Comparison of suicide rates during the Covid-19 pandemic and the 10 years prior in Split-Dalmatia county

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COMPARISON OF SUICIDE RATES DURING THE COVID-19 PANDEMIC AND THE 10 YEARS PRIOR IN SPLIT-DALMATIA COUNTY

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TABLE OF CONTENTS

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To my parents and my brother: we have experienced some ups and downs these past years, but there was not a single moment I could not count on you! Every time I was ready to quit, you encouraged me to continue.

To my grandma, aunt and uncle: thank you for your support and encouragement every day, being the best second family someone can wish for.

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List of Abbreviations

ARDS - Acute respiratory distress syndrome

CNS - Central Nervous System

COVID-19 - Coronavirus disease 2019

CRP - C-reactive protein

ESR - Erythrocyte sedimentation rate

GSR - Gunshot residues

ICD-10 - International Classification of Diseases, Tenth Revision ICD-10

MERS - Middle east respiratory syndrome

PHEIC - Public Health Emergency of International Concern

S01 - Laceration without foreign body of scalp, initial encounter

SARS-CoV-2 - Severe acute respiratory syndrome coronavirus 2

SIB - Self-injurious behavior

T07 - Unspecified multiple injuries

T71 - Asphyxiation

T75 - Unspecified effects of drowning and nonfatal submersion, subsequent encounter

WHO - World Health Organization

X61 - Intentional self-poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified

X62 - Intentional self-poisoning by and exposure to narcotics and psychodysleptics [hallucinogens], not elsewhere classified

X63 - Intentional self-poisoning by and exposure to other drugs acting on the autonomic nervous system

X64 - Intentional self-poisoning by and exposure to other and unspecified drugs, medicaments and biological substances

X65 - Intentional self-poisoning by and exposure to alcohol

X66 - Intentional self-poisoning by and exposure to organic solvents and halogenated hydrocarbons and their vapors

X67 - Intentional self-poisoning by and exposure to other gases and vapors

X68 - Intentional self-poisoning by and exposure to pesticides

X69 - Intentional self-poisoning by and exposure to other and unspecified chemicals and noxious substances

X70 - Intentional self-harm by hanging, strangulation and suffocation

X71 - Intentional self-harm by drowning and submersion

X72 - Intentional self-harm by handgun discharge

X73 - Intentional self-harm by rifle, shotgun and larger firearm discharge

X74 - Intentional self-harm by other and unspecified firearm and gun discharge

X75 - Intentional self-harm by explosive material

X78 - Intentional self-harm by sharp object

X80 - Intentional self-harm by jumping from a high place

X81 - Intentional self-harm by jumping or lying in front of moving object

X84 - Intentional self-harm by unspecified means

X87 - Pesticide attack

1. INTRODUCTION

The biggest pandemic of the 21st century was challenging for everybody. No one was able to see their friends and family, people were locked in their tiny apartments or flats without a balcony or garden, ending up alone and in isolation. Travelling has been restricted, jobs were lost, borders were closed and billions of people isolated themselves in their home to prevent the spread of the infection. Structured schedules like school for children and work for adults, as well as social interaction are the two pillars of human civilization. These two main pillars have been distorted during the COVID-19 pandemic. All of this has been very challenging for the general population so one can only imagine how people who are already struggling with mental health problems were feeling during the pandemic. Pre-existing mental problems were exacerbated, uncertainty about the future, unemployment, stress, mass panic and isolation have all contributed to one concerning cause of mortality: suicides (1). Every year 703 000 people take their ow life and many more attempt suicide. Every single suicide or suicidal attempt is a tragedy that affects families and friends, leaving a long-lasting effect on the people left behind. Suicide is omnipresent, occurring throughout the entire life and was the fourth leading cause of death among 15-29 years old globally in 2019. Suicide is not only a problem in high-income countries, it is a global phenomenon, with 77% of global suicides occurring in low- and middle-income countries in 2019 (2). With suicides being such a global phenomenon, they also make one of the leading causes of death in Croatia. Over the last 10 years there have been oscillations in the number of suicides committed (3).

1.1 Pandemic

Pandemic is defined as the global expansion of a new disease. A pandemic is not the same as an endemic by definition. In an epidemic, more cases of a health condition occur in a community or region than expected. The biggest difference is that the condition does not spread further, meaning it is localized to a region and not spread over the borders. Viral respiratory diseases, such as those caused by the coronavirus is the most likely to turn into a pandemic (4).

1.1.1 Coronaviruses

Coronaviruses are a family of enveloped positive-strand RNA viruses with their genome encoding spike, small membrane, nucleocapsid and internal proteins. The positioning of the spike proteins which are planted in the envelope is named giving to the coronavirus because they look like a crown or have a crown-like appearance (5). The first occurrence of human coronavirus was separated by scientists in 1965 from a person having a common cold (6).

Coronaviruses compromise a large variety of viruses that are known to cause mild to moderate upper respiratory tract illnesses in humans. Three viruses out of the large family have caused more severe ad fatal diseases in people: The first of them emerged in November 2002, causing severe acute respiratory syndrome (SARS) is known as SARS-coronavirus (SARS-CoV), The second MERS coronavirus (MERS-CoV) which emerged in 2012 and causes Middle East respiratory syndrome (MERS) and SARS-CoV2, which emerged in 2019 and causes coronavirus disease 2019 (COVID-19) (7).

1.1.2 Epidemiology of COVID-19

Late December 2019, a cluster of patients with pneumonia of unknown etiology was linked to a seafood wholesale market in Wuhan, China. Concerning the initial cases, 55% of cases were associated with to the Wholesale Seafood marked. The number of cases fell to just 8,6% in late December with an exponential raise of cases that were not linked to the marked.

The time needed to pass from infection to onset of symptoms was 5,2 days while its 95th percentile of the distribution was 12,5 days. Both of these factors suggest a two week period of quarantine where the patients were monitored and screened (8). This novel coronavirus was discovered by isolating human airway epithelial cells, named 2019-nCoV (9). Since the emergence of the virus in China at the end of 2019 the pandemic has been occurring in several phases. In Europe outbreak in the spring of 2020 was followed by a decrease in the number and causes of deaths (10).

