



COVID-19 pandemic and alcohol consumption: Impacts and interconnections

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ARTICLE INFO

Edited by Dr. Dimitrios Kouretas

Keywords:

COVID-19
Alcohol consumption
Immune response
Psychological imbalances
Public health

ABSTRACT

Alcohol consumption is associated with multiple diseases and might contribute to vulnerability to SARS-CoV-2 infection. It can also catalyze exacerbations of mental and organic illnesses and predispose to behaviors with an increased risk of infection, severity of disease but also independently of sociopathic behavior and violence. Globally, millions of premature deaths from excessive alcohol consumption occur each year. This paper discusses the effects of increased alcohol consumption and the most important consequences on the health of the population during the social isolation and lockdown during current COVID-19 pandemic.

1. Introduction

Coronaviruses (CoVs) are a large family of viruses that can infect both humans and animals [1]. In humans, coronaviruses cause respiratory infections, which can range from a common cold to severe conditions, such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS) [2]. From the coronavirus family, SARS-CoV-2 causes COVID-19 disease [3]. COVID-19 was first identified in late 2019 in Wuhan, the capital of Hubei Province in China, in patients who developed pneumonia without being able to establish a clear cause [4]. There are no specific treatments for COVID-19 infection yet, although many candidate therapies are being evaluated in clinical trials [5–8] and several COVID-19 vaccines are approved or under evaluation for approval by authorities [9–11]. Initially, social distancing, along with increasing population testing, are the only effective measures to control the pandemic but with several consequences on long-term

[12–14]. Public health measures include non-pharmacological interventions that can be used to reduce and delay community transmission [4]. The goal is to slow down the pace of new cases and reduce the peak of cases in the community, as well as the burden on health systems.

Despite the huge and interlinked efforts of most states, the COVID-19 pandemic has affected people's lives in a wide range of dimensions, at individual (all kind of fears - of the unknown, of illness, of death, isolation, physical and financial insecurity), and societal level (economic recession, educational and opportunities limitations, job loss, rising inequities and stigma, infodemia, coronaphobia) [15] [16].

Considering the scale of its consequences and the huge stress-related burden, COVID-19 pandemic can be considered as a mass trauma, which can lead to psychological problems, health behavior changes, and addictive issues, including alcohol consumption [16,17].

Ethyl alcohol (ethanol or alcohol) is part of the cultural traditions of

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most societies, since the beginning of civilization. Evidence of obtaining alcohol by distillation dates from the year 1100 BCE. Although the history of alcohol abuse is as old as its production, alcohol consumption has become a public health problem since the 18th and 19th centuries, with the impoverishment of industrial workers. Ethanol in the form of alcoholic beverages is obtained by fermentation of sugars from cereals and fruits, while ethanol used in the production of pharmaceuticals and cosmetics, disinfectants, food additives, preservatives and fuels is obtained mostly by petrochemical processes [18].

Alcohol consumption is associated with many physical ailments and mental disorders [19], which can make the individual vulnerable to the new coronavirus. This is because alcohol affects the immune system and thus increases the risk of developing certain diseases [20]. Alcohol has long- and short-term effects on every organ in the body, so there is no "safety" limit to consumption [21]. Moreover, the risk of deteriorating health increases with each glass of alcohol consumed [22]. In the current context, excessive alcohol consumption weakens the immune system, making it more susceptible to infection with the SARS-CoV-2 virus. Alcohol consumption is also associated with certain types of cancer, including liver cancer [23]. Alcohol abuse is the most widespread drug addiction in all geographical regions and in all population groups.

Rebalancing the 'covid-19 effect' on alcohol sales

Therefore, consumption should be moderate in general, and especially during the pandemic [24]. In contrast, Nielsen IQ reported [25] a 477 % increase in online alcohol sales by end of April 2020. WHO experts say alcohol abuse during social isolation and lockdown is a dangerous way to deal with reality and discourages the use of potentially addictive substances to manage the burden of social isolation [26]. Alcohol consumption also exacerbates psychological imbalance in the context of the COVID-19 pandemic. Social stressors include social isolation, unemployment, frontline work such as in a hospital, working from home, management of children's schooling, as well as loss of loved ones, constrained financial resources and/or emotional and social support. Alcohol-related disorders are a major social problem especially during the COVID-19 pandemic [27].

