



Review article

The prevalence and characterisation of energy drink consumption in North America: A systematic review



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ABSTRACT

Objectives: Energy drinks (ED), which contain high levels of caffeine, are widely popular and their consumption is increasing, especially among young people who may have limited understanding of the associated risks. The aim of this study was to identify the prevalence of ED consumption in North America (Canada, Mexico and the US) and to characterise ED consumers.

Study design: Systematic review.

Methods: A systematic review of studies estimating the prevalence of ED consumption was conducted. The characteristics of the studies, populations included, consumption assessment and prevalence of consumption were recorded. Study quality was evaluated using an adaptation of the Newcastle-Ottawa scale. A descriptive analysis of the results was performed.

Results: In total, 91 studies conducted in North America were included. All studies were of low to moderate quality. The prevalence of ED consumption was assessed using different temporalities in different studies, which made it impossible to reach a conclusion about the prevalence in North America. Across all populations and temporalities, a considerable range of ED prevalence was observed. It is noteworthy that in studies of university students, weekly ED consumptions >60 % were reported. ED consumption was associated with being male and the co-consumption of alcohol, tobacco and marijuana or cannabis.

Conclusions: Results show that ED consumption was highly heterogeneous and widely prevalent, especially among younger populations. This review provides information to help guide and design appropriate public health measures and strategies.

1. Introduction

Energy drinks (ED) are defined as non-alcoholic beverages that contain caffeine, other ingredients, such as guarana or ginseng, and are marketed as energy-boosting beverages. ED also contain sugar; in some cases, in quantities equivalent to sugar-sweetened beverages.^{1–4} In addition, ED contain amino acids, such as taurine and L-carnitine, herbal supplements or vitamin B.^{2,5} However, caffeine is the main ingredient, ranging from 70 to 200 mg per 16 fl oz.^{6,7}

The consumption of ED has been shown to have a negative impact on

health.⁸ In children and adolescents, ED consumption has been associated with an exacerbation of mental health symptoms and disorders (e.g. anxiety, depressive symptoms, suicidal ideation or stress).^{1,5,9,10} One of the most concerning related practices in this youth population is the co-consumption of ED with alcohol (commonly known as ‘Alcohol mixed with Energy Drinks’ [AmED]) and with other drugs, such as tobacco, cannabis, amphetamines and nonmedicinal use of prescription drugs.^{2,5,8,11} This combination is also related to risky behaviours, such as binge drinking, problems with behavioural regulation, unsafe sex and/or unsafe vehicle use.⁹

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For adults, the evidence about the health-related effects of ED consumption is controversial. Some studies have reported that ED consumption can improve some aspects of cognitive function,⁸ while other studies reported cardiovascular events, such as increased blood pressure.⁶

ED are popular worldwide, particularly among children, adolescents and young adults.⁸ The growing popularity can be linked to aggressive marketing strategies targeting younger populations.^{12,13} By 2020, the ED market had become a \$45.8 billion business and is projected to reach \$108.4 billion by 2031.^{9,14} Despite this rapid growth, regulation in the US remains limited, with the Food and Drug Administration (FDA) lacking specific regulations for ED.⁵ In contrast, Canada requires warning labels on ED regarding consumption by children and pregnant women, and excessive consumption.¹¹ Mexico imposes an additional tax to all non-alcoholic beverages with added sugar, including ED; since 2014, this tax has led to a 6 % decrease in ED purchases.⁵

Despite the popularity of ED and their health implications, the prevalence of their consumption in North America remains to be elucidated. Consequently, a comprehensive understanding of this prevalence is imperative to facilitate the implementation of targeted measures tailored to this region. This review aimed to identify the prevalence of ED consumption in North America (Canada, Mexico and the US) and characterise ED consumers.

2. Methods

A systematic review was conducted following the 2020 PRISMA¹⁵ guidelines (see Table S1 in the supplementary material). The study was registered in the PROSPERO database (register number: CRD42023473014). The protocol delineated a comprehensive analysis of the worldwide prevalence of ED consumption; however, the present review focuses on studies conducted in North America.