According to newer studies the novel corona virus had already been spreading globally by that time (11).

In the beginning of 2020, the WHO declared this novel outbreak a Public Health Emergency of International Concern (PHEIC) because there were already close to 100 registered cases in 18 countries outside of China.

With the increasing numbers and worry by the concerning levels of global inaction, the WHO declared the situation a pandemic with Europe being the new epicenter of it (12).

With the pandemic already going on for one year the WHO dispatched an international expert team to China to evaluate four scenarios regarding the introduction of this novel virus.

Decreasing in likelihood according to the WHO expert team:

- Introduction through an intermediate host, followed by spillover to humans
- Direct zoonotic transmission (spillover)
- Introduction through the cold/food chain
- Introduction though a laboratory incident (13).

Even though it was, possible for the Team to rule out any of the expected scenarios. The likelihood of the pathways was estimated based on qualitative risk assessment. The most likely scenario of introduction was considered through an intermediate host, this assumption was followed by the direct zoonotic transmission and introduction through the cold/food chain. Introduction from a laboratory incident was considered very unlikely (13).

1.1.3 Symptoms of COVID-19

The spectrum of COVID-19 ranges from asymptomatic or mild to life-threatening complications (14). Clinical signs that showed to be linked with a large pervasiveness are olfactory and gustatory dysfunction including anosmia, hyposmia, agenusia a well as hypogusia. The growing consciousness of these dysfunctions improved the recognition of patients with COVID-19 (15).

The majority of patients infected with COVID-19 presented with fever, nonproductive cough, fatigue and myalgia. Additional symptoms observed include dyspnea, anorexia, tightness of the chest and sore muscles. Symptoms appeared less frequently involved pharyngula, gastrointestinal symptoms, shivering and headaches.

A small number of infected individuals does not develop symptoms any at all (14,16). Frequently observed complications include ARDS, organ failure or shock, acute cardiac injury and acute injury, all of them ultimately resulting in the death of the patient. The median duration from onset of symptoms to dyspnea, hospital admission and ARDS were 5 days, 7 days and 8 days, respectively. Patients experiencing a stronger course of the disease usually have one or more underlying coexisting conditions, including hypertension, diabetes, cardiovascular disease and malignancy being the most common ones (14).

Commonly disbalances of laboratory values are observed during an infection with SARS-CoV.2. Increased values observed include lymphopenia, c-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) despite normal leukocyte counts (17).

D-dimer is commonly elevated in patients with COVID-19 and is shown to correlate with severity of the illness. Values of D-dimers greater than 2,0 nanogram/mL at the time of admission manifested to be a reliable prognostic marker for in-hospital mortality (18).

1.1.4 Risk factors

According to current data higher age is the most significant risk factor for severe COVID-19 or death, with the mortality risk increasing continuously from the 6th decade of life and being 20 times higher for an 80-year-old person than for a 50-year-old person. Additional risk factors that were established throughout the pandemic for severe disease progression include obesity, male gender, cardiovascular disease, diabetes mellitus, chronic kidney or liver diseases, cerebrovascular or neurological disease, cancer, COPD, immunodeficiency or treatment with immunosuppressants. The presence of more than one of these factors increases the risk for severe disease (14,19).

1.1.5 **Management and prevention of COVID-19**

COVID-19 is mainly managed by supportive therapy along with mechanical ventilation in severe cases (20). As we today know SARS-CoV-2 is primarily spread via respiratory droplets during close face-to-face contact. Infection can be spread by asymptomatic, presymptomatic and of course symptomatic carriers.

Besides the vaccine the primary methods to reduce spread are face masks, social distancing, contact tracing and if infected isolation and quarantine (21). Social distancing and hygiene measures seem to be effective in the reduction of a number of transmitted virus particles and therefore could alter the mode of transmission (22).

1.1.6 Isolation and Quarantine

Isolation is defined as separating sick individuals from healthy people, while Quarantine is defined as the separation and restriction of movement of people who were exposed to a contagious disease and to see if they will develop symptoms of the disease (23). Both of them go hand in hand and Quarantine as we know it today began during the 14th century in an effort to protect the cities on the coast from plague epidemics. Ships that were arriving in Venice from infected ports were placed in the port for 40 days before landing. That is where the name quarantine comes from as in Italian “quaranta giorni” means 40 days (24). Dubrovnik was the major trading center on the Dalmatian coast and was thereby a major target during the plague epidemics in the 14th century. The first Quarantine was introduced in 1377 in Dubrovnik on Croatia’s Dalmatian Coast. The Great Council of Dubrovnik introduced in a decree measure that would protect the city against plague. The text of the original document, which is kept in the Archives of Dubrovnik, states that all newcomers had to spend 30 days in a restricted location before entering the city to wait for symptoms of the plague to develop.

Later the isolation in a restricted area was prolonged to 40 days and was called quarantine. Along with Dubrovnik, Venice and Milan were the first cities around the world introducing isolations to prevent the spread of infectious diseases.

During the years, isolation proved to be effective as none of the plague epidemics was as devastating as the Black Death during the mid-14th century. The biggest achievement of medieval medicine is probably the finding of isolation (25).

1.1.7 Previous epidemics and their connection to suicide

Not a single thing in mankind can be compared to the magnitude of the COVID-19 pandemic. The last comparable crisis with a similar magnitude was the Spanish Flu lasting from 1918 to 1919 which was caused by H1N1 virus with its genes originating from avian species. Around 500 million people were infected with the Spanish Flu viruses, making up one third of the worlds' population back then. At least 50 million people died around the world. The Spanish Flu, also called “Spanish Lady” was associated with an increased number of suicides due to the decreased interaction and the fear of contracting the illness. Research indicated that the increase is attributed to fears of getting infected and of being a burden to loved ones, social isolation in general and loneliness (26).

