and Spearman's test for correlation	The presence of seasonality was observed in the incidence of TT cases ($p< 0.001$), and a non-significant correlation with temperature ($r= -0.47$, $p> 0.05$)
15	Mbibu et al.	2004	Acute scrotum in Nigeria: an 18-year review	A total of 178 patients with acute scrotal syndrome who underwent surgery, of whom 90 were for TT (mean age 23 years [range, 3 weeks-55 years]), were retrieved from the hospital registry during the period 1978-1997 (1984 was excluded) The source of information on the mean daily ambient temperature for each month was obtained from the Agricultural Research Institute, Zaria. The seasons in Nigeria are usually divided into the hot and humid months (March to October) and the harmattan months (a dry trade wind in which humidity and temperature drop, November to February)	Nigeria	A retrospective study was conducted to analyze the seasonality of TT cases in students' t-tests	TT was more frequent in the harmattan season, confirming seasonality ($p= 0.05$)
16	Molokwu et al.	2020	Cold weather increases the risk of scrotal torsion events: results of an ecological study of acute scrotal pain in Scotland over 25 years	33,855 reports of patients with acute scrotal syndrome (TT, testicular appendage torsion, and epididymo-orchitis) during 1983-2007 were obtained from the National Health Service (NHS) Information Services Division The mean ambient temperature was obtained from the United Kingdom Meteorological Office. The distribution of months of the year by season was spring (March-May), summer (June-August), fall (September-November), and winter (December-February)	Scotland	A retrospective study in which patients were divided into groups A (TT and testicular appendage torsion) and B (epididymis-orchitis). Friedman's test was used to analyze the variability of monthly frequency. The Mann-Whitney U test was used to compare cold and warm months, and the Spearman test was used for correlation	Of the cases, 23% were in group A, and 77% were in group B. The warmest months were from May to October (4.8-9.6°C), and the coldest months were from November to April (0.1-2.5°C). In group A, there was a higher frequency of episodes in the coldest months than in the warmest months ($p< 0.0001$) There was a negative correlation between the frequency of episodes in group A and ambient temperature ($r= -0.87$; $p= 0.0004$)

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TABLE 2 *(Cont.).* Characteristics of selected studies.

#	Author	Year	Title	Method of data collection	Country	Study design and statistical analysis	Main results
17	Paladino et al.	2021	Testicular torsion and climate changes in macroregions of São Paulo, Brazil	2,351 records of patients with intravaginal testicular torsion confirmed by surgery between January 2008 and December 2016 were obtained from DATASUS Brazil Each location's average ambient temperature information was obtained from the Agrometeorological Information Center (CIIAAGRO). In addition, the year was divided into warm months (January-March and October-December, which correspond to summer and spring) and cold months (April-September, fall, and winter)	Brazil	A retrospective study was conducted in which patients were divided into the five macro-regions of Brazil, denominated A to E. The student's t-test was used for statistical analysis	In all areas studied, there was a significant difference in temperature variation between cold and warm months ($p< 0.05$). In macro-regions B, C, and E (n= 2,130), there were statistical differences in the association between TT and low temperatures ($p= 0.019$, $p= 0.001$, and $p= 0.006$, respectively). In contrast, there were no significant differences in zones A and D (n= 221) ($p= 0.066$ and $p= 0.494$, respectively)
18	Shukla et al.	1982	Association of cold weather with testicular torsion	46 records of patients with a diagnosis of TT confirmed by surgery were retrieved from the hospital database Mean ambient temperature information was obtained from the Irish Meteorological Service. The seasons of the year in Ireland are as follows: spring, March-May; summer, June-August; fall, September-November; and winter, December-February	Ireland	A retrospective study was conducted in which the distribution of cases of TT over the months and their comparison with the ambient temperature were studied using the X^2 test	87% of the cases occurred when the temperature was below 2°C, considering that only 23.6% of the days of the year were below this mark ($p< 0.01$)
19	Srinivasan et al.	2007	Climatic conditions and the risk of testicular torsion in adolescent males	58 patients were surgically diagnosed with intravaginal TT between January 1999 and December 2006 The date of symptom onset was recorded with the corresponding month and season of the year. Seasons in the United States of America were divided into summer (June-August) and winter (December-February)	United States	Retrospective study in which two stratifications were performed: the first was divided into two groups according to atmospheric temperature (group 1, < 15°C and group 2, > 15°C); the second stratification was divided into three groups (group 1, < 5°C; group 2, 6-15°C; and group 3, > 15°C). X^2, Mann-Whitney U, and Kruskal-Wallis tests, Spearman correlation, and multivariate analysis were used for statistical analysis	The distribution across the 4 seasons was not significant ($p> 0.05$), but the clustered incidence during spring and winter was 67.2% of cases compared to the fall and summer group ($p= 0.0007$). The mean temperature at symptom onset was 6.9°C (12-23°C). In the first stratification, group 1 (< 15°C) accounted for 81% of cases ($p< 0.001$) and in the second stratification, group 1 (< 5°C), 48% ($p< 0.001$) Spearman's test showed a negative correlation between ambient temperature and TT incidence ($r= -0.94$; $p< 0.0001$). Similarly, multivariate analysis corrected for covariates such as age showed a negative correlation between temperature and TT incidence ($p< 0.05$)

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TABLE 2 *(Cont.).* Characteristics of selected studies.

