



OPEN ACCESS

EDITED BY
Pradeep Nair,
Central University of Himachal Pradesh, India

REVIEWED BY
Yunting Zheng,
Fujian Medical University, China
Rizanna Rosemary,
Syiah Kuala University, Indonesia

*CORRESPONDENCE
Rui Zhang
✉ 2088690453@qq.com

RECEIVED 30 March 2023
ACCEPTED 09 November 2023
PUBLISHED 05 December 2023

CITATION
Chan K-S, Xu J, Zhang R, Pang PC-I, Chen Y,
Zhang H, Liu S, Mao A, Pu G and Au JKf (2023)
The impacts of tobacco control legislation on
public view of e-cigarette usage in Macao—The
co-word analysis of Macao daily.
Front. Commun. 8:1196744.
doi: 10.3389/fcomm.2023.1196744

COPYRIGHT
© 2023 Chan, Xu, Zhang, Pang, Chen, Zhang,
Liu, Mao, Pu and Au. This is an open-access
article distributed under the terms of the
[Creative Commons Attribution License \(CC BY\)](https://creativecommons.org/licenses/by/4.0/).
The use, distribution or reproduction in other
forums is permitted, provided the original
author(s) and the copyright owner(s) are
credited and that the original publication in this
journal is cited, in accordance with accepted
academic practice. No use, distribution or
reproduction is permitted which does not
comply with these terms.

The impacts of tobacco control legislation on public view of e-cigarette usage in Macao—The co-word analysis of Macao daily

Kin-Sun Chan¹, Jing Xu², Rui Zhang^{1*}, Patrick Cheong-lao Pang³,
Yu Chen², Heng Zhang¹, Shiyu Liu⁴, Aimei Mao⁵, Guanwen Pu¹
and Johnny Ka fai Au⁶

¹Faculty of Social Sciences, University of Macau, Macao SAR, China, ²School of Journalism and Communication, Peking University, Beijing, China, ³Faculty of Applied Sciences, Macao Polytechnic University, Macao SAR, China, ⁴Global Health Institute, School of Public Health, Xi'an Jiaotong University, Xi'an, China, ⁵Education Department, Kiang Wu Nursing College of Macau, Macao SAR, China, ⁶Smoking Abstinence and Good Health Association, Macao SAR, China

Introduction: Macao has been certified as a “Healthy City” by the World Health Organization, and has been adhering to the principle of combining prevention with proper medical care to build its medical system. As tobacco epidemic is a risk factor leading to a series of non-communicable diseases, the Macao SAR Government has continuously improved tobacco control measures.

Methods: The data for this study were derived from a news report on “e-cigarettes” published in Macao Daily. Co-word analysis and thematic analysis were conducted to analyze the development of tobacco control legislation against e-cigarettes. Co-word analysis examined the association and frequency of keywords, while thematic analysis identified prevalent themes within the data.

Results: The study identified three stages of legislation against e-cigarettes: the pre-implementation stage, the early implementation stage, and the epidemic period. Each stage exhibited distinct characteristics and attention toward specific groups, particularly “teenagers” and “students,” increased significantly. Thematic analysis further highlighted the potential issues of drug use and smuggling associated with e-cigarettes.

Discussion: The findings suggest that the Macao SAR Government should prioritize the development of healthy behaviors among adolescents in the context of e-cigarette control. Additionally, considering regional cooperation to promote the “Healthy Bay Area” could be beneficial. Social media platforms and effective data management should be utilized as tools in these efforts.

KEYWORDS

Macao SAR China, e-cigarette, new tobacco control law, co-word analysis, thematic analysis

1 Introduction

At the 7th Conference of the Parties to the Framework Convention on Tobacco Control, the World Health Organization (WHO) proposed to face up to the harm of electronic cigarettes, and called for restricting or prohibiting the manufacture, import, distribution, sale and use of electronic cigarettes. With WHO MPOWER strategy, including monitoring, preventing, quitting smoking, warning, banning tobacco propaganda and raising tobacco tax, provides the guiding strategy to regulate traditional tobacco all over the world. Banning smoking can directly and effectively reduce the proportion of smokers, reduce the harm of second-hand and third-hand cigarettes, and help reduce the incidence of other associated behaviors caused by smoking, such as alcoholism and drug

addiction (Weinberger et al., 2017). The global usage rate, especially in the United States, Europe and Asia, is rising rapidly (Park-Lee et al., 2021). In 2014, the global sales of e-cigarettes were 27 billion, which has soared to 150 billion dollars by 2019. In order to attract more new customers, manufacturers actively promote e-cigarettes to the public actively, especially teenagers (Carroll et al., 2016). At the 7th Conference of the Parties to the WHO Framework Convention on Tobacco Control, it was proposed to face up to the harm of electronic cigarettes, calling on all countries to restrict or prohibit manufacturing, import, distribution, sale and use of electronic cigarettes.

In Healthy China 2030, the state has put forward the goal of to reduce the proportion of smokers over 15 years old to 20% (Tan et al., 2017). With the increasing turnover of people in Guangdong-Hong Kong-Macao Greater Bay Area, the current tobacco control policy can no longer start from the angle of “being independent.” Instead, the policies should take the smoking control service methods and management in neighboring areas into consideration as a whole, and to learn from each-others’ strengths points to improve the smoking cessation services and related processes in Macao. COVID-19 pandemic impacts on most social activities, including education and employment, in the World, and Macao has no exception. Clearly during the pandemic, the SAR Government has just lost an effective way to implement the anti-e-cigarette legislation against Macao youths. The low mortality rate shows that the public health system of China and Macao is at the leading level in the World. Smoking is an important public health issue drawing the public’s attention. With the rising prevalence of electronic cigarette usage and the beautification of electronic cigarettes, young people are more likely to use electronic cigarettes. Therefore, the Central Government of China, the Macao SAR Government, and the Hong Kong SAR Government have already enacted legislation on the cessation policy on electronic cigarettes.