1.1.8 Psychological impact of COVID-19

While lockdown can be the most effective strategy of social distancing to prevent the spread of the extremely infectious COVID-19 virus, one must at the same time keep in mind that it can have a high degree of psychological impact on people.

It is known from previous pandemics and epidemics that quarantine and isolation are associated with mental health problems like fear, anxiety, depressive symptoms, sleep disturbances, loneliness and anger due to the restriction of free movement. Lockdown shows to have different effects depending on age (27). Schools, restaurants, cinemas, kindergartens have been closed all public gatherings were forbidden all this created a feeling of uncertainty and anxiety in the general population. Many families were isolated at home, working from home and of course supporting their children with school from home. The loss of taking personal space, visiting friends and spend some time away from the family were creating parental stress.

Research shows that fear, as well as anxiety, can be transferred from parent to child. Children are sensitive to the emotional state of adults around them. Adults are the anchor of well-being and security for children. The restriction to a life at home without any possibility to step out of a tense situation can lead to exacerbation in an already abusive home with an increase in child abuse, sexual abuse and neglect. Staying at home in quarantine or isolation makes children with already preexisting traumatic experiences more prone to child maltreatment (28).

1.1.9 Impact of COVID-19/ isolation/ quarantine on mental health

The COVID-19 pandemic and its appertaining isolation and quarantine have had a great impact on mental health globally. This exceptional situation has led to an increase in anxiety and depression in the general population. Especially the more vulnerable population such as patients already suffering from previous mental disorders. Fear of infection, loneliness during the lockdown, financial stress and unavailability to continue face-to-face treatment and the psychological stress have already linked to an increase in depressive and anxious symptoms but also alcohol and substance abuse to the early phase of the COVID-19 pandemic, all of them being sole risk factors for suicide (29,30).

Social distancing and social isolation may trigger suicidal thoughts and ideas and in extreme cases end in suicide. In 2003 during the SARS outbreak a higher suicide rate was recorded, with most of them being older adults over the age of 65.

Anxiety, loneliness, fear of being a burden to the family once infected and isolation itself were the thought to be associated with the increase in suicide rate in older observed during the SARS epidemic. Like the SARS epidemic, COVID-19 has implanted an uncertainty in people throughout the world leading to people committing suicide, with more cases reported in developing countries than in other parts of the world (31).

1.2 Suicide

Suicide describes by definition the act of taking one´s own life. Suicidal behavior intends to permanently end one´s life whether consciously or consciously motivated. True suicidal acts need to be distinguished from self-harming, self-injurious, or parasuicidal acts and gestures that do not intend to cause death (32). In 1951 Emilie Durkheim tried to understand what makes a person commit suicide and what other factors may have led to the final decision or act. According to Durkheim´s theory on suicide, he found four different types of suicide.

Egoistic suicide relates to a person being alone or having the perception they are being alone. They see themselves alone in the world and generally have low or no social interaction. Altruistic suicide, as the name implies this type of suicide is seen in people being highly involved in social groups, always giving the most. Expectations are met at a very high level. An example would be a Marta or suicide bomber who meets the high expectations of the cult or religion by sacrificing himself. In Anomic suicide suicidal act is carried out during periods of enormous stress and frustration, relating to a low degree of self-regulation.

An example would be an immense financial loss. The fourth type of suicide is defined as Fatalistic suicide and is seen when people are kept under strict regulations like in China which leads them to lose individuality (33).

1.2.1. Self-injurious behavior

Self-injurious behavior (SIB) is commonly seen in clinical practice. The nature of injury varies from mild and superficial to very severe, isolated or repetitive. Banging the head, kicking limbs, skin picking, dripping acid on the hands, biting and burning are all examples of mild and moderated injuries. Very severe forms include self-mutilation of various parts of the body such as removal of the ears, eyes, tongue, genitalia (34). Cutting and burning oneself are the usual methods of self-injurious acts. Behind these behaviors, there is no intention to end one´s life it is about causing intense sensations of pain and damage. Their initial goal is not suicidal but if taken too far, self-injurious behavior may lead to accidental suicide (35).

1.2.2. Suicidal Ideation

Suicidal ideation is a term used to describe suicidal thoughts and feelings without any suicidal actions. The presence of suicidal ideation, occurring alone in the absence of any plans to act out actual suicide is classified as low or less-dangerous. The potential risk is present but not acute (36).

1.2.3. Suicidal Gestures

Suicidal gestures are defined as a self-injury with no intent to die, but instead give others the appearance of a suicidal attempt to get their attention. These gestures are lacking the intention to kill but death may inadvertently ensue (37).

1.2.4. Suicidal injuries

1.2.4.1. Stabbing and cutting

Most stab and incised wounds are self-inflicted. The motive is either mental aberration, self-destruction or some form of gain. All motives must be separated from each other, but they also need to be differentiated from accidental and homicidal wounds (38).

Distinguishing homicidal cuts from suicidal cutting wounds is essential. In homicide defensive cuts on the palms and arms can be observed.

The location of the wounds as well as the number help to differentiate. In homicide multiple stab wounds on the side, the back and the stomach are observed. In suicide cuts usually one wound is found which is located most commonly across the wrist. Presence or absence of the murder weapon and note is another indicator, with the weapon present and a note written, it is considered suicide (41). Suicidal attempts and gestures have certain features that point to these motives. Knife wounds if suicidal in origin favor specific “sites of election” which can be seen in Figure 1. Those are mostly found on areas like the wrist, throat, the front of the chest, just above the heart. Cutting of the throat and stabbing of the chest is predominantly seen in men, as the most violent suicidal method, but the cutting of the wrist is not an uncommon method in women.

Other indicators of a suicidal motive are that the wounds are typically multiple and often characterized by several practice cuts, called “tentative incisions”.

Trial cuts are mostly noticed on the sites of election. The person usually produces multiple, shallow incisions, presumably hesitating while gaining the courage to make the final cut. Presence of trial cuts is a strong indicator for suicide however, exceptions do occur (38).