#	Author	Year	Title	Method of data collection	Country	Study design and statistical analysis	Main results
20	Takure et al.	2013	Torsion of the testis and factors that determine the choice of orchidectomy and unilateral orchidopexy	169 records of patients (mean age, 9 months-45 years) with a surgically confirmed diagnosis of TT between July 1998 and June 2010 were retrieved from the medical records of the urology department of each hospital Mean ambient temperature was obtained from the British Broadcasting Corporation (BBC) weather map. In Nigeria, the seasons are divided into the hot and humid months (March to October) and the harmattan months (November to February)	Nigeria	A retrospective, descriptive, and correlational study using Pearson's test for statistical analysis	The month with the lowest number of TT cases was June (9 cases), and the highest was September (23 cases); however, the mean ambient temperature was the same, 25.5°C. Overall, there was no significant correlation between the incidence of TT and ambient temperature (r= 0.248; p= 0.437)
21	Williams et al.	2003	Testicular torsion: is there a seasonal predilection for occurrence?	A total of 135 patients with surgically confirmed intravaginal testicular torsion during the period 1987-2002 were identified from the hospital registry The year's seasons in the United States of America were divided into summer (June-August) and winter (December-February)	United States	A retrospective study was conducted using the X^2 test to determine statistical significance	The distribution of TT cases by season was spring (23%), summer (22%), fall (30%), and winter (24%) (p> 0.05)
22	Williamson	1983	Cold weather and testicular torsion	A total of 293 patients (mean age 13 years) diagnosed with TT, of whom 275 were saved by the month in which the episode occurred, were studied from 1960-1974 The seasons of the year in Ireland are as follows: spring, March-May; summer, June-August; fall, September-November; and winter, December-February	Ireland	A retrospective study was conducted using the X^2 test for nonparametric statistical analysis	More cases were observed in November to February (late fall and winter) than in the warmer months (p< 0.005)

Location and year of publication

The association between low ambient temperatures and TT was first described in Ireland[9] more than 50 years ago. Since then, numerous studies have assessed this association, with a peak in research activity in the last decade, resulting in 11 publications (Figure 2). Among the analyzed studies, the most frequently represented countries were Brazil (4 studies, 18.2%)[1,4,6,10], the United States (4 studies, 18.2%)[9,11-13], and Nigeria (3 studies, 13.6%)[14-16]. The majority of the studies were conducted in the Northern Hemisphere (18 studies, 81.8%).

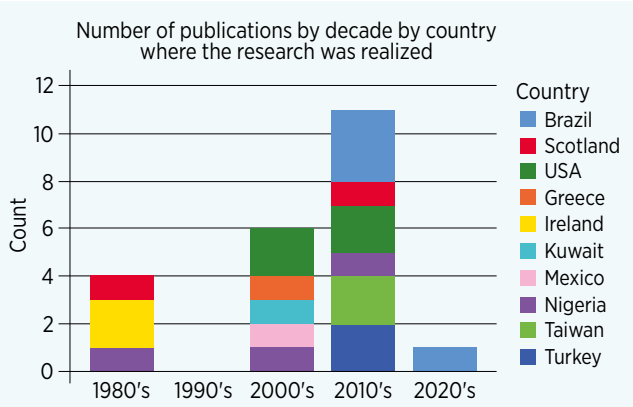
Study design

Most of the studies were retrospective (21, 95.4%). Of the total, 10 studies (52.3%)[1,6,14,17–23] examined the association of TT cases with both seasons and ambient temperature, whereas eight studies (30%)[11–13,15,24–27] assessed only the association with seasons and four (19%)[4,9,10,16] only the association with temperature.

Data Collection Method and Statistical Analysis

In terms of participants, the sample sizes of the studies ranged from 30 to 21,289 patients. Six studies (27.3%) used national databases, while 16 studies (72.7%) were based on hospital records. The diagnosis of TT was confirmed through surgical intervention in 13 studies (59.1%), through Doppler ultrasound and physical examination in three studies (13.6%), and six studies (27.3%) did not specify the diagnostic method. In addition, five studies (22.7%) did not report the age of the patients. Regarding meteorological data, of the 15 studies examining the relationship with ambient temperature, 11 reported mean monthly temperatures, while the remaining four provided mean daily temperatures.