Being recognized as a “Healthy City” by the World Health Organization, the Macao SAR Government adheres to the tobacco control policy recommended by the WHO, promoting MPOWER comprehensive tobacco control measures. The effectiveness of comprehensive tobacco control policies has been demonstrated. The Macao SAR Government based on the principle of New Public Management to deliver public administration reform, so the Macao SAR Government has already introduced various measures, like ISO certification, performance pledge and satisfaction survey. It can be seen that the direction of Macao’s public administration reform has gradually been in line with WHO recommendation and the world, which provides very favorable conditions for Macao to improve its smoking control efforts.

2 Literature review

2.1 The world trend of e-cigarette research

In the WHO Global Tobacco Epidemic Report 2021, it is mentioned that there are 111 countries that control e-cigarettes in different ways, of which 32 countries (covering 2.4 billion people) prohibit the sale of e-cigarettes, and the other 79 countries have taken one or more legislative measures (World Health Organization, 2021). Among the countries that prohibit the sale

of e-cigarettes, 18 are middle-income countries. Although many countries have control measures for e-cigarettes, there are still 84 countries still have no laws and regulations on e-cigarettes. These countries are more vulnerable to the tobacco industry and related industry activities. At present, only 30 countries completely ban E-cigarettes. E-cigarettes are used in all indoor public places, workplaces and public transportation. At present, there is no universal way to control e-cigarettes in the world, and different countries have different ways to levy taxes on e-cigarettes (World Health Organization, 2010). Teenagers, whether using traditional tobacco or new e-cigarettes, are the focal point of social concern (Jongenelis et al., 2018). About 2.6% of teenagers aged 13–15 reported that they are currently using smokeless tobacco products. Related studies also revealed studies that the use of e-cigarettes in adolescence may lead to smoking in the future (Barrington-Trimis et al., 2018). E-cigarettes are rapidly flocking to the market in various forms, and the characteristics of these products are becoming more and more difficult to describe. Tobacco regulation has presented numerous challenges, and false advertising has even influenced the smoking habits of teenagers (Yoong et al., 2021).

Advertising and internet are important ways to influence the cognition of e-cigarettes (Stroup and Branstetter, 2018). Some studies have already shown that advertising is an important regulating factor for the public’s cognition toward e-cigarettes. A study investigating the correlation between the perception of harm from e-cigarette advertising and susceptibility to using e-cigarettes revealed that while advertising does have some impact on e-cigarette usage, accurate advertising has played a crucial role (Madison et al., 2020). For youth groups, the internet is an important way to influence their cognition and behavior (Perikleous et al., 2018; Wagoner et al., 2022). In a multiple logistic regression study on the use of electronics by teenagers in Shanghai (Dai et al., 2022), it was found that the proportion of e-cigarette information from the Internet is as high as 42.4%. In addition, movies/TV, advertising columns, advertising leaflets and peers are all sources of learn e-cigarette information. It can be seen that it is important to improve the network for the use of electronic cigarettes. For those who have never used e-cigarettes, there is a certain deviation in their understanding of e-cigarettes. For example, they think that using e-cigarettes will make them feel good and reduce boredom and stress. These erroneous expectations have indeed led to the behavior of smoking e-cigarettes afterwards. E-cigarette content on social media promotes the taste of e-cigarette, and false publicity such as traditional cigarettes is wrong guidance for teenagers (Sun et al., 2018; Pokhrel et al., 2021).

2.2 Development of e-cigarette control in Macao

In the WHO report, it is worthy-mentioned that electronic cigarettes may cause lung damage, and long-term use will have adverse effects on the lungs. The Central Government of China and the Municipal Governments also attach great importance to the problem of youth smoking. As shown in the Table 1, the Law on the Protection of Minors involves the relevant regulations on e-cigarettes, which is the first time that the national law explicitly

TABLE 1 Development of e-cigarette control in Macao.

2015	The Health Bureau reiterated that electronic cigarettes contain poison, not tobacco substitutes.
2016	Customs investigated and dealt with smuggling of electronic cigarettes.
2017	Law 9/2017 amended Law 5/2011 “System of Prevention and Control of Smoking”, which would be implemented on January 1, 2018.
	The Health Bureau visited Macao associations to promote the revised New Tobacco Control Law.
2018	The revised New Tobacco Control Law was implemented on January 1, 2018. The law defines electronic cigarettes, prohibits the sale of electronic cigarettes and tobacco products for oral or nasal inhalation, prohibits any form of advertising and promotion of tobacco, tobacco products and electronic cigarettes, and those who sell electronic cigarettes or tobacco products for oral or nasal inhalation will be fined MOP 4,000.
2019	The Macao Health Bureau held the online prize-winning quiz “Recognizing the Harm of Electronic Cigarette” to publicize the harm of electronic cigarette and tobacco products to the general public (especially teenagers), so as to reduce their contact or use of electronic cigarette and correct their wrong ideas.
2020	The Health Bureau held an online prize-winning quiz to publicize the hazards of electronic cigarettes to the public.
	The Health Bureau holds a series of activities to quit smoking, hoping that all people would quit smoking.
2021	The Health Bureau completed the 5th Survey on Tobacco Use among Adolescents in Macao, and the survey results showed that the use rate of e-cigarettes was higher than that of cigarettes, and adolescents faced the threat of e-cigarettes.
	Completed the follow-up and evaluation report 2018–2020 of the Health Bureau’s “Smoking Prevention and Control System”, and mentioned the basic content and future control methods of e-cigarettes of Macao government.
2022	The Health Bureau advised residents not to use electronic cigarettes to prevent COVID-19 virus infection.
	On August 29th, the plenary session of the Legislative Council of the Macao Special Administrative Region passed the Amendment of Law No. 5/2011 on the Prevention and Control of Smoking, which would prohibit the manufacturing, distribution, sale, import and export of electronic cigarettes and tobacco products for oral or nasal inhalation, including the prohibition of carrying such products out of the country and into the country.