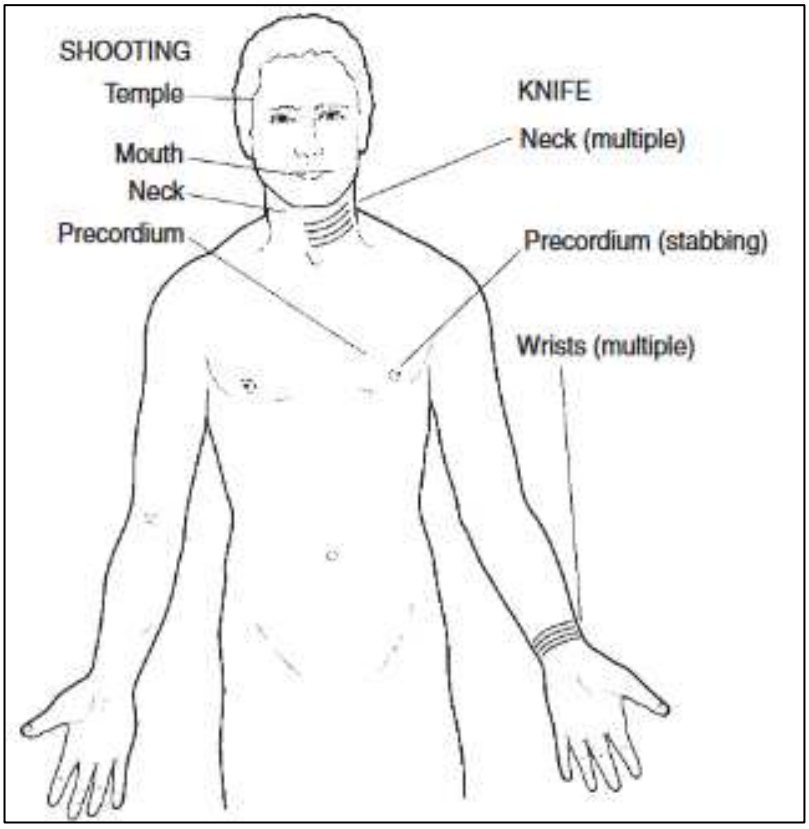

Figure 1. Sites of election; Source: (38).

1.2.4.2. Suicidal cut throat

Usually, trial incisions can be found on a suicidal cut throat varied from only one to two. If the attempt was successful, one or more deep incisions can be found. Those incisions may destroy some of the previously made shallow cuts, an example of suicidal cut throat can be seen in Figure 2. Assuming that the victim is right-handed the typical description for the cutthroat would define an incision starting just below the angle of the jaw on the left side of the neck, passing obliquely across the front of the neck and ending at the lower right level. This description would assume the victim is right-handed. At the origin cuts tend to be deeper, becoming more and more shallow as they cross the throat almost ending superficial at the extremity.

Attention must be paid to the character of the cuts: most people raise the chin to ensure better access to the throat, leading to straight-edged incisions rather than "Toothed" incisions which are incisions when the knife is moved over non-stretched, flappy skin. Raising the chin may displace the carotid bundle, which is under the protection of the sternocleidomastoid muscle. If the cuts are confined to the center of the neck they are rather damaging to the larynx and trachea than to the large blood vessels of the neck. Suicidal cutthroat leading to death relies on the nature, but also the degree of the localized damage to the neck; massive hemorrhage from the vessels of the neck like the jugular veins, or less often the well-protected carotid arteries lead to exsanguination. Damage to the larynx or trachea may lead to hemorrhage from local vessels which may block the airway with blood or clots. Rarer than blockage of the airways, air embolism is likely to occur by aspiration of air into the cut vessels of the neck while standing or sitting with the neck above the level of the thorax. Nevertheless, unrelated causes should always be kept in the back of the head, as many suicides use multiple methods of suicide to ensure success. (38).

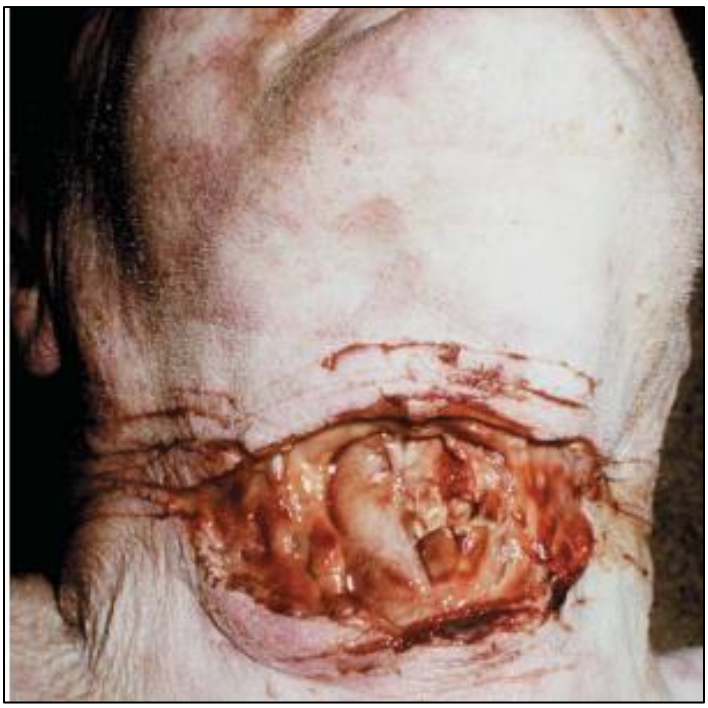

Figure 2. Suicidal cut throat. Source:(38).

1.2.4.3. Cutting of the wrist

Cutting of the wrist is known to be hardly successful as the only method of suicide but is still a commonly observed injury. Large numbers of suicides that resulted from other causes show scars on the wrist, indicating suicidal gestures and previous unsuccessful attempts. The frequently used site is depicted in Figure 3 and is found at the level of the skin flexion creases. Just as observed as with cutting the throat, several tentative cuts may be present.