Of the 18 articles that analyzed the seasonality of TT, most used the X^2 test (11), either alone or in combination with other statistical methods, including ANOVA, the Mann-Whitney test, or Spearman's correlation. Two studies focused only on descriptive analysis[24,25]. In contrast, for the relationship with



USA: United States of America.

FIGURE 2. Number of publications per decade by country of research.

ambient temperature (14 articles), the most commonly used tests were Spearman's correlation (5 studies) and Pearson's correlation (2 studies). Four studies divided the data into two groups based on different temperatures and evaluated them using the X^2 test.

Main results

Of the 18 articles that examined the relationship between the incidence of TT and seasons, 10 reported a statistically significant association. On the other hand, 13 of the 14 studies that investigated the association between ambient temperature and TT found sufficient evidence to confirm a relationship.

DISCUSSION

Summary of the evidence

Here, we present the first up-to-date review of the available literature on the correlation between ambient temperature, seasons, and TT, with special emphasis on methodological aspects. Our review suggests that low temperatures are a strong predisposing factor for TT, while the seasonality of TT remains inconclusive, showing conflicting results. Nevertheless, the quality of these findings should be considered with caution due to potential methodological limitations, such as patient selection bias and the use of hospital administrative and meteorological databases. In addition, as testicular torsion is a multifactorial condition where temperature may play a significant role, further research is needed to better understand this relationship. Future studies should employ more rigorous methodologies, such as prospective designs, larger sample sizes, and broader geographical representation, especially considering the high prevalence of cases in the Northern Hemisphere. Moreover, further etiopathogenic studies are also necessary.

Limitations

Our review has two significant limitations that should be acknowledged. First, eight articles were excluded during the selection process (five due to language barriers and three due to lack of availability), which may have limited the information available on the phenomenon studied. Second, the synthesis of the information was conducted by a single researcher, which introduces the potential for error, even though efforts were made to minimize this risk (the data collection was conducted over three months with four time points to evaluate content completeness).

Clinical implications

As TT is a medical emergency, delayed diagnosis and ineffective treatment may not only result in loss of the testis but also have legal implications for the treating physician[1]. Therefore, it is important to consider risk factors associated with its occurrence to minimize these outcome. Although the current evidence is limited, establishing recommendations and public policies aimed at educating the general population and healthcare personnel about the association between TT and low temperatures could promote early intervention. This approach would encourage patients to seek immediate medical attention, especially during colder months[1], and ensure that emergency department professionals refer patients early to specialists with a presumptive diagnosis.

CONCLUSION

In conclusion, the available evidence strongly suggests that low temperature is a risk factor for the development of TT, although its association with seasonality remains unclear due to conflicting results. Our findings emphasize the need for further, more rigorous research to improve our understanding of the relationship between temperature and TT.

REFERENCES

1. Paladino JR, Korkes F, Glina S. Testicular torsion, and climate changes in macroregions of São Paulo, Brazil. Einstein (Sao Paulo). 2021; 19: eAO5472. doi: 10.31744/einstein_journal/2021AO5472
2. García-Fernández G, Bravo-Hernández A, Bautista-Cruz R. Torsión testicular: reporte de un caso. Cir Cir. 2017; 85(5): 432-5. doi: 10.1016/j.circir.2016.05.014.
3. Monge Ropero N, Calvo Cebrián A, Gómez Moreno R, Cebrián Patiño E. Valoración del síndrome escrotal agudo en atención primaria. Med Integral. 2003; 41(1): 4-7.
4. Korkes F, Cabral PR dos A, Alves CDM, Savioli ML, Pompeo ACL. Testicular torsion and weather conditions: analysis of 21,289 cases in Brazil. Int Braz J Urol. 2012; 38(2): 222-8; discussion 228-9. doi: 10.1590/s1677-55382012000200010.
5. Fehér ÁM, Bajory Z. A review of main controversial aspects of acute testicular torsion. J Acute Dis. 2016; 5(1): 1-8. doi: 10.1016/j.joad.2015.06.017.
6. de Oliveira Gomes D, Vidal RR, Foeppel BF, Faria DF, Saito M. Cold weather is a predisposing factor for testicular torsion in a tropical country. A retrospective study. Sao Paulo Med J. 2015; 133(3): 187-90. doi: 10.1590/1516-3180.2013.7600007.
7. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. Int J Soc Res Methodol. 2005; 8(1): 19-32. doi: 10.1080/1364557032000119616.

8. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. 2018; 169(7): 467-73. doi: 10.7326/M18-0850.
9. Williamson R. Cold weather and testicular torsion. Br Med J (Clin Res Ed). 1983; 286(6375): 1436. doi: 10.1136/bmj.286.6375.1436.
10. Cabral Dias Filho A, Gonçalves de Oliveira P. Immediate and delayed effects of atmospheric temperature in the incidence of testicular torsion. J Pediatr Urol. 2018; 14(2): 170.e1-7. doi: 10.1016/j.jpurol.2017.11.010.
11. Cost NG, Bush NC, Barber TD, Pediatric testicular torsion: demographics of national orchiopexy versus orchiectomy rates Huang R, Baker LA. J Urol. 2011; 185(6 Suppl): 2459-63. doi: 10.1016/j.juro.2011.01.016.
12. Grushevsky A, Allegra JR, Eskin B, McCarthy C. The seasonality of testicular torsion. Pediatr Emerg Care. 2011; 27(12): 1146-7. doi: 10.1097/PEC.0b013e31823aba2e.
13. Williams CR, Heaven KJ, Joseph DB. Testicular torsion: is there a seasonal predilection for occurrence? Urology. 2003; 61(3): 638-41; discussion 641. doi: 10.1016/s0090-4295(02)02498-6.
14. Mabogunje OA. Testicular torsion and low relative humidity in a tropical country. Br Med J (Clin Res Ed). 1986; 292(6517): 363-4. doi: 10.1136/bmj.292.6517.363.
15. Mbibu NH, Maitama HY, Ameh EA, Khalid LM, Adams LM. Acute scrotum in Nigeria: an 18-year review. Trop Doct. 2004; 34(1): 34-6. doi: 10.1177/004947550403400117.
16. Takure AO, Shittu OB, Adebayo SA, Okeke LO, Olapade-Olaopa EO. Torsion of the testis and factors that determine the choice of orchidectomy and unilateral orchidopexy. Niger Postgrad Med J. 2013; 20(3): 197-202.
17. Ekici M, Ozgur BC, Senturk AB, Nalbant I. Relationship of Low Temperature with Testicular Torsion. J Coll Physicians Surg Pak. 2018; 28(5): 378-80. doi: 10.29271/jcpsp.2018.05.378.
18. Karakan T, Bagcioglu M, Özcan S, Telli O, Turgut H, Özkan M, et al. Seasonal preponderance in testicular torsion: is it a myth? Arch Esp Urol. 2015; 68(10): 750-4.
19. Chen JS, Lin YM, Yang WH. Diurnal temperature change is associated with testicular torsion: a nationwide, population based study in Taiwan. J Urol. 2013; 190(1): 228-32. doi: 10.1016/j.juro.2013.02.013.
20. Chiu B, Chen CS, Keller JJ, Lin CC, Lin HC. Seasonality of testicular torsion: a 10-year nationwide population based study. J Urol. 2012; 187(5): 1781-5. doi: 10.1016/j.juro.2011.12.104.
21. Shukla RB, Kelly DG, Daly L, Guiney EJ. Association of cold weather with testicular torsion. Br Med J (Clin Res Ed). 1982; 285(6353): 1459-60. doi: 10.1136/bmj.285.6353.1459.
22. Srinivasan AK, Freyle J, Gitlin JS, Palmer LS. Climatic conditions and the risk of testicular torsion in adolescent males. J Urol. 2007; 178(6): 2585-8; discussion 2588. doi: 10.1016/j.juro.2007.08.049.
23. Molokwu CN, Ndoumbe JK, Goodman CM. Cold weather increases the risk of scrotal torsion events: results of an ecological study of acute scrotal pain in Scotland over 25 years. Sci Rep. 2020; 10(1): 17958. doi: 10.1038/s41598-020-74878-0.
24. Gutiérrez-García JD, Arratia-Maqueo JA, Gómez-Guerra LS, Cortés-González JR. Importancia del tiempo en el manejo de la torsión testicular. Med Universitaria. 2010; 12(42): 112-4.
25. Al-Hunayan AA, Hanafy AM, Kehinde EO, Al-Awadi KA, Ali YM, Al-Twheed AR, et al. Testicular torsion: a perspective from the Middle East. Med Princ Pract. 2004; 13(5): 255-9. doi: 10.1159/000079523.
26. Lyronis ID, Ploumis N, Vlahakis I, Charissis G. Acute scrotum -etiology, clinical presentation and seasonal variation. Indian J Pediatr. 2009; 76: 407-10. doi: 10.1007/s12098-009-0008-2.
27. Driscoll PA, Brume J, Meehan SE. Cold weather and testicular torsion. Br Med J. 1983; 286(6379): 1751. doi: 10.1136/bmj.286.6379.1751.