2. Short- and long-term alcohol consumption during COVID- 19

Alcohol consumed for long time acts as a stressor on the body and makes it difficult to maintain homeostasis [28,29]. The immediate benefit of alcohol consumption can mask the long-term harmful effect [30,31]. Most often, adults who drink alcohol constantly justify consumption by claiming reducing mental stress, maintaining a state of physical and mental relaxation, but also improving their social behavior [32]. However, due to the action of ethanol on the central nervous system, at high doses of alcohol, there is an inhibitory effect that involves reduced discernment and weakened attention and memory [33]. Thus, it becomes a risk factor for altering behavior and decision-making. The danger is even greater for those diagnosed with psychological or psychiatric pathologies, as often the concomitant administration of psychotropic medication and alcohol is contraindicated [34].

Globally, the significant health issues that existed before COVID-19 have not gone away: in many instances, the pandemic may have exacerbated the problems. While waiting for official national and international statistics, taking into consideration the potential changes in the health behaviors, a multitude of research projects were performed in different countries, most of them showing an increase in alcohol consumption in different proportions of the population.

A remarkably interesting approach was the attempt of predicting the impact of the pandemic on alcohol use based on the Previous Crises in the 21 st Century. Starting from the hypothesis that the huge challenges induced by the COVID-19 pandemic are comparable or even harder than the ones associated with previous world crises and alcohol consumption was often used as a coping stress strategy, the authors tried to predict the changes in drinking behavior and the potential consequences, based on the previous vents. Their research has shown that mass crisis as

terrorism - 9/11, epidemic outbreaks -SARS in 2003 or economic crises - such as 2008's Great Recession, were associated with increases in alcohol use, related to anxiety and depressive symptoms, and post-traumatic stress disorders, especially in young and single male subjects, who have a higher vulnerability to develop harmful drinking behavior [35].

In line with these findings, a recently published study on alcohol consumption during the pandemic in US, conducted among 1,540 people aged between 30 and 80 years, showed that Americans drank about 14 % more alcohol this year, amid the COVID-19 pandemic compared to 2019. Thus, an alarming increase, more pronounced among women shows a 17 % increase in alcohol consumption among women and a 19 % increase among people aged between 30 and 60. According to this study, the consumption of large amounts of beverages among women - four or more drinks in two hours - has increased by 41 % this year. The increase reported for most participants translates into consuming an extra drink daily within a month [36].

In Canada, a Report published by Nanos Research, analysing the data from *Canadian Centre on Substance and Addiction*, showed that during the pandemics, 20 % of the Canadians who had to stay at home reported drinking more and 21 % more frequent, the top three declared reasons being the lack of a daily routine, boredom, and perceived stress [37]. In Europe, evidence showing an increased alcohol consumption, emerged during the second half of 2020 and early 2021.

In the United Kingdom, a cross-sectional study performed on 691 adults, showed that 17 % of them reported increased alcohol consumption during the lockdown, with a higher proportion in younger subjects (18–34 years). There was a significant association between increased alcohol consumption and poor overall mental health, depressive symptoms, and lower mental wellbeing [38]. In another survey, applied by the charity Alcohol Change UK on 1555 people, around a fifth of the subjects responded that, during the lockdown, they had been drinking more frequently in the same period and 15 % had been drinking more per session, indicating the emergence of a subgroup of drinkers at risk of establishing potentially dangerous patterns of alcohol consumption [39].

In Belgium, a survey exploring the changes in alcohol, tobacco, and light drugs consumption during the lockdown, performed on 3,632 subjects, showed an increased alcohol consumption ($d = 0.21$) and smoking more cigarettes ($d = 0.13$) than before the COVID-19 pandemic, but no significant changes in the consumption of cannabis. Increased alcohol consumption was associated with younger age, more children at home, non-healthcare workers, and technical unemployment due to COVID-19, while increased smoking were associated with younger age, current living situation, lower education, and working situation related to COVID-19. Boredom, isolation, loss of daily routine, loneliness and shared habits were the main reasons for consuming more of the various substances [40].