The most common target is the left wrist, being the consequence of right-handed dominance, being 86% in men and even 98% in women. As with the neck, the victim mostly hyperextends the wrist before cutting, thereby displacing the radial artery under the protective shelter of the lower end of the radius. Majority of cuts miss blood vessels and flexor tendons and thereby do not do anything but superficial damage, that's why most cuts to the wrist accompany more effective methods of self-destruction (38).

Figure 3. Knife wound of the wrist. Source: (38).

1.2.4.4. Injuries to the chest

Injuries of the chest are almost always stab wounds. Stab wounds are commonly found over the left side of the chest, with the person aiming for the heart. These wounds are most likely single, but also multiple wounds have been observed (38).

1.2.4.5. Firearm wounds

To determine if it is dealt with a suicide or homicide the body needs to be examined carefully. Injuries to the side of the head, into the mouth or on the chest are usually typical sites for suicidal wounds.

Most suicide wounds are shots fired from a contact or near range, due to the limitation of one's arm length. The burn mark around the wound is cause by the shot and leaves residues of gun powder. Also examine if there are any gun powder residues on the victim's hand, this finding is also pointing to a suicide.

Gunshot residues (GSR) are produced because all firearms explode when fired. As the bullet is fired smoke and particles of unburned power are carried sideways by the expansion of gases, those residues also contain nitrates. Nitrates can stick to the hand of the person shooting and thereby being the indicator that the person is the shooter. With increasing distance from victim to shooter the amount of GSR is decreasing, this is demonstrated in Figure 4.

Figure 4. Comparison of shooting distance as seen in GSR. The closer the shooter is to the victim, the darker the GSR. Source: (39).

GSRs can be removed by washing, but chemical testing often reveals the residue despite the attempt to remove the evidence. Differentiation between entrance wound and exit wound is an important step in recreating and understanding the crime scene.

Generally speaking, entrance wounds are smaller than exit wounds, because the skin is elastic and stretches while the bullet is entering the body. In contrast to smaller entrance wounds, exit wounds are usually larger because the bullets collect bone, tissue or blood on their way through the body. The presence of GSR is indicative for an entrance wound, as residues are usually only found on entrance wounds.

Telltale marks can be found if the bullet is fired with the muzzle in contact to the skin, the hot gases that are released from the muzzle burn the skin and leave those characteristic marks.

Organs, bones and tissue bend the path of a travelling bullet and cause a tumbling effect, which can result in more irregular and larger exit wounds than expected. A bullet may cause considerable damage before exiting the body, but there is also the possibility that a bullet does not exit the body at all.

Several factors determine if a bullet is exiting the body or remaining lodged like speed, if the bullet has a high speed the energy transferred is enough to pass through the body while low velocity bullets are more likely to remain in the body. Another determining factor is the caliber of the bullet. Large caliber bullets tend to exit the body while mall caliber bullets tend to lodge within the body. Can any defense wounds of marks be found what point us to the homicide? Is the person dresses or undressed, usually shots through clothing suggest homicide? Also, the angle of the shot must be determined as most suicidal shots are aimed slightly upward (39).

Shooting, as a method of suicide, is rarely seen in women. Men tend to shoot themselves more often than females with numbers decreasing with age. Although exceptions may occur a sot woman is a murdered woman until proven otherwise. Sites of election for firearm wounds are the temple, neck, mouth and chest. Targeting and shooting an anatomically inaccessible sites can never be declared suicide (37). For damage to occur from a shoot some or even all of the kinetic energy of the moving bullet has to be absorbed by the targeted tissue. This energy can be absorbed as noise, mechanical disruption and heat. If a bullet passes completely through soft tissue, it retains most of the kinetic energy. It thereby fails to transfer its energy as damage to the tissue apart from the bullet track. If the bullet track is at a limb no serious effects may be apparent, though the same track in the brain, lung or heart may prove fatal. The air route of the projectile also regulates how much and how fast the energy is transferred to the targeted tissue. Besides the mechanical blow tissues can be lacerated or crushed, bones displaced and blood vessels ruptured.

The passing missile delivers a shock wave of compression ahead of the laceration tract. Although the wave lasts only for a brief period it lasts long enough to raise the tissue pressure.

This increase in tissue pressure can lead to severe damage within a wide area around the bullet track to tissues like the brain, liver and muscle (38).

1.2.4.5.1. Type of weapon

Recent firearms are divided into two basic types, long guns and hand guns (39). A long-gun or shotgun is usually not the weapon of choice. Most of the people are using a handgun to shot themselves. Accounting for the preference of handguns may be the easier handling. The short barrel length may be of importance, as it is difficult to aim and pull the trigger at oneself with a long gun. Another factor making a handgun the weapon of choice is the availability, as most people keep guns for their protection at home (40).

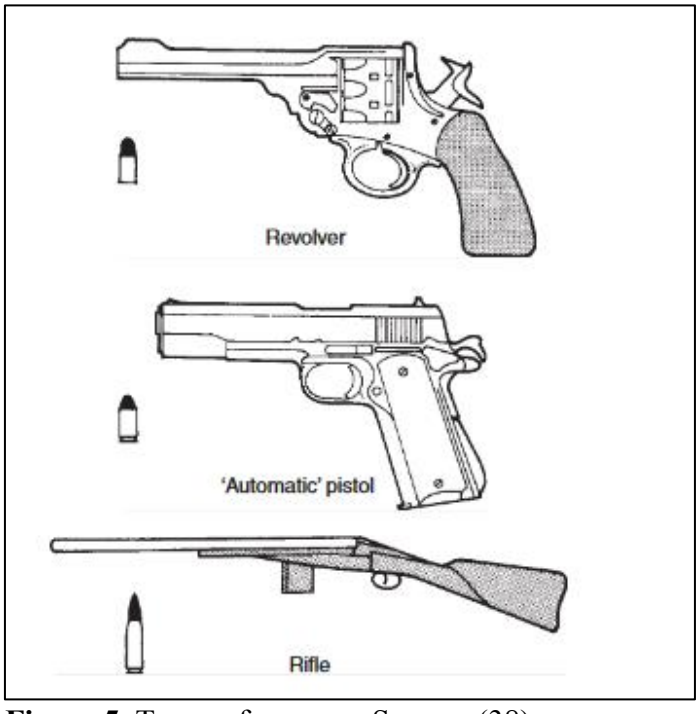

Figure 5. Types of weapon. Source: (38).