2.1. Search strategy

A bibliographic search was performed and updated until July 2023 in Embase, MEDLINE (Ovid), Scopus and Cochrane databases, after applying a pre-designed search strategy drawn up by three expert reviewers in the subject area (Table S2).

The search strategy was developed by combining MeSH, Emtree and free terms. No restrictions of country, study period, study design or language were applied. Furthermore, the bibliographic references of selected articles were reviewed.

2.2. Inclusion/exclusion criteria

The review considered all studies that included prevalence data of ED consumption in any time frame, country and population, regardless of whether their main objective was the estimation of prevalence of ED consumption. This review reports the results from North America; studies conducted in countries other than Canada, Mexico and the US were excluded. Original articles that fulfilled PECOS (Population, Exposure, Comparability, Outcomes and Study design) criteria were selected if they could provide answers to the following questions: “What is the prevalence of energy drink consumption in North America?” and

Table 1
PECOS criteria.

PECOS CRITERIA	
Population	North American population (Canada, Mexico and United States)
Exposure	Energy drink consumption
Comparability	Not applicable
Outcomes	Prevalence of energy drink consumption/Characterisation of the consumers
Study design	All (except from systematic reviews and meta-analysis)

“What are the characteristics of the consumers?” (Table 1).

Studies with the following characteristics were excluded: studies that estimated prevalence of overall caffeine consumption; studies that only provided prevalence of dual consumption of ED and alcohol; studies that provided the combined prevalence of ED and other beverages and substances without providing ED individual outcomes; studies that targeted populations with pathologies or people with drug dependence; and international studies that covered more than one country without providing country-specific prevalence data.

Moreover, studies published in languages other than Spanish, English or Portuguese, and conferences proceedings, letters to the editor, opinion articles, narrative reviews, systematic reviews with or without meta-analysis, simulation studies and retracted publications were excluded.

2.3. Studies selected and extraction synthesis

After elimination of duplicate studies, four authors screened the titles and abstracts of all articles yielded by the search through a blinded peer review process. Subsequently, the full text of studies considered to be potentially relevant were reviewed by the same researchers.

All authors participated in manual extraction of selected study data in a pre-designed extraction sheet adapted to the STROBE checklist.¹⁶

Information was extracted on:

Study characteristics: publication characteristics, study and survey characteristics, study period, country and geographical scope, sample size and representativeness, and whether the main objective of the study was to estimate ED prevalence.

Population characteristics: population group in which ED consumption was assessed, sex and age.

ED consumption data: definition of ED consumption, prevalence in percentage (%) of ED consumption and consumption temporality (i.e. daily, weekly, monthly, yearly, ever, occasionally, regularly or other).

Prevalence of ED consumption was described according to their temporality data, globally and differentiated by sex (if specified). Characterisation of the consumers was recorded from multivariate analysis that established ED consumption as the dependent variable. Discrepancies in eligibility, data interpretation and extraction were discussed and settled by consensus. Data were grouped by population study group.

2.4. Assessment of quality

Study quality was evaluated using an adaptation of the Newcastle-Ottawa scale.¹⁷ Adjustments were made to the scale to suit the methodological design and particularities of the studies included in the current review. This adaptation enabled assessment of specific aspects of the included studies, such as data collection methods, the definition and characterisation of ED consumption, and the stratification of ED prevalence, which are not fully addressed by the original scale (Table S3). Each study was screened by two independent researchers and discrepancies were addressed through consensus with a third researcher.

3. Results

The search strategy yielded 1663 articles, with 1283 remaining after removal of duplicates. After screening by title and abstract, 360 studies were assessed for eligibility by reading the full text. Of these, 227 fulfilled the inclusion criteria. A further 124 articles were identified by citation searching, of which 87 were included. Finally, 314 studies fulfilled the inclusion criteria. In this review, 91 studies conducted in North America were included (Fig. 1).