In Greece, a study performed on 705 adults, exploring the drinking habits before and during the COVID-19 pandemic, revealed that the consumption by drink type was broadly similar, but more people drank alone (8.0 % vs. 29.0 %) or with their life partners (20.2 % vs. 40.7 %) than with friends (68.2 % vs. 18.5 %). All the participants drank at home during the lockdown, 20.7 % reported an increased consumption, mainly due to isolation (29.7 %), changes in everyday habits (27.5 %) or for coping with anxiety or depression (13.6 %) [41].

In Eastern Europe, a research project implemented in Poland has shown an increase in alcohol consumption in 146%, with a higher tendency to drink more found among the subjects with previous alcohol addiction [42].

In Australia, different surveys, conducted in various pandemic moments, showed that over 25 % of the adults increased their alcohol consumption during the pandemic, mainly due to higher levels of stress, anxiety, and depression symptoms, but the proportion of harmful drinking, measured by AUDIT (Alcohol Use Disorders Identification Test), decreased compared with the first pandemic pick, especially in

young people (aged 18–25) [43,44].

Different studies performed in China underlined the increased addictive behaviours and higher proportions of harmful/hazardous alcohol use, especially in the most affected provinces – Hubei and Wuhan, mainly related to very high levels of stress and stress coping strategies

At the same time, there are some evidence that shows little changes in consumption patterns at the community level or even a decrease in overall alcohol use. For example, in the United Kingdom, a study that investigated if COVID-19 confinement led to excess alcohol purchases by British households by analysing Kantar Worldpanel's data from 23,833 British households during January to early July 2020, compared with 53,428 for the same period during 2015–2018, suggests that households did not buy more alcohol for the expected time of the year when adjusting for what they normally would have purchased from on-licensed premises [45].

In Australia, lower levels of alcohol were detected in wastewater during the quarantine, comparing with the similar periods of the previous years, suggesting a reduction in drinking among the general population, possibly as a result of missing social events and changes in overall drinking patterns [46].

Other interesting examples may be the decrease of alcohol consumption in college students, after the campus closure, the main explanation being that they got back home, to live with their families, with less social events and binge drinking [46,47].

The same decrease in binge drinking, when comparing similar time-intervals from 2019 and 2020 has been revealed by the results of a wide international online survey, covering countries from Europe, North and South America, Africa, Asia, fewer social events, less clubbing and parties, and lower peer pressure being listed as possible explanations [48].

3. Alcohol consumption, immune system and COVID-19

The immune system is a complex set of organs, structures and molecules (such as humoral factors, signal molecules and immunoglobulins), lymphatic vessels and white blood cells are its most important components [49]. Through the immune system, the body provides a shield against disease and infection [50,51]. The role of the immune system is to protect the body from pathogens such as viruses, bacteria, parasites, toxins [52,53]. Certain foods, sports, supplements and natural remedies are some of the ways are suggested to augment immunity [54–56].

In recent years, conclusive evidence has been gathered that alcohol increases the risk of infectious diseases, especially HIV infection, tuberculosis, pneumonia with germs resistant to treatment and difficult to eradicate [57]. The explanation consists, on the one hand, in the effect of alcohol to reduce immunity: the consumption of over 40 g of alcohol/day increases the rate of illness through infections in consumers versus non-consumers, under the conditions of the same exposure to infection [58]. In addition, there are social factors associated with problematic alcohol consumption: low income or lack of income, reduced access to care, lack of medical support [58]

Chronic ethanol abuse almost doubles the risk of developing acute respiratory distress syndrome [59]. The association between bacterial and viral lung infections and ethanol dependence is supported by multiple pathophysiological mechanisms [60,59,61]:

- reducing the number of T lymphocytes - by preventing proliferation and by altering cell turnover;
- favoring a pro-inflammatory status through an increased level of proinflammatory cytokines, such as tumor necrosis factor alfa (TNF α) and interleukins 1 and 6 (IL-1, IL-6);
- decreases the function and number of NK (Natural Killers) cells responsible for removing infected or malignant cells;
- disturbance of macrophage functions in the lung alveoli;
- damage to the respiratory ciliated cells which plays an essential role

in filtering pathogenic microorganisms.