1.2.4.6. Suicide by submersion

Submersion is a commonly observed mode of self-destruction seen in both genders. As this mode of self-destruction is depended on the presence of water such as rivers, seas, lakes and even bathtubs, marked geographic variations are present. Often submersions are mixed with other means of self-destruction such as drug overdose, especially in baths the combination with electrocution is not uncommon. People who kill themselves by submersion usually remove their clothes (38).

1.2.4.6.1. Signs of submersion

The process of skin maceration begins within minutes in warm water, like a bathtub but can take longer with the minimum being about 4 to 5 hours in cold water with a variable time depending on the water temperature. The first areas being affected are the ones with a noticeable keratin layer. Such areas include palms, fingertips, the back of the soles and the hands These areas become wrinkly, pale and sodden, also called washer-woman's skin. Parts of the body protected by clothes develop these changes later.

After the body has spent days in warm water or even several weeks in cold water the keratin of hands and feet detaches and peels off at the same time the nails and hair become loosened. “Goose flesh” or “Cutis anserina” is a frequent discovery in immersed bodies mainly found in cold water.

This “goose flesh” is observed because the erector pilae muscles which are attached to every hair follicle contract in any type of death and cause the generalized pimpling of the skin.

Often mud, seaweed, silt, aquatic animals or sand may be present in or on the body (38).

1.2.4.6.2. Duration of immersion

Estimation of the duration a body spent in the water is a difficult problem with the decisive factors being water temperature which has the most effect regarding decomposition. With a body being immersed in water of average temperature some findings may guide to the right timing. If there is no wrinkling on the fingers the body is has spent less the a few hours in water. In comparison if wrinkled fingers, palms or feet are observed time spent in water is estimated to be between half a day and three days.

If decomposition is found on the neck or the head the body has spent 4 to 10 days in the water, whilst a bloated face or abdomen or peeling of the epidermis of the hand and feet indicates a time spent in water between 2 and 4 weeks. If muscle loss with skeletal exposure or gross skin shedding is seen the body spent 1 to 2 months immersed (38).

1.2.4.6.3. Deaths in the bathtub

Many suicides take place in the bathroom, with the cabinet holding a wide variety of options for self-destruction like razors for cutting or drugs for overdosing but also electricity is more fatal in a wet surrounding making the bathroom a commonly chosen place for suicide (38).

1.2.4.7. Drowning

Deciding if a person downed post-mortem depends on the time that passed between death and the examination of the body as signs of drowning progressively disappear (38).

1.2.4.7.1. Froth in the airways

The signs indicating drowning are in comparison to immersion not specific, but the most useful of them is the presence of frothy fluid in the airway, found in the nostrils and mouth of fresh bodies.

This edematous fluid consists of a proteinaceous exudate and surfactant mixed with the water of the drowning medium. The froth is usually white in appearance but may vary from pink to red if intrapulmonary bleeding has occurred. The froth then spreads into the trachea, down into the main bronchi and enters the smaller airways. The lungs themselves become clogged with water and exude a frothy fluid when squeezed. Unfortunately, the presence of frothy fluid is not diagnostic for drowning as in "dry-lung drowning" no fluid can be observed, presumably because all of the aspirated water has been absorbed through the alveolar walls into the plasma (38).

1.2.4.7.2. Overinflation of the lungs

As mentioned above the lungs get clogged with water but they also may show marked overinflation. The surface of the lungs appears rather pale and crepitant, resembling the finding in asthma, this condition is also known as "emphysema aquosum".

The edema fluid in the bronchi blocks the passive collapse of the lung that usually occurs at death keeping the lungs in an inspiratory position. Some areas of intrapulmonary hemorrhage may be seen, which gives the edema fluid a pink appearance. These areas seldomly are large or intense. Moreover, the stomach can contain water or foreign material from the water like silt, weed or sand but the presence of watery fluid in the stomach is not enough to aid the diagnosis (38).

1.2.4.8. Other asphyxia injuries

The underlying process of asphyxial death is the cellular failure to receive or utilize oxygen. The partial lack of oxygen deprivation is called hypoxia whereas a total deprivation is known as anoxia.

Visceral congestion, petechiae and cyanosis are the classical signs found in asphyxia but can also occur in deaths from other causes.

Figure 6. Petechial hemorrhage in the eye. Source: (38)

Visceral congestion is the result of obstructed venous return, while petechiae are produced by the rupture of small vessels. Cyanosis of course is a nonspecific sign and can be the result of a variety of other conditions (41).

1.2.4.8.1. Suffocation

Suffocation is the term used if death is ensured from reduced oxygen concentration in the respired atmosphere. A variety of situations can lead to the reduction of atmospheric air.

Decompression, as occurs in-cabin failure in an aircraft, can be the cause of reduced atmospheric oxygen but more commonly the cause is the replacement of oxygen by other gases like cyanide, carbon monoxide, and many other toxic gases released from the burning of plastic. Deaths are not caused by the toxicity of the gases but rather by the displacement of oxygen from the atmosphere. Methane and Carbon dioxide are the most common suffocating gases both being odorless and nontoxic. A reduction to less than 25% of atmospheric oxygen results in unconsciousness within seconds and death occurring in minutes.

In the domestic setting, death may ensure from a heating apparatus that removed all the oxygen in the absence of ventilation. Usually, the heater is left burning all night long in a small room with the effect being attenuated by the victim having blocked up cracks in the doors and windows to keep out draughts (41).

1.2.4.8.2. Strangulation

Strangulation, is defined as the occlusion of the blood vessels and airways of the neck. This closure is the result of external pressure on the neck. Strangulation can be divided into three forms: Ligature strangulation, manual strangulation and hanging. Hanging is always suicidal while ligature and manual strangulation appear to be homicidal. The cause of death in all forms of strangulation is cerebral hypoxia. Cerebral hypoxia is occurring secondary due to the compression and thereby occlusion of the vessels supplying the brain. Circulation to the brain is maintained through the internal carotid, vertebral, small spinal arteries and branches of the external carotid and subclavian regarding arterial supply.