Reference: News and related reports of the Health Bureau of Macao SAR Government.

prohibits the sale of e-cigarettes to minors. Macao implemented the revised “New Tobacco Control Law” in 2018 to add control over electronic cigarettes, defining electronic cigarettes as products with or without nicotine inhalation through cigarette holders, or any components of such products, including cigarette cartridges, storage boxes and devices without cigarette cartridges. Heated tobacco products share the characteristics defined for electronic cigarettes in Australia; thus, both the electronic heating device and the tobacco products should be classified as “electronic cigarettes.” In Macao, forbids the sale of electronic cigarettes and tobacco products for oral or nasal inhalation, prohibits any form of advertising and promotion of tobacco, tobacco products and electronic cigarettes, and imposes fines for violations. Then, the harm of e-cigarettes and tobacco products is publicized to the public by holding lectures, quiz games and other forms. The public, especially teenagers, are told about the correct concept of e-cigarettes. A total of 1,820 students from 25 schools in Macao were surveyed in the Survey on Tobacco Use among Youth in Macao published in 2021. A survey of tobacco use among students aged 3 to 15 shows that although the proportion of using traditional tobacco has decreased, the use rate of e-cigarettes is 4.0%, which is higher than 2.6% in 2015. Studies show that many students mistakenly believe that e-cigarettes are helpful for quitting smoking, which is a new challenge for the future tobacco control work of Macao Government. In 2018–2020, the follow-up and evaluation report of “Smoking Prevention and Control System” published in the same year mentioned the basic contents and future control methods of e-cigarettes, indicating that the publicity and education on the hazards of e-cigarettes will be strengthened in the future.

The paper adopts agenda-setting as a theoretical framework to examine the presentation and the distribution of e-cigarette-related

news in the most popular local newspaper, Macao Daily, in the three different periods, namely stage I – pre-e-cigarette regulation (2014–2017), stage II – e-cigarette regulation in effect (2018–2019), and stage III – COVID-19 pandemic (2020–2022). For instance, in the first phase, e-cigarettes were not a focal point of government policy. However, in the second phase, the government took notice of the impact of e-cigarettes on the health of Macao residents and subsequently introduced specific policies for regulation. Moving into the third phase, due to Macao’s unique geographical position, the government engaged in policy competition in the realm of e-cigarette regulation.

3 Methods

3.1 Data collection

The contents of this article come from Macao Daily, a representative authoritative newspaper in Macao, and collects relevant news containing “e-cigarette” as the key word. Drawing from the literature review, the New Tobacco Control Law, which Macao SAR officially enacted in 2018, included electronic cigarettes. Newspapers are divided into 3 stages (2014–2017, 2018–2019, and 2020–2022) to deal with news content. Before 2014, there was no news about e-cigarettes.

1. Stage i (2014–2017): 2014 was taken as the starting year of news collection.
2. Stage II (2018–2019): in 2018, the Macao government implemented the revised new tobacco control law, officially writing the control of e-cigarettes into the law.

3. Stage III (2020–2022): in 2020, a large-scale outbreak of e-cigarettes broke out in COVID-19, and the attention to e-cigarettes gained a new perspective.

3.2 Data processing

As far as research methods are concerned, at present, most articles about e-cigarettes use questionnaires as research methods, and the use of e-cigarettes is known through regression analysis. As a mass media, the news content can influence the decision-making of policy makers, and the news coverage of public interest stories and the public opinion reaction can influence the government's policy behavior (Patterson et al., 2016; Pang et al., 2022). At the same time, the government can better convey its policies to the public through news and newspapers. This paper collects the co-words and themes of "e-cigarette" in Macao Daily, the most representative newspaper in Macao, and puts forward some suggestions on the basis of understanding the attitude of the Macao SAR government toward e-cigarette and the society's perception of e-cigarette. This paper adopts the text analysis method of natural language processing-Co-word Analysis and Topic Modeling, two data processing methods of natural language.

Co-word analysis refers to observing the news focus by calculating the word frequency of key words, and calculating the eigenvector centrality. Eigenvector Centrality is a quantitative research method to reflect the importance and influence of words. The keywords with higher centrality values have more interconnections with other words with high centrality values, and therefore they can reflect important concepts in the news data. Thematic analysis refers to dividing key words in news into different topics by a certain calculation method. Experts in this field screen, examine and explain the common meanings of related key words, and make a general description of each topic. Keywords of the same category are represented by the same color in the semantic network diagram. At the same time, the research results of co-word analysis and topic analysis can be observed in the semantic network. Co-word analysis can know the key degree of a word by observing its position. The more it is in the center, the more related it is to other words, and the more frequently used it is. It is worth noting that although some words are at the edge of the semantic network graph, it only means that the centrality of the word is relatively low, but it does not mean that the word is a low-frequency word. These words have certain dependence on other words. In practice, such peripheral keywords can provide a more accurate reflection of the specific measures and directions mentioned in the news, offering valuable insights for the analysis in this paper. In general, co-word analysis allows us to identify key words in e-cigarette news. However, solely relying on these key words makes it challenging to establish meaningful connections between the different elements of the news content. The findings will be deliberated within a multidisciplinary research group, encompassing fields such as journalism, nursing studies, public administration, data sciences, and social work. Moreover, a local NGO, i.e., Macao Smoking Abstention and Good Health Association, was invited to join the research team and it provided us with solid practical experience in lobbying for smoking control

policy in Macao. This collaboration aims to bridge the gap between the research findings and practical applicability in the context of Macao.