3.1. General characteristics of the studies

Of the 91 included studies, 74 were carried out in the US, 14 in

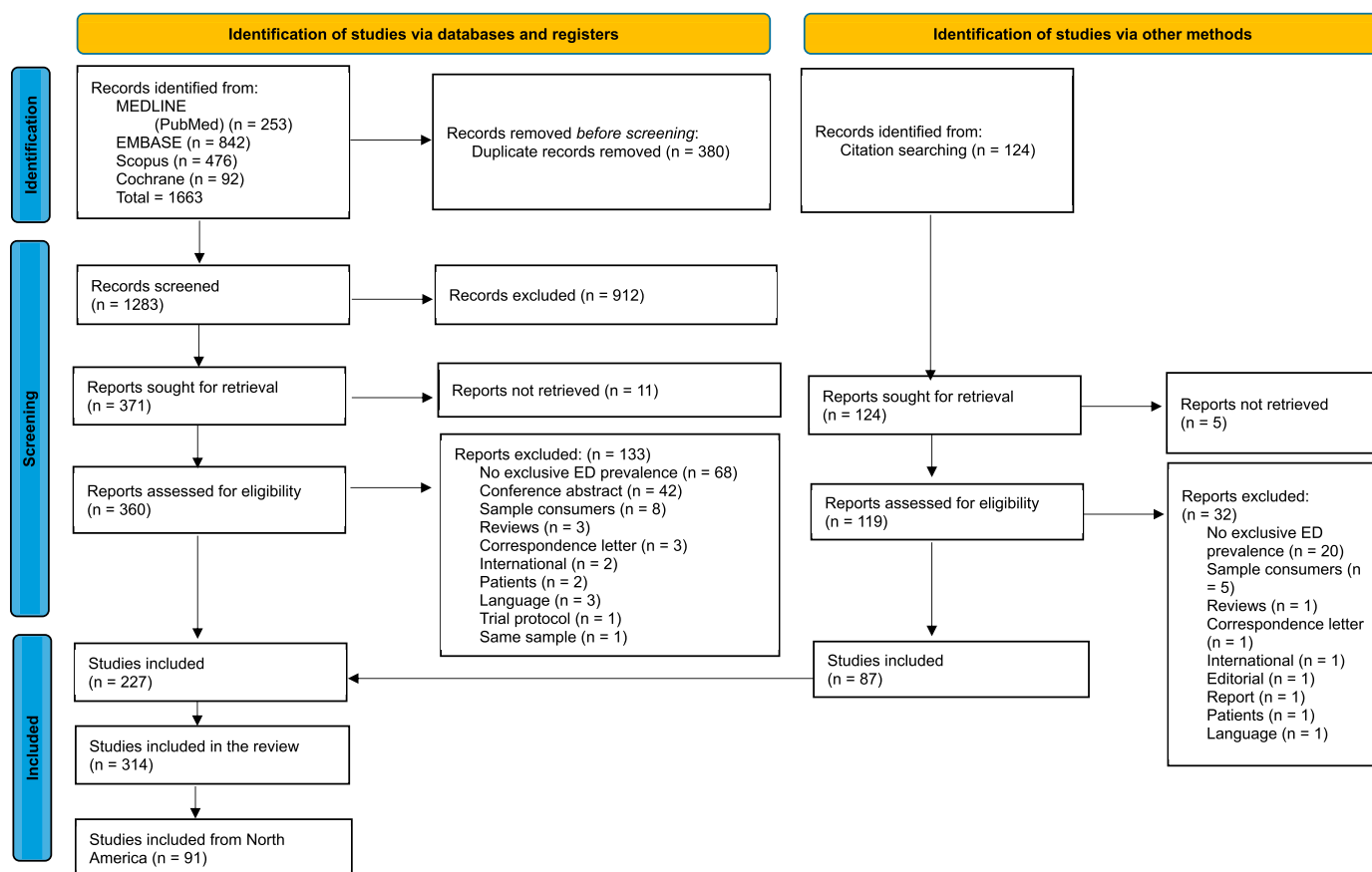


Fig. 1. Flow diagram of studies included.