The venous drainage is maintained mainly by the jugular veins and the cervicalis profunda veins. Due to the superficial location of the carotid arteries, they can be easily compressed by direct pressure applied to the front of the neck. In contrast, due to their anatomic location the vertebral arteries are resistant to direct pressure but can be occluded by severe lateral flexion or rotation of the neck, like in hanging.

Pressure needed to occlude the carotid arteries is approximately 11lb, while the pressure to occlude the vertebral arteries is 66lb, showing again the difference in anatomical locus. Occlusion of the carotid arteries causes unconsciousness within seconds (41).

1.2.4.8.3. Hanging

Binding or squeezing of the neck by a noose or other constricting bands that tighten the bodyweight is the cause of asphyxia in hanging. Suspension of the body may be complete or incomplete. Complete and incomplete suspension is shown in Figure 7 and 8.

Figure 7. Hanging, incomplete suspension. Source: (39).

Figure 8. Complete suspension hanging. Source: (39).

In incomplete suspension the lower extremities, like toes or feet, but also the knees or buttocks, less commonly touch the ground. All hangings are suicidal, accidental hangings are uncommon and homicidal hangings are very rare though still possible. As already mentioned above death is caused by compression of blood vessels of the neck, thereby an insufficient amount of oxygen reaches the brain. Air passages can also get obstructed, but airway obstruction is not necessary to cause death. Fractures of the neck play no role and if observed are frequently seen in individuals with already advanced degenerative disease of the cervical spine like osteoarthritis. Because of their anatomical availability, only a small amount of pressure is needed to compress the carotid arteries, that is why hanging can occur while sitting, kneeling or even lying down.

To occlude the carotid arteries sufficiently the sole weight of the head against a noose is already enough. A simple slipknot type of noose is typically used, with the noose being tied from anything handy like a rope.

Electrical cords and belts are most commonly used in the general population while hanging in prisons use sheets, T-shirts and even socks. The side of the neck is the most commonly chosen point of suspension followed by the back and the front. The noose slips above the larynx at the time of suspension and gets caught under the chin leaving a furrow.

This furrow does not encircle the entire neck, it rather leans upward toward the knot and fades out at the point of suspension. The structure of the furrow depends on the material used.

While a rope will give a well-demarcated and distinct furrow, soft material will leave a poorly defined groove devoid of bruises and abrasions. Also, the time the body has been suspended influences the furrow. In almost all cases of hanging the face is pale and the tongue protrudes and is black. Exceptions to this presentation are seen in partially suspended individuals where the carotid arteries and venous drainage are obstructed but the supply blood to the head from the vertebral is still preserved, producing congestion of the face and petechiae. Secondary to gravity, blood will flow into the forearms, hands and legs causing rupture of the vessels from increased hydrostatic pressure. This rupture of vessels leads to punctual hemorrhages and Tardieu spots (38,41).

1.2.4.9. Jumping from a height

Jumping from a height, also known as `precipitation` is a mode of suicide that is determined rather by the circumstances than the autopsy findings postmortem. The injuries gained from jumping may be variable depending on factors like how the body was striking the ground, was there any contact with obstacles during the fall, and what was the height of the drop.

Most commonly head injuries are found in people choosing this method of suicide, but if they fall on their feet first, injuries ensue at any point from the talus to the cranium (38).

Most jumps occur from high residential houses, but also other sites like bridges have become well-known places to take one´s life. As private as suicide can be, when choosing to jump from a high place like a public building, or a bridge it becomes a public action by nature. Individuals jumping from residential building units are usually older and male, choosing this pace out of comfort due to the easy accessibility and proximity. In comparison precipitation occurring from a public area like a bridge is usually seen in younger males suffering from psychiatric illnesses (42).

1.2.4.10. Overdosing

Overdosing is defined as taking more than the recommend amount of something, often a drug. There are different types of overdosing, if it is done on purpose, it is called intentional or deliberate. In contract if an overdose is taken by mistake it is defined as accidental.

Overdosing can have serious consequences, resulting in serious symptoms or even death. Overdosing should not be mistaken with poisoning, although the resulting symptoms can be the same. Poisoning is when someone or something, like the environment is exposing a person to dangerous goods like chemicals, plans, or any harmful substances without yourself knowing about it (43). Overdosing as method of suicide is a growing global health care problem. The typical patient attempting suicide by overdosing is a young, single female taking an overdose of an already prescribed drug, most commonly a benzodiazepine. People with a higher risk for overdosing are recently separated or divorced, alcoholics or those with a preexisting mental problem like depression (44). Studies show that intentional suicide is varying by month, with the lowest rate noted in December, while the highest rates are observed during late spring and summer. The lower rates during December may be explained by the positivity and excitement during the holiday season.

The longer daylight hours during late spring and summer are related to a seasonal change in mu receptors in the brain. These mu receptors are opioid receptors that influence mood and behavior, they are also the targets of opioid drugs, the drugs that are most frequently identified in deliberate overdose deaths (45).

Over the last years the drug of choice has changed from benzodiazepines and barbiturates to antidepressants being the drug of choice, specifically tricyclics. The mechanism causing death from an overdose of tricyclic antidepressants is cardiac by producing abnormalities in intraventricular conduction, tachycardia and a marked widening of the QRS complex and ventricular fibrillation. CNS effects observed are confusion, agitation, hallucinations seizures and coma. After tricyclic antidepressants the drug being most responsible for intentional overdose is actually a combination of several drugs. The most commonly combined drugs are alcohol mixed with tricyclic antidepressants, followed by diazepam (41).