4 Results

4.1 Co-words analysis

In this part, word frequency and feature vector centrality in three periods were compared. From the overall trend, before the implementation of the e-cigarette policy, it was mainly attached to the Tobacco Control Law revised in 2012. Although the news had searched for "e-cigarette" at that time, the feature vector centrality was only ranked in "Macao" and "Tobacco Control," which was only at the initial stage and during the implementation of the policy. However, the attention of "youth" is constantly increasing, and the word frequency of "youth" has increased from 170 times at the initial stage to 246 times during the period.

4.1.1 Stage I (2014–2017)

The key words are mainly Macao, tobacco control, e-cigarette, smoking, youth, tobacco, health, quitting smoking, government, and work. Among them, e-cigarette, Macao and smoking are the three keywords with the highest word frequency, and the words with higher eigenvector centrality are Macao, Tobacco Control and e-cigarette. It can be seen that e-cigarette has become one of the focuses of tobacco control in Macao, which reflects the same from high-frequency keywords. The eigenvector centrality of youth, tobacco, health, government and work is also high, which indicates that the health of youth is an important dimension of the key government work under Macao's control of smoking and electronic cigarettes.

4.1.2 Stage II (2018–2019)

The words with high word frequency include e-cigarette, Macao and teenagers, and they are also the keywords with the highest feature vector centrality. The word frequency of the above three keywords in the news is also much higher than that of the previous news, especially the increase of the key degree of the word "teenager" in word frequency and centrality is consistent with the susceptibility of teenagers to e-cigarettes in literature review.

4.1.3 Stage III (2020–2023)

Table 2 shows that the keywords in the last stage are similar to those in the previous stage, such as e-cigarette, Macao and youth, which are still high-frequency words and the top three words in terms of centrality. However, the difference is that the frequency of e-cigarette is higher, and compared with other keywords in the previous two periods, it can be seen that the attention paid to e-cigarette has increased during the pandemic period, which is related to the possible spread of e-cigarette and also reflected in the news content.

TABLE 2 Comparison of word frequency and eigenvector centrality in the three stages.

Keyword	Stage I		Stage II		Stage III			
	Word frequency	Eigenvector centrality	Keyword	Word frequency	Eigenvector centrality	Keyword	Word frequency	Eigenvector centrality
Macao	264	0.325	Electronic cigarette	487	0.486	Electronic cigarette	570	0.433
Control smoke	200	0.29	Macao	308	0.331	Teenagers	246	0.263
Electronic cigarette	256	0.277	Teenagers	198	0.268	Macao	176	0.204
Smoke	209	0.276	Tobacco	148	0.183	Health	169	0.173
Teenagers	170	0.262	Health	129	0.179	Macao	171	0.169
Tobacco	140	0.198	Control smoke	140	0.167	Government	152	0.165
Health	117	0.174	Smoke	128	0.155	Education	136	0.158
Give up smoking	122	0.171	Publicize	95	0.133	Student	117	0.154
Government	109	0.151	Harm	88	0.131	Harm	134	0.154
Work	75	0.117	Electron	Seventy-two	0.125	Strengthen	134	0.153

4.2 Thematic analysis

4.2.1 Stage I (2014–2017)

In the stage before the implementation of Macao’s e-cigarette policy, news content can be divided into seven categories according to the thematic analysis. As shown in Table 3, similar to the findings from the co-word analysis, there is an ongoing process of legislation regarding e-cigarettes. This aspect is crucial, and two key themes emerge: “legislative consideration” and “legislative influence.” These results align with the literature review and provide additional support to the co-word analysis. On the other hand, the enforcement of traditional tobacco control laws (“Law Enforcement Issues”) remains a focal point of attention. This research outcome is consistent with the co-word analysis results as well. Combined with the semantic network diagram of this stage (Figure 1), except electronic cigarettes, tobacco is still in the center of the network diagram, and casinos and smoking rooms with high correlation with traditional tobacco and grass appear in the network diagram. Some peripheral keywords such as “smoke-free health,” “region” and “WHO” on the semantic network map are all the achievements of Macao following the WHO tobacco control policy.

4.2.2 Stage II (2018–2019)

At this stage, e-cigarettes in Macao are in the early stage of legislation, and many e-cigarettes need to be implemented by associations (Table 4). The main body of “community tobacco control” is more clearly reflected in the second analysis. Similar to the result of co-word analysis, the publicity and education of e-cigarettes is the key work in the early stage of legislation. Schools and education are also reflected in the thematic analysis. Compared with the semantic network diagram of the previous stage, the government of this stage distinguishes e-cigarette from traditional tobacco, and the relationship between keywords is more concentrated. Publicity, students and education are also at the center of the network diagram, which shows that the attention to e-cigarette is more targeted (“Publicity and Education”). The news has repeatedly mentioned the definition, harm and specific control measures of e-cigarettes, citing that “the World Health Organization has not indicated that e-cigarettes are harmless and may threaten health,” and the Macao Government will also prohibit electronic sales (“Affect Electronic Cigarettes”). As for the use of e-cigarettes, Macao also shows that teenagers use more e-cigarettes. Keywords related to Macao’s social organizations, such as “society,” “association” and “Ou Jiahui,” also appear in the semantic network. For example, the intervention of Macao Smoking Abstinence and Good Health Association on the behavior of young people smoking e-cigarettes shows the positive role of Macao’s social organizations. In the past, “government-people cooperation” has always been a feature of Macao’s smoking control work, and it has won the title of “Healthy City.” Tobacco control is quite effective, and the future control of e-cigarettes also needs the cooperation of associations (“Community Tobacco Control”). The theme of “regional cooperation” can be regarded as a supplement to co-word analysis. Words such as “China” appear on the edge of the semantic network diagram (Figure 2), but they are also connected

TABLE 3 Summary of news topics of “e-cigarette” in Macao in the stage before law implementation.