Canada and three in Mexico. Studies were published from 2006 to 2023 and were conducted between 2001 and 2020. In 59 of the studies (64.8 %), the main objective focused on ED prevalence consumption of the study population. In total, 36 % ($n = 33$) of the studies focussed on university students, 26.4 % ($n = 24$) included only high school students and 18.7 % ($n = 17$) were conducted in the general population. Ten studies were conducted among military personnel (11.0 %) and five among athletes (5.5 %). One study reported ED prevalence from two different cohorts separately (university students and the general population) and is therefore recorded in both categories.¹⁸ Three studies were conducted among specific populations (anaesthesiologists, nurses and musicians).^{19–21} The main characteristics of each study are presented in Table S4 and the reference for each can be found in Table S5. Details on prevalence estimates for each study can be found in Table S6.

3.2. Quality of the included studies

In total, 71 studies were classified as ‘low quality’ and 20 as ‘moderate quality’. Bias was most frequently observed in sample selection/strategy and comparability, as the association between ED consumption and potential confounders was not usually addressed. In 54 of the studies, the study population was neither representative nor sampled (Tables S3 and S7).

3.3. University student studies

Of the 33 studies among university students, one was a cohort study²² and the others were cross-sectional studies. Only one study had national scope.¹⁸ Eight studies were conducted at a regional/state level, while 24 were conducted locally. Two studies were conducted through face-to-face interviews, 15 deployed self-administered paper

questionnaires and 13 used online questionnaires. Three studies provided no information about the type of survey used (Table S4).

The majority of the studies estimated prevalence to weekly or monthly ED consumption (15 and 16 studies, respectively). Weekly ED consumption ranged from 9.1 % to 63.8 % and monthly consumption ranged from 20.0 % to 86.8 % (Table 2).

Ten studies included characterisation of ED consumers. Five studies found that males were more likely to consume ED than females. Associations of ED consumption with ethnicity were not consistent among included studies. Six studies showed ED consumption was more frequently associated with use of alcohol, tobacco, marijuana and prescription drugs (such as stimulants and analgesics) (Table S8).

3.4. High school student studies

Of the 24 studies conducted among high school students, 19 were cross-sectional and five were cohort studies. Eight studies investigated ED consumption at a national level and nine at a regional level. The remaining seven studies were conducted locally. Fourteen studies included participants aged 12–19 years, while six included participants aged 7–12 years. The remaining studies did not state the age range of participants. In five studies, ED consumption data were recorded through online questionnaires. In six studies, questionnaires were administered during classes. Twelve studies reported using self-administered questionnaires and one study did not report the method in which information was recorded (Table S4).

Daily ED consumption was estimated in seven of the studies and varied between 1.1 % and 35.0 %. Weekly ED consumption ranged from 4.9 % to 20.3 % (Table 2).

Five studies characterised ED consumers. ED consumers were more likely to be male, and two studies showed an association with being of

Table 2
Energy drink (ED) prevalence estimates presented by their population group.