Another important factor is malnutrition secondary to excessive alcohol intake [62]. The harmful effect on the mucosa of the digestive tract consists in decreasing the absorption and metabolism of certain nutrients, including B vitamins (B1, B6 and B9 or folic acid), leading to a slowing of leukocyte proliferation and differentiation [63]. The defense mechanisms of the mucosal immune system are also affected, resulting in a dysfunction of the function of IgA and IgG immunoglobulins, which are responsible for local protection against infectious agents [64].

4. Alcohol consumption, psychological imbalances and COVID-19

Alcohol is a substance with wide availability, accepted by most societies, with the potential for abuse and acute and chronic toxicity [65]. It has a depressing effect on the central nervous system, causing a decrease in neural activity [66–68]. It also has an anxiolytic, antidepressant, relaxing and sedative effect, being used by many people who face anxiety, depression or insomnia [69]. General medical problems secondary to alcohol consumption, acute and chronic toxicity of ethanol can affect the entire body [70]. The effects of alcohol on the brain are described below [71–73]:

- under the influence of alcohol, emotions can become exaggerated and the consumer is excessively happy, expansive or emotional
- alcohol has a depressing effect on the central nervous system, causing drowsiness, an effect dependent on the amount consumed; over time alcohol changes the architecture of sleep, decreasing periods of deep sleep and increasing the number of awakenings during the night
- on a short-term, alcohol has an anxiolytic effect, but the period of relaxation and mental comfort is short
- influences the pleasure centers (dopamine-mediated) and the reward system in the brain, which partly explains the installation of alcohol dependence
- acts on the production of opioid substances, which explains the analgesic effect
- affects the hippocampus, the area of the brain where memory-related processes take place and so the consumer no longer remembers what he did during consumption and immediately afterwards
- inhibits the production of neurotransmitters, such as gamma-amino-butyric acid (GABA) and glutamate, the effect being to slow down the transmission of nerve impulses through the brain
- increased blood alcohol level over 0.05 % causes disorders of nerve activity in the frontal lobe and thus difficulties in impulse control and decision making, decreased thought and judgment, reduced censorship
- the effect of alcohol on the cerebral amygdala causes consumers not to realize that certain actions of theirs can have dangerous effects and thus scandals, violence, accidents can occur
- the action of alcohol on the cerebellum leads to loss of balance, coordination of movements and instability of gait
- when the alcohol level exceeds 0.04 %, the functioning of the reflex centers in the brainstem that control breathing, coughing, sneezing can be inhibited and they become unable to regulate the vital functions of the body, in extreme cases, death can occur [74].

Theories and even ongoing information about the effects of the SARS-CoV-2 can often bring uncertainty. Psychologists who treat alcohol addiction have noticed that its consumption has increased. Events with repercussions on society and, implicitly, on the human psycho-social side, such as the SARS epidemic of 2002, and now the SARS-CoV-2 pandemic of 2020, were a challenge to maintain the psychological balance. A recent study looked at the impact of the COVID-19

pandemic on mental health, using online questionnaires. The results highlighted the following clinical psychiatric symptoms: generalized anxiety disorder; depressive symptoms; decreased sleep quality or insomnia [75]. Another recently published analysis highlights the fact that the psycho-social effects on the population exposed to strict epidemiological measures are visible up to a few years after the crisis is resolved. Approximately 25 % of those who expressed symptoms specific to post-traumatic stress disorder (PTSD) during lockdown remained with the same degree of impairment at 30 months after lifting the lockdown, and the risk of developing depressive tubing was 5 times higher in those who were isolated in quarantine compared to the group that was not subjected to these measures. The association between depressive-anxiety disorders and alcohol consumption is studied and attested by multiple scientific publications [76].

The interconnection between alcohol dependence and depression is based on a circular etiopathogenic process, the two diseases worsening each other. For example, women with depressive disorders are more prone to excessive alcohol consumption by internalizing symptoms, a situation favored by social isolation.

5. WHO recommendations on alcohol consumption during the COVID-19 pandemic

Specialists from the World Health Organization have warned against the consumption of alcohol for therapeutic purposes [77].

According to the false information circulated recently, the ingestion of alcohol would have helped to destroy the SARS-CoV-2 virus. There is no medical basis to support this fact, on the contrary, alcohol abuse weakens the body's protection against viral respiratory infections [78].