Law enforcement issues	Smoking area setting	Legislative consideration	Publicity and education	Externality of smoking	Electronic cigarette supervision	Legislative influence
Smokers	Smoking area	The Health bureau	School	Secondhand smoke	Electronic cigarette	Modify
Enforce the law	Smoker	New tobacco control law	Student	Smoker	Nicotine	Strengthen
Bus stop	Total smoking ban	Tobacco	Publicize	Tobacco	Survey	Raise
Decrease	Government	Recreation ground	Smoking abstinence and good health association	Be Relevant	Supervision	Legislation
Avoid	WHO	Control of smoking	Education	System	Medicine	Legislative council
Authorities	Member of parliament	Smoking-free range	Information		Sell	Pass
Measure	Casino	Show	Teenagers			

with other keywords (“Regional Cooperation”). Through thematic analysis, these marginal words can be combined to observe the future control direction of e-cigarettes.

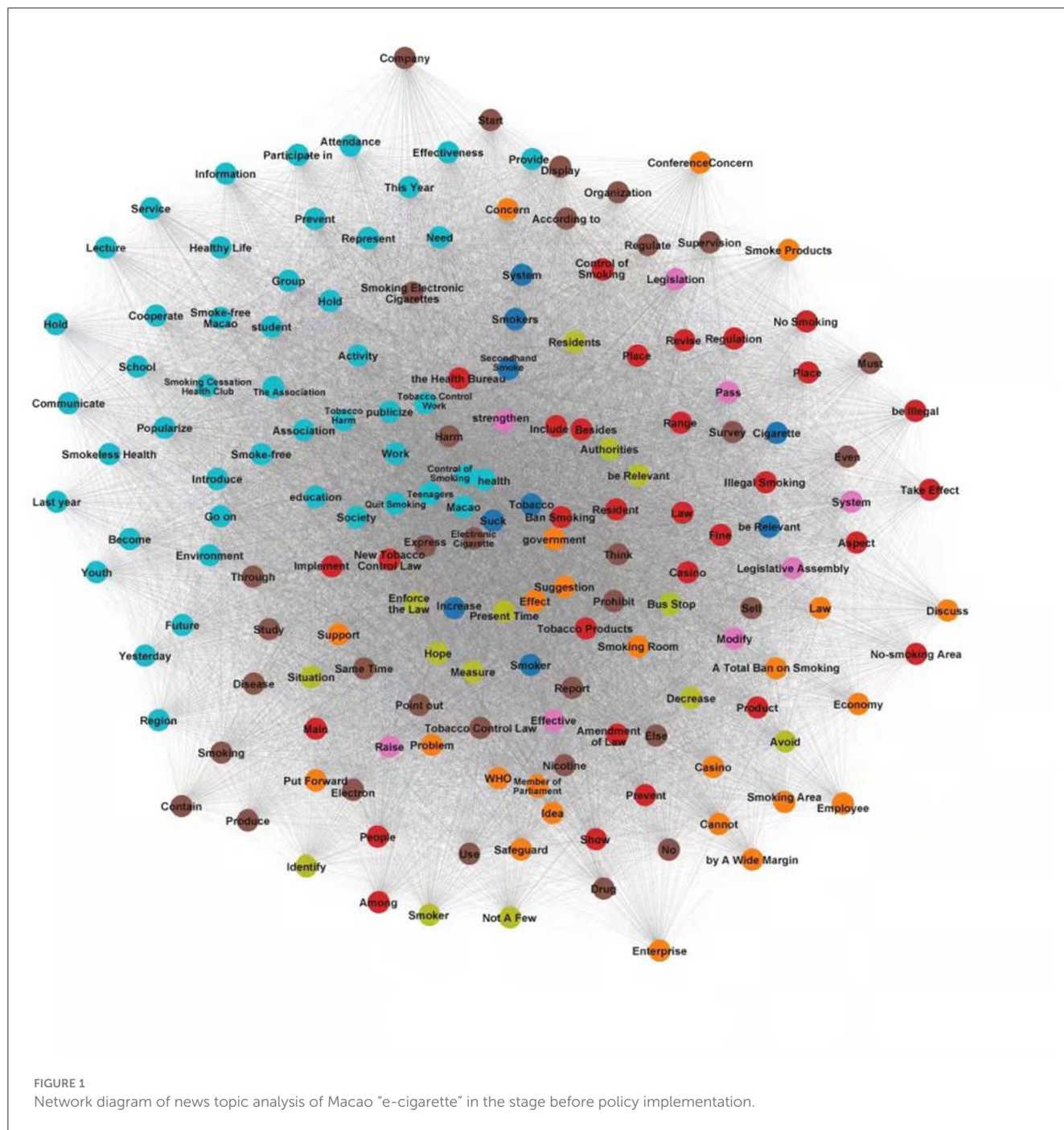
4.2.3 Stage III (2020–2022)