Studies reporting	Temporality						
	Daily	Weekly	Monthly	Yearly	Ever	Occasionally	Regularly
University student studies (n = 33)							
Global ED prevalence estimates (n of total)	4 of 33	15 of 33	16 of 33	5 of 33	6 of 33	1 of 33	1 of 33
Global ED prevalence (range)	2.6 %–29.1 %	9.1 %–63.8 %	20.0 %–86.8 %	36.4 %–86.0 %	24.9 %–81.4 %	25.0 %	9.0 %
Female ED prevalence (range)	0.5 %–12.1 %	14.3 %–29.5 %	18.0 %–42.0 %	34.7 %	46.6 %	NS	8.0 %
Male ED prevalence (range)	7.0 %	18.6 %–73.5 %	24.0 %–60.4 %	36.4 %–46.9 %	43.5 %	NS	10.0 %
High school student studies (n = 24)							
Global ED prevalence estimations (n of total)	7 of 24	11 of 24	4 of 24	4 of 24	3 of 24	2 of 24	4 of 24
Global ED prevalence (range)	1.1 %–35.0 %	4.9 %–20.3 %	10.4 %–28.3 %	27.8 %–62.2 %	14.6 %–64.3 %	12.8 %–14.0 %	14.9 %–59.0 %
Female ED prevalence (range)	NS	5.7 %–15.6 %	35.1 %–41.0 %	24.8 %–31.4 %	30.5 %–71.4 %	NS	12.5 %
Male ED prevalence (range)	NS	9.8 %–25.2 %	22.6 %–45.0 %	29.6 %–41.1 %	44.7 %–70.2 %	NS	17.1 %
General population studies (n = 17)							
Global ED prevalence estimations (n of total)	5 of 17	5 of 17	4 of 17	3 of 17	7 of 17	0 of 17	0 of 17
Global ED prevalence (range)	0.1 %–10.2 %	8.5 %–18.8 %	17.4 %–86.8 %	10.8 %–26.3 %	19.6 %–75.4 %	NA	NA
Female ED prevalence (range)	4.4 %	12.2 %–12.6 %	NS	NS	NS	NA	NA
Male ED prevalence (range)	2.0 %–8.3 %	19.7 %–26.7 %	NS	NS	39.5 %	NA	NA
Military personnel studies (n = 10)							
Global ED prevalence estimations (n of total)	4 of 10	7 of 10	3 of 10	0 of 10	1 of 10	0 of 10	0 of 10
Global ED prevalence (range)	12.0 %–44.8 %	25.4 %–42.9 %	21.1 %–53.0 %	NA	76.7 %	NA	NA
Female ED prevalence (range)	NS	16.8 %–19.5 %	33.0 %	NA	67.0 %	NA	NA
Male ED prevalence (range)	NS	29.9 %–31.3 %	56.0 %	NA	81.0 %	NA	NA
Athlete population studies (n = 5)							
Global ED prevalence estimations (n of total)	0 of 5	0 of 5	2 of 5	1 of 5	1 of 5	0 of 5	0 of 5
Global ED prevalence (range)	NA	NA	22.9 %–39.0 %	80.1 %	14.4 %	NA	NA
Female ED prevalence (range)	NA	NA	NS	74.2 %	8.0 %	NA	NA
Male ED prevalence (range)	NA	NA	NS	84.0 %	21.0 %–23.1 %	NA	NA

NA: not applicable; NS: not specified.

Hispanic ethnicity. Variables conferring a higher likelihood of ED consumption were the use of alcohol, tobacco and marijuana (Table S8).

3.5. General population studies

In total, 17 studies estimated ED consumption prevalence in the general population. Of these, 16 were cross-sectional studies and one was a cohort study.²³ Ten studies had a national scope, three were regional and four were local studies. Ten studies included children and adults. Two studies conducted face-to-face interviews and two conducted telephone interviews. Five studies used self-administered questionnaires and eight studies administered online questionnaires (Table S4).

Seven studies estimated ever ED consumption prevalence. In this case, ED prevalence ranged from 19.6 % to 75.4 %. Daily and weekly ED consumption were reported in five studies and showed wide ranges of prevalence data (Table 2).

Five studies characterised ED consumers. All studies found that ED consumers were more likely to be males. In terms of ethnicity, Black, African American or Hispanic population groups showed an increased likelihood of ED consumption in four studies. One study found that having a body mass index (BMI) ≥ 25 kg/m² was associated with a higher likelihood of ED consumption. The same study found an association of ED consumption with use of tobacco, e-cigarettes, binge drinking, marijuana and other unspecified illegal drugs (Table S8).

3.6. Military personnel studies

Among the 10 studies involving military personnel, all were cross-sectional studies from the US. There were two studies that only included male participants. Four studies recorded ED consumption using a self-administered questionnaire, four studies used online questionnaires and two studies did not report the method of data collection (Table S4).

Seven studies estimated weekly ED consumption and the prevalence ranged from 25.4 % to 42.9 %. Only one study estimated ever ED consumption, showing a global prevalence of 76.7 % and male prevalence of 81.0 % (Table 2).

Four studies characterised ED consumers. All studies found that ED consumption was more likely with a decrease in age. As BMI increased, military personnel were more likely to be ED consumers. Tobacco and alcohol use were associated with an increased likelihood of ED consumption (Table S8).