WHO's published advice on maintaining a balanced psychological state addresses the following issues [16]:

- avoid alcohol consumption as much as possible
- in the case of uncontrolled alcohol consumption, you can call on the help of a specialist
- avoiding the association between alcohol consumption and smoking, because the two habits are mutually supportive
- avoiding alcohol to manage stress or anxiety
- social isolation and ethanol abuse are often associated with an increased suicide rate
- alcohol consumption and administration of certain drugs are contraindicated during the COVID-19 pandemic.

6. COVID-19 pandemic, lockdown and alcohol consumption: connecting the dots, looking to the future

Apart from the intensively and analyzed trends and motivations of adults' alcohol consumption, there are several sensitive and less discussed issues, with potential long-term consequences, that would deserve more attention.

One of these topics is related to the way in which parental drinking is influencing the next generations. During the lockdown, the children were more likely to see their parents drinking, due to the time spent together at home. Parental model regarding the drinking behaviors can play a major role in the intergenerational transmission of excessive alcohol consumption [79].

In a study performed on 1,054 Canadian adolescents ($M_{\text{age}} = 16.7 \pm 0.8$), in which they completed an online survey, the reported the frequency of alcohol use, binge drinking, cannabis use, and vaping in the 3 weeks before and directly after social distancing. The results showed a decrease in binge drinking and vaping, but over 93 % declared that they were drinking at home with their parents, seen as more acceptable behavior.

Another less discussed topic is the alcohol exposure *in utero*, which is considered to be the main cause of Fetal Alcohol Spectrum Disorders (FASD), characterized by neurodevelopmental deficiencies, learning

disabilities, and behavioural problems that can lead to mental health problems, educational problems, substance abuse and lack of social integration [80].

Considering the evidence of increased alcohol consumption in women during the pandemic, the pandemic duration and the risks of unintended pregnancies, the odds of increased rates of FASD in the future are high. "Although we might soon enter a post-COVID era, new cases of FASD will persist for decades and permanently compromise the lives and life chances of those affected. FASD is both predictable and largely preventable but has been consistently ignored" [81].

The last but not the least is the reverse analysis – how alcohol use disorder may influence the way of dealing with the pandemic from the personal safety perspective. The results of a cross-sectional survey, performed in Romania, on 115 male patients and 57 controls, showed that patients with severe mental illness (SMI) and alcohol use disorder (AUD) are at higher risk for contracting COVID-19 and for poor outcomes of COVID-19 infection, one reason being the lack of knowledge regarding preventive measures against COVID-19 and the inability to discern misinformation from facts [82].

Also, the alcohol consumption is a calorie problem: Alcohol is high in calories (7 kcal per gram of ethanol). While data are somewhat controversial about alcohol consumption vs. obesity [67,83,84]. Obesity aggravates the harmful effects of alcohol on the liver.

Overall, there seems to be a positive association. For example, in English adults, mean alcohol calorie consumption was 27 % of the recommended daily calorie intake in men and 19 % in women on the heaviest drinking day in the last week, with a positive association between alcohol calories and obesity [85]. Especially changes in alcohol consumption are not necessarily counterbalanced by changes in eating behavior. Students who binge drink twice per week consume total calories in one year ranging from 52 000 to 114 400 (equivalent to 6.74–14.83 kg of fat) [86]. Noteworthy, other behavioral changes during the pandemic add to obesity concerns [87]. Obesity and its association with a metabolic syndrome [88], i.e., risk factors for cardiovascular disease and type 2 diabetes linked to reduced HDL-cholesterol, raised triglycerides, blood pressure and fasting plasma glucose, all of which are related to weight gain, is a problem on its own. However, there is also the strong association of obesity with COVID-19 susceptibility [89]

[89]; Popkin et al., 2020) is of concern here.

In Fig. 1 we summarized the most important effects of increasing alcohol consumption on health during COVID-19 pandemic.

7. Conclusions

In the context of the COVID-19 pandemic caused by the new coronavirus, alcohol consumption is a way to relax for many people, but it is important to know that alcohol can increase the vulnerability of the individual, both physically and mentally.