There are many new dimensions in this stage compared with to the earlier stage. What deserves more attention is that “drug addiction” has become the focus of attention. In particular, some cites have legalized marijuana and incorporated it into various products, leading to concerns regarding “Drug Addiction Problem.” Therefore, as shown in Table 5, some e-cigarettes are mixed with marijuana, which can lead to drug-related issues. Additionally, there are numerous keywords related to “customs control” involved in the analysis. It can be seen that e-cigarettes have been regarded as a regional problem and cannot be controlled only by the legislation and law enforcement of the Macao SAR Government (“Customs Control”). Nevertheless, the approach to address the issue of e-cigarettes among “teenagers” has become more sophisticated, with a clear division of “school family education” and “community propaganda.” Education related to this matter has expanded beyond schools to include families, and the propaganda efforts have become more targeted under the theme of “School and Family.” As Macao’s tobacco control policy has achieved certain results, the Macao SAR Government has paid more attention to the effectiveness analysis of related services. Combining the results of co-word analysis with the semantic network diagram, although the frequency and centrality of keywords in 2020–2022 are the same as those in 2018–2019, the semantic network diagram is obviously different. In the network diagram, the relationship between keywords is closer, and similar keywords such as teenagers, students, education, and schools are in the center of the network diagram, while related words such as courses and teachers also appear in the diagram. The news of e-cigarette regulation could catch the public’s attention more easily. After the sale of e-cigarettes was banned in Macao, many e-cigarettes entered Macao through the mainland, and the customs also investigated and dealt with many cases.

According to the results of thematic analysis, the theme of illegal smuggling would involves more keywords related to the Mainland’s semantic network map. At the later stage of this stage, the news also indicated that it would make legislative supplement to the illegal smuggling of electronic cigarettes into Macao. The society pays more and more attention to e-cigarettes (“Customs Control”). Through holding activities and lectures, we enter schools to publicize the harm of e-cigarettes to teenagers and warn them of the health problems caused by e-cigarettes. During the pandemic period (Figure 3), the risk of COVID-19 infection caused by the use of electronic cigarettes has become the focus of social attention, and the keyword pandemic situation also appears in the network map. By observing the semantic network diagram, we can find that the words “mainland” and “customs” appear on the edge. Back to the news content, we can find that in the process of managing e-cigarettes in Macao, smuggling e-cigarettes from the mainland has become the focus of social attention and has been questioned by Macao legislators.

4.3 Summary

In summary, co-word analysis and thematic analysis in the three stages constitute the primary components of e-cigarette regulation, with the semantic network diagram of the Government, the Health Bureau, and the New Tobacco Control Law holding a central position. With a growing emphasis on e-cigarettes, attention in the three stages has been steadily increasing, reflecting a shift from traditional tobacco regulation toward more targeted management. During this transition, social organizations and policymakers (including officials and Legislative councilors) play a crucial role in advancing the Government’s initiatives. Notably, social organizations are offering smoking control services to intervene in young people’s e-cigarette usage. Meanwhile, policymakers are urging the SAR Government to enhance its monitoring of illicit e-cigarette imports, contributing to the progress of creating smoke-free cities in Macao. Teenagers are a pivotal demographic requiring close attention regarding their e-cigarette usage. Based on the follow-up and evaluation report of



the Smoking Prevention and Control System from 2018 to 2020, the research indicates a concerning rise in the prevalence of e-cigarette use among teenagers. Many adolescents are purchasing e-cigarettes online. E-cigarettes can serve as a means to deliver drugs, as users may mix substances like marijuana into e-cigarette oil for consumption. This not only contributes to the development of smoking habits among teenagers but also leads to the formation of risk-taking behaviors, like alcoholism and drug addiction. Notably, during the early stage of policy implementation, the theme of “regional cooperation” emerged prominently in the thematic analysis. As the central city in the west of the Guangdong-Hong Kong-Macao Greater Bay Area and the theme city of the Hengqin

Macao Deep Cooperation Zone, Macao’s regional cooperation presents a significant opportunity for its future development. Leveraging lessons from national and bay power, it offers an important avenue to address the issue of electronic smuggling through customs.

5 Discussion

In China’s14th 5-Year Plan and Macao’s 2nd 5-Year Plan of, the direction of the social services development is put forward, and the electronic cigarettes regulation is also required to be

TABLE 5 Summary of news topics of “e-cigarette” in Macao during the implementation of the law.

Service effectiveness	School and family	Drug addiction problem	Customs control	Quit smoking	Community tobacco control	Adolescent tobacco control
World health	System	Electronic cigarette	Inspection	Healthy life	Community	Last
Publicity and education	Country	Enforce the law	Control smoke	Smoker	Work	Get in Touch with
Tobacco control work	School	Hemp	Prosecute	Quit smoking	Idea	Spread
Effect	Student	Drugs	Customs	Smoke-free Macao	Macao SAR	Aim at
New tobacco control law	Family	Ban smoking	The Health Bureau	Environment	Implement	Teenagers
Survey	Teacher	Online	Illegal	Cognition	Pay close attention	
Tobacco use	Education	Harm	Tobacco	Information		

professional and intelligent. According to the results of the study, the governments, including Macao SAR Government and neighboring municipal governments, and local social organizations play important roles in e-cigarette control and legislation. In order to deepen the impacts of the present achievements of the control, there are three suggestions to be provided.