3.7. Athlete population studies

Five studies assessed ED consumption related to enhanced sport performance. All studies were of cross-sectional design. Three studies included university students who participated in college sports or were college athletes. Of these, one included university athletes from all over the US, while the other two studies had a regional or local scope. Another study was conducted among college sport trainers and one included current and former baseball players. Almost all studies were conducted using online questionnaires and one study reported using a self-administered questionnaire without any other specification (Table S4).

ED consumption was estimated by monthly, yearly and ever consumption. The study that only included male baseball players estimated an ever ED consumption of 21 % (Table 2).

Characterisation of ED consumers was not included in any of the studies assessing athlete population.

4. Discussion

This study highlights the fact that ED consumption is highly prevalent in North America. In addition, the results show that the prevalence of ED consumption was heterogenous, mainly because of the variability among the included studies regarding study design, study population, measurement methods and definitions of consumption. Most of the studies included in the review were cross-sectional; therefore, ED prevalence estimates are associated to a specific time point. Only 7 of the 91 articles included reported results from cohort studies. Different study populations had different demographic and sociocultural characteristics, which may impact ED consumption. Assessment of ED consumption was conducted using different methods, from face-to-face interviews to online questionnaires. The studies also employed a variety of definitions

of ED consumption based on diverse time frames of evocation, from daily to lifetime consumption. Some studies did not limit their definition to a specific time frame, but used approximations of frequency based on imprecise criteria such as occasional or regular consumption. These discrepancies hinder the comparison of the prevalence estimates of ED consumption.

4.1. Quality of the studies included

The included studies showed low to moderate quality; thus, reducing the certainty of the estimations due to methodological shortcomings. Lack of a representative sample of the study population is one key aspect, with only 23 % of all the studies and 35 % of the national studies being truly representative. National estimates of ED consumption enable the formulation of evidence-based public health decisions.²⁴

Another important methodological limitation was how ED consumption was ascertained. In 48 % of the studies, self-administered questionnaires were used and 38 % used online questionnaires. Self-administered data are often argued to be unreliable as they are prone to bias.²⁵ Additionally, studies commonly failed to mention which specific questionnaires and surveys were used or if the questionnaires were validated. In addition, ED-related questions were not uniform among the different questionnaires. Furthermore, most of the studies did not include a precise definition of ED consumption and failed to record the level of that consumption (data not shown). As with other foods, beverages and substances,^{26,27} it is important to standardise how to ask about ED consumption to improve the quality of these studies and their estimates. Currently, there is no standard questionnaire or survey to assess ED consumption.

4.2. Prevalences of ED consumption

The current results show a wide variety of ED consumption temporalities assessed, even within each set of studies on a specific population. In addition, between the temporalities, the range of ED prevalence estimates was broad. The diversity provided by the temporalities is an important issue hampering analysis; it cannot be considered the same to have consumed an ED throughout a lifetime as to be a daily consumer. This variability made it impossible to reach a conclusion about the real prevalence of ED consumption. Nevertheless, the existence of studies estimating prevalences of weekly or monthly ED consumption >60 % is concerning.^{18,28,29} This is particularly troubling given that these estimates come from studies of university students, a population specifically targeted by ED marketing strategies.^{12,13}

Similarly, high prevalence of weekly or monthly ED consumption was observed among military personnel. Several studies have shown that due to their specific duties, ED consumption was associated with maintaining their physical performance after sleep deprivation and improving their mental alertness and mental endurance.³⁰ Consumption of these drinks is part of an accepted 'cultural norm' within the military.³¹

4.3. Characteristics of the consumers

In most of the included studies that characterised ED consumers, an association was found between ED consumption and consumption of other substances. Alcohol, tobacco and marijuana or cannabis use were associated to an increased likelihood of ED consumption. This co-consumption has been reported in other studies^{2,9,12} and is a cause for concern, especially among adolescents and young people. Additionally, one study found a predictive probability of alcohol, tobacco and cannabis use among high school students who consumed ED compared to those who did not use them. This suggests that, in general, adolescents who consume ED have a higher risk of consuming such substances.³² Given the known consequences of alcohol, marijuana and tobacco use and the possibility of their co-consumption with ED, high prevalences of

ED consumption should not be underestimated.