Alcohol is a psychoactive substance that is associated with certain mental disorders. Therefore, people who suffer from a mental illness or are predisposed to certain disorders, such as depression or anxiety, are particularly vulnerable, especially in the context of social distancing. Alcohol consumption can affect the immune system and contribute to obesity, but also intensify risky behavior, such as violent reactions, depression or anxiety. All of these increase the risk to acquire COVID-19. In the context of high global alcohol consumption, with a significant number of casualties, it is important that people who are accustomed to drinking alcohol review their attitude towards this issue during the COVID-19 pandemic.

The current pandemic circumstances of COVID-19 may influence the amount of alcohol consumed and how the individual relates to this consumption but also may induce medium- and long-term alterations in health behavior and health status for other persons, through rising acceptability of alcohol consumption in families, influencing the young members, higher consumption in pregnant women, increasing the risk of FASD.

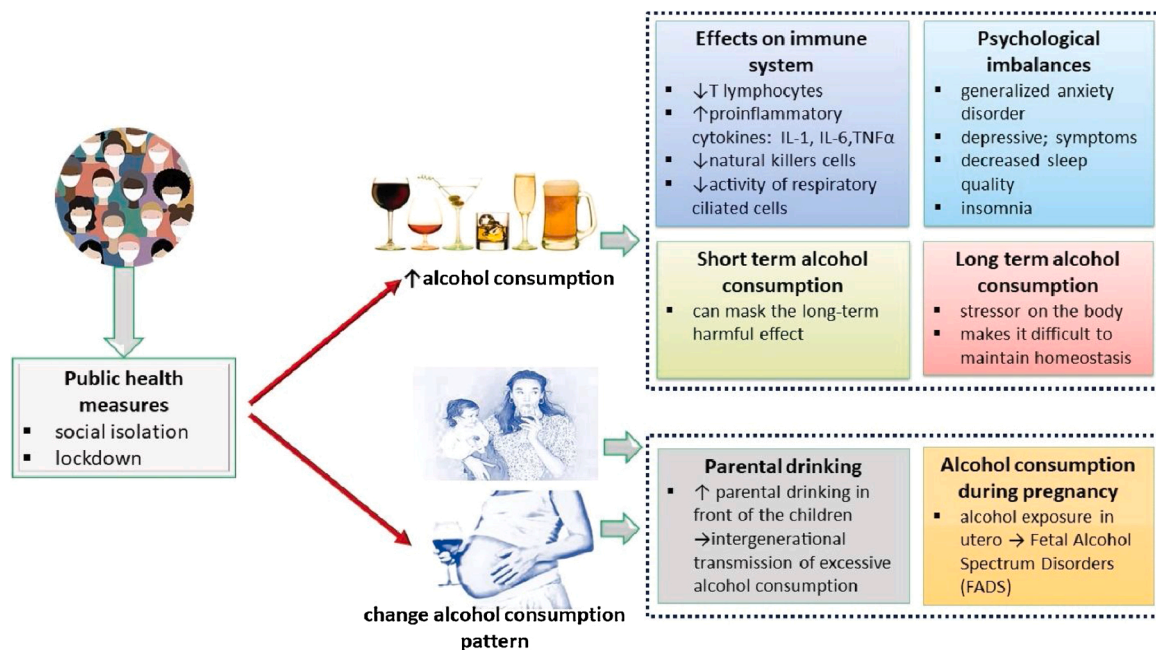


Fig. 1. The main effects of increasing alcohol consumption on health during Covid-19 pandemic.

For mitigating the potential long-term consequences of increasing or pattern changing alcohol consumption, beyond statistics, a more in-depth analysis of the root causes, of interconnections with mental health, socio-economic circumstances and social support, a close monitoring of the phenomenon and tailored public policies, containing appropriate measures aimed to address especially the groups with the high risk of harmful alcohol consumption would be highly recommended.

Authors' contributions

All authors read and approved the final manuscript.

CRedit authorship contribution statement

Daniela Calina, Thomas Hartung, Anca Oana Docea: Conceptualization. **Ileana Mardare, Mihaela Mitroi, Konstantinos Poulas, Aristidis Tsatsakis, Ion Rogoveanu:** Data curation. **Daniela Calina, Thomas Hartung, Anca Oana Docea, Aristidis Tsatsakis:** Validation, Writing - all authors, Supervision, writing - review & editing.

Funding

No funding was received.

Ethics approval and consent to participate

Not applicable.

Declaration of Competing Interest

The authors declare no conflict of interest.

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