5.1 The participation of Macao social organizations in e-cigarette control

Macao’s community organizations conducted smoking control work earlier than the SAR Government. The Macao Smoking Abstinence and Good Health Association has been established for 40 years, and the smoking cessation clinic service of O’ Hansen Charity Association has a history of nearly 20 years. Therefore, Macao’s community organizations all play an important role in smoking control work in Macao. Macao’s traditional tobacco smoking cessation service consistently follows the “government-people joint venture” smoking control work mode, mainly by the Government, including the Health Bureau, Social Work Bureau, Education and Youth Bureau and Healthy City Committee. Government departments are responsible for organizing related work. With the emergence of tobacco products in various forms, the emergence of e-cigarettes and the increase in the number of users, the current tobacco control work needs great changes, requiring the SAR Government to play a more active role, and more importantly, the participation of Macao social organizations to create a more effective tobacco control work at a higher starting point. From a practical point of view, social organizations in Macao, such as the Smoking Abstinence and Good Health Association, shall provide some comprehensive e-cigarette smoking control services for teenagers. In the future, on the basis of past work, social organizations can deepen community prevention education, enhance community people’s awareness of addiction problems such as tobacco, alcohol and drugs, and strengthen community prevention publicity and education. Through interactive games and simple detection equipment, public

can know more about addiction hazards, strengthen citizens’ anti-drug ability and sense of mission, and provide referral services for those in need. In view of the misconception that many teenagers use e-cigarettes to help them quit smoking, they need to be guided by education and publicity. In the past, Macao social organizations joined the Education Bureau to hold exchange meetings on campus, and hold prize contests to convey positive information. This kind of work needs to be carried out continuously. However, in the face of e-cigarette as a new type of tobacco, community’s tobacco control work needs to cooperate with social development, and constantly update the tobacco control work methods.

In 2018, under the guidance of the “Smoke-Free Next Generation” initiative, the Macao SAR government took strict measures to combat the online marketing of electronic cigarettes. They particularly emphasized the need to strengthen cooperation with civil society groups and schools to raise awareness of the dangers of electronic cigarettes and promote a correct understanding among the citizens [Macao Daily, Representing Macau at the World Health Organization’s Tobacco Control Conference, the Smoke-free Conference draws lessons from e-cigarette prevention and control, Mar. 8, 2018].

In 2019, the Macao SAR government’s Health Bureau organized a tobacco control seminar, inviting representatives from various organizations to attend and express their opinions on tobacco control efforts. The representatives suggested that, apart from increasing the monetary cost of smoking, it could also be effective to increase the time cost of smoking. This could be achieved by implementing a tobacco sales monopoly system and reducing smoking spaces, making it difficult for smokers to buy and smoke cigarettes. By reducing their desire to smoke, these actions would serve as additional incentives to quit smoking beyond financial aspects [Macao Daily, Macao SAR government’s Health Bureau: Smoking control has no impact on gambling revenue. Groups advocate increasing cigarette taxes and banning the import of e-cigarettes, Jun. 1, 2019].

organizations to rely on social media, other means and ways that are more acceptable to young people to control electronic cigarettes.

The WHO calls on all countries to promote communication between influential figures in popular culture, social media, family, or classrooms and young people to protect adolescents from manipulation by the tobacco industry [Macao Daily, No Tobacco Day protects young people from tobacco industry manipulation of tobacco epidemic in Macao and tobacco control is effective, May 31, 2020].

The Macao SAR government has already organized lectures on e-cigarettes through multimedia and interactive quizzes, creating a relaxed and enjoyable atmosphere for students to learn about the dangers of smoking and reflect on their attitudes toward life [Macao Daily, Campus interactive theater promotes smoke-free, Oct. 13, 2018].

However, with the emergence of new electronic cigarette products, there is a need to adapt to the trend of using new media to propagate information about the hazards of drugs and to enhance the vigilance of young students against drug use [Macao Daily, Improve awareness and stay away from drugs, Jul. 11, 2019].

5.3 Application of big data technique for Greater Bay Area's tobacco control

Both mainland China and Hong Kong pay great attention to the investigation and research on tobacco control. As COVID-19 has been upgraded from “Epidemics” to “Pandemics,” mainland China has fully docked and cooperated with international institutions to effectively deal with this problem. Similarly, for smoking as an epidemic, the state has promoted the tobacco control policy to the level of national strategy, and through various national monitoring surveys, the effectiveness of relevant policies has been improved. Smart cities are mainly supported by big data, so big data management is the core technology of smart cities. One-stop service is one of the administrative reform directions of the Macao SAR government. Even though the Macao SAR Government has separated the powers and responsibilities of the administrative departments, a same beneficiary can often receive support from multiple bureau-level departments. Therefore, from the perspective of beneficiaries, this idea may have reached the bottleneck position. Previously, all social services emphasized seamless integration, information transmission was an important part of departmental communication. If information between departments cannot be effectively transmitted, it would easily lead to “information islands,” which is difficult for the Macao SAR Government to promote smart cities and one-stop services. In addition, the problem of e-cigarette has already involved “drugs” and “smuggling” and other issues. The cities in the Bay Area have been paying more attention to tobacco harm, they have deepened the research on tobacco harm according to WHO. Moreover, the problem of e-cigarette has become a regional problem, it can no longer be dealt with as a “lonely city.”

Tobacco control work in the Bay Area cities must be connected, and the results of tobacco control work in various regions should be examined through investigation in the Bay Area, so that it can be improved.

Relevant organizations have also suggested that the Macao SAR government collaborate with cities in the Greater Bay Area to jointly study the regulation of new tobacco products and establish a comprehensive smoking ban schedule. Through regional cooperation, they aim to build smoke-free, pleasant, and livable cities, ensuring the health of the people in the Greater Bay Area [Macao Daily, The Smoking Abstinence and Good Health Association advocates a comprehensive smoking ban timetable, May 31, 2019].