It is possible that ED could be a gateway to alcohol consumption for adolescents who have not yet tried alcohol.¹² Some studies have reported an association between ED consumption and early initiation of alcohol use. Initiation of risky behaviours during adolescence are predisposing factors to continue with these habits during adulthood and becoming dependent on them.^{8–10,12} The combination of alcohol and ED often reduces users' perception of intoxication, as caffeine (a stimulant) masks the depressant effects of alcohol.^{8,11} This could result in an overestimation of the ability to perform activities that require fine motor skills, such as driving.³² Given the risks, ED consumption in this vulnerable population should be closely monitored, and public health strategies should be implemented to address the issue.

4.4. Implications for policymakers

Several European countries have implemented regulations to address concerns about ED consumption among young people. Lithuania, Latvia and Poland have banned ED sales to minors.^{33,34} In North America, regulatory measures are limited, with some regulations in Canada and Mexico, although not specific to ED. In 2014, the American Beverage Association published a guide encouraging ED companies to report caffeine quantities, limit marketing to children and report adverse events to the FDA.^{5,35} However, the 'Buzz Kill Report', a study commissioned by Senators Markey, Durbin and Blumenthal, revealed that most companies were reluctant to adopt these measures to protect young people from ED consumption.¹⁴ In the US, proposals to regulate ED are under discussion, and cities like Berkeley and Philadelphia have imposed taxes on sugar-sweetened beverages (SSB), including ED, with mixed results. For example, the tax imposed by Berkeley reduced sugary drink consumption by 25 %, while in Philadelphia the tax did not lead to significant reductions in sales.^{36,37} Connecticut will implement a ban on ED sales to minors aged <16 years in 2025.³⁸ Given the high prevalence of ED consumption among adolescents and the potential health risks, targeted measures and further research are needed to address this public health concern effectively.

4.5. Strengths and limitations

While the protocol was oriented towards estimating the worldwide prevalence of ED consumption, the present review is focused on North America studies. This decision was made, firstly, because the consumption of ED is intricately linked to the demographic and sociocultural particularities that characterise each region, and secondly, to manage the large number of studies included. In the context of North America, where the regulatory landscape concerning ED has a paucity of regulations, it is of interest to determine the characteristics of ED consumption in the region. For this reason, classification by continent is a rational approach to gain more valuable insights to be used at the regional level by different stakeholders.

Due to the great variability in the temporalities that were used to assess ED consumption, it was not possible to determine the exact prevalence of ED consumption in North America. Nevertheless, this review provides a valuable insight into the significant variability in the approaches used to estimate ED consumption. The decision was made to prioritize peer-reviewed articles and not to consider grey literature. While grey literature is being considered in other public health reviews,^{39,40} the substantial number of articles from peer-reviewed journals included in this review was expected to provide sufficient information of considerable quality. Unfortunately, a number of records could not be retrieved, despite employing a variety of search methods. Nevertheless, of the 11 records not retrieved, only two were from North America. With this exception, the likelihood of missing information was minimal. Given the large number of articles identified, a considerable number of researchers participated in the review. To avoid errors and differences in data extraction, two researchers supervised the process,

set standards and reached consensus. The quality of the studies was explored using a validated scale that was adapted to better align with this study and confer a rigorous methodology.¹⁷ Finally, the characterisation of ED consumers provides crucial information for addressing and/or designing strategies in relation to ED.

4.6. Conclusion

The assessment of ED consumption is highly heterogeneous. Nevertheless, the results of this review show that consumption of ED is widely prevalent, especially among the younger population. The association between ED consumption and the use of other substances, such as alcohol, tobacco and marijuana or cannabis, should not be underestimated. This review provides information to help guide and design appropriate public health measures and strategies.

Author statements

Ethical approval

No ethical approval was needed for this study, as it is a systematic review.

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Competing interests

The authors do not have any conflict of interest.

Data availability

The data used in this study are publicly available.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2025.02.035>.

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