By engaging in exchanges with relevant service agencies in neighboring regions, it is possible to assist in making Macao's smoking control services more transparent. This will allow both patients and their family members to participate in smoking cessation programs. In the future, there is hope that standardized smoking cessation services can be established for the Bay Area [Macao Daily, New types of tobacco products can still be imported into Macao through online shopping and other methods. Liang Sunxu advocates amending the law to ban e-cigarettes from the source, Dec. 14, 2020].

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

- Barrington-Trimis, J. L., Kong, G., Leventhal, A. M., Liu, F., Mayer, M., Cruz, T. B., et al. (2018). E-cigarette use and subsequent smoking frequency among adolescents. *Pediatrics* 142, 86. doi: 10.1542/peds.2018-0486
- Carroll, A. J., Labarthe, D. R., Huffman, M. D., and Hitsman, B. (2016). Global tobacco prevention and control in relation to a cardiovascular health promotion and disease prevention framework: a narrative review. *Prevent. Med.* 93, 189–197. doi: 10.1016/j.ypmed.2016.10.004
- Dai, L., He, Y., Tan, Y., Yu, Z., and Zhu, J. (2022). Online E-cigarette information exposure and its association with e-cigarette use among adolescents in Shanghai, China. *Int. J. Environ. Res. Pub. Health* 19, 3329. doi: 10.3390/ijerph19063329
- Jongenelis, M. I., Kameron, C., Brennan, E., Rudaizky, D., Slevin, T., Pettigrew, S., et al. (2018). E-cigarette product preferences among Australian young adult e-cigarette users. *Austr. New Zealand J. Pub. Health* 42, 572–574. doi: 10.1111/1753-6405.12842
- Madison, M. C., Landers, C. T., Gu, B. H., Chang, C. Y., Tung, H. Y., You, R., et al. (2020). Electronic cigarettes disrupt lung lipid homeostasis and innate immunity independent of nicotine. *The J. Clin. Inv.* 129, 4290–4304. doi: 10.1172/JCI128531
- Pang, P. C. I., Jiang, W., Pu, G., Chan, K. S., and Lau, Y. (2022). Social media engagement in two governmental schemes during the COVID-19 pandemic in Macao. *Int. J. Environ. Res. Pub. Health* 19, 8976. doi: 10.3390/ijerph19158976
- Park-Lee, E., Ren, C., Sawdey, M. D., Gentzke, A. S., Cornelius, M., Jamal, A., et al. (2021). Notes from the Field: E-cigarette use among middle and high school students - national youth tobacco survey, United States, 2021. *MMWR* 70, 1387–1389. doi: 10.15585/mmwr.mm7039a4
- Patterson, C., Hilton, S., and Weishaar, H. (2016). Who thinks what about e-cigarette regulation? A content analysis of UK newspapers. *Addiction* 111, 1267–1274. doi: 10.1111/add.13320
- Perikleous, E. P., Steiropoulos, P., Paraskakis, E., Constantinidis, T. C., and Nena, E. (2018). E-cigarette use among adolescents: an overview of the literature and future perspectives. *Front. Pub. Health* 6, 86. doi: 10.3389/fpubh.2018.00086
- Pokhrel, P., Ing, C., Kawamoto, C. T., Laestadius, L., Buente, W., Herzog, T. A., et al. (2021). Social media's influence on e-cigarette use onset and escalation among young adults: What beliefs mediate the effects?. *Addict. Behav.* 112, 106617. doi: 10.1016/j.addbeh.2020.106617
- Stroup, A. M., and Branstetter, S. A. (2018). Effect of e-cigarette advertisement exposure on intention to use e-cigarettes in adolescents. *Addictive Behav.* 82, 1–6. doi: 10.1016/j.addbeh.2018.02.021
- Sun, S., Veltri, G. A., and Wang, F. (2018). Representations of electronic cigarettes in Chinese media. *BMC Pub. Health* 18, 1–11. doi: 10.1186/s12889-018-5644-x
- Tan, X., Liu, X., and Shao, H. (2017). Healthy China 2030: a vision for health care. *Value Health Reg. Issues* 12, 112–114. doi: 10.1016/j.vhri.2017.04.001
- Wagoner, K. G., Reboussin, B. A., Ross, J. C., Denlinger-Apte, R., Spangler, J., Sutfin, E. L., et al. (2022). Exposure to e-cigarette health claims and association with e-cigarette use and risk perceptions: a cohort study of young adults. *Addict. Behav.* 132, 107359. doi: 10.1016/j.addbeh.2022.107359
- Weinberger, A. H., Platt, J., Esan, H., Galea, S., Erlich, D., Goodwin, R. D., et al. (2017). Cigarette smoking is associated with increased risk of substance use disorder relapse: a nationally representative, prospective longitudinal investigation. *J. Clin. Psychiatr.* 78, 19746. doi: 10.4088/JCP.15m10062
- World Health Organization (2010). *WHO Technical Manual on Tobacco Tax Administration*. Geneva: World Health Organization.
- World Health Organization (2021). *WHO Report on the Global Tobacco Epidemic, 2021: Addressing New and Emerging Products*. Geneva: World Health Organization.
- Yoong, S. L., Hall, A., Turon, H., Stockings, E., Leonard, A., Grady, A., et al. (2021). Association between electronic nicotine delivery systems and electronic non-nicotine delivery systems with initiation of tobacco use in individuals aged < 20 years. A systematic review and meta-analysis. *PLoS ONE* 16, e0256044. doi: 10.1371/journal.pone.0256044