2. OBJECTIVES

2.1. Aim of this study

The aim of this study was to investigate suicide rates in Split-Dalmatia County, Croatia during the COVID-19 pandemic compared to suicide rate the 10 years prior. This was achieved by comparing the data collected by the Croatian institute of public health, Zagreb leading up to the COVID-19 pandemic between 2010 to 2019 with the COVID-19 pandemic starting 2020, using different parameters including the following: age groups, gender, place, cause of death and type of suicide. This study puts the collected data into retrospective and accesses the development of suicide rates in the dalmatian population in the pre- and early COVID-19 period.

Hypotheses:

- There will be no statistically significant change in suicide rates/100,000 per year comparing the pre-COVID and COVID period.
- There will be an increase of suicidal rates in the age group of 25-29 years.
- The suicidal rate for this age group will be 3,4 times higher during the COVID period.
- No statistically significant difference of suicidal rates will be observed in other age groups.

3. SUBJECTS AND METHODS

3.1. Subjects

This retrospective epidemiological study included 482 subjects/participants, which were categorized by age groups, gender, place, type of suicide and cause of death. The data were obtained from the Department of Public Health in Zagreb, Croatia.

3.2. Methods

This was a retrospective epidemiological study on suicide incidence in Split-Dalmatia County from January 1st 2010 to December 31st 2020. The study was approved by Ethics Committee of the Croatian institute of public health Zagreb. The data of suicide cases was obtained from the mortality database of the Croatia public health institute Zagreb.

The collected data contained information about the year of suicide, place, gender, age groups and cause of death. Causes of death and mechanism of suicide were coded according to International Classification of Diseases, Tenth Revision (ICD-10).

The MedCalc (version 19.2.6, MedCalc Software, Ostend, Belgium) statistical program was used for data analysis in this study. The results of the study were presented as whole numbers (%) and suicidal rates, which were compared by "Comparison of two rates". The level of statistical significance was set at $P < 0.05$. Confidence intervals were given at 95% level.

4. RESULTS

In Split Dalmatia County 481 suicides were reported from 2010 to 2020. The youngest person committing suicide was in the group from 10-14 years of age, the oldest person committing suicides was older than 85 years.

Table 1. Incidence of suicides / 100.000 persons per year from 2010-2020.

Year	Number of suicides (%) (n=481)	Suicidal rate/100.000 persons/year	*P**
2010	46 (9.6)	11.3	0.915
2011	50 (10.4)	12.3	
2012	42 (8.7)	10.3	
2013	44 (9.1)	10.8	
2014	43 (8.9)	10.6	
2015	35 (7.3)	8.6	
2016	53 (11)	13	
2017	40 (8.3)	9.8	
2018	56 (11.6)	13.8	
2019	29 (6)	7.1	
pre-COVID period: (10 years total)	438	10.8 (95% CI: 7.9-14.5)	
COVID year:			
2020	43 (8.9)	10.6 (95% CI: 7.6-14.2)	

*Comparison of two rates, MedCalc

COVID – Covid 19 disease; CI – confidence interval

There was no statistically significant difference in suicidal rates / 100.000 persons / per year between pre-COVID period and COVID-year (*P*=0.915).

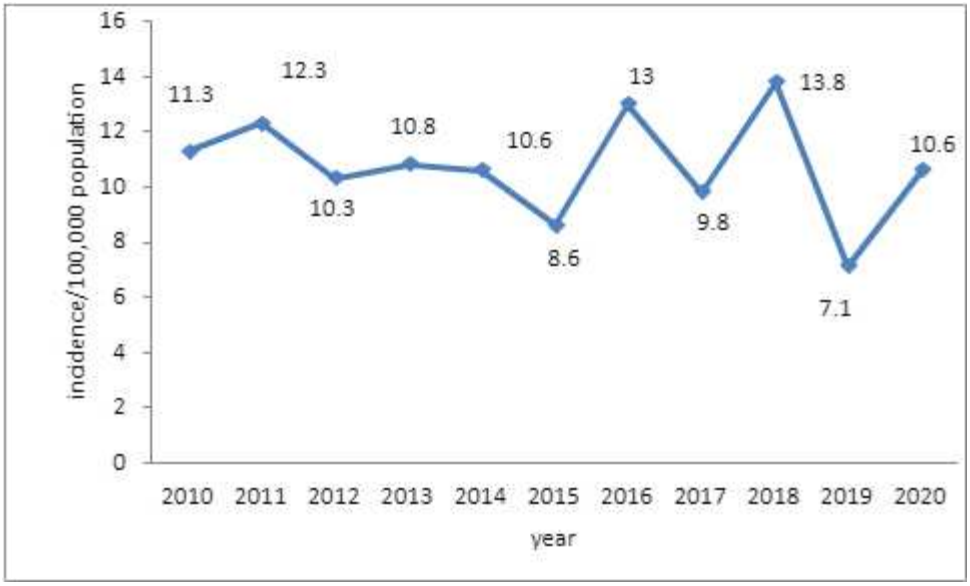

Figure 9. Incidence of suicides per 100.000 population / year from 2010-2020 in Split- Dalmatia County.

Table 2. Number of suicides from 2010-2020 (pre-COVID and COVID period together) according to gender in Split-Dalmatia County.

Gender	Total number of suicides (%) from 2010-2020	Suicidal rate/ 100.000 persons/year	*P**
			0.003
Male	337 (70)	15.8 (95% CI: 10.7-22.3)	
Female	144 (30)	6.2 (95% CI: 6.3-10.6)	
Incidence rate difference between male and female		9.5 (95% CI: 3.1-15.9)	
Male (n=337)			0.799
pre-COVID (2010-2019)	305	15.2 (95% CI: 10.3-21.8)	
COVID (2020)	32	16.2 (95% CI: 11.1-22.9)	
Female (n=144)			
pre-COVID (2010-2019)	133	6.3 (95% CI: 3.3-10.6)	0.683
COVID	11	5.2 (95% CI: 2.6-9.4)	

*Comparison of two rates, MedCalc

COVID – Covid 19 disease; CI – confidence interval

The incidence of suicides in males was 2.5 times higher than in females. The incidence rate difference between males and females was 9.5 (P=0.003). There was no statistically significant difference of incidence of men (P=0.799) between pre-COVID and COVID period as well as in women (P=0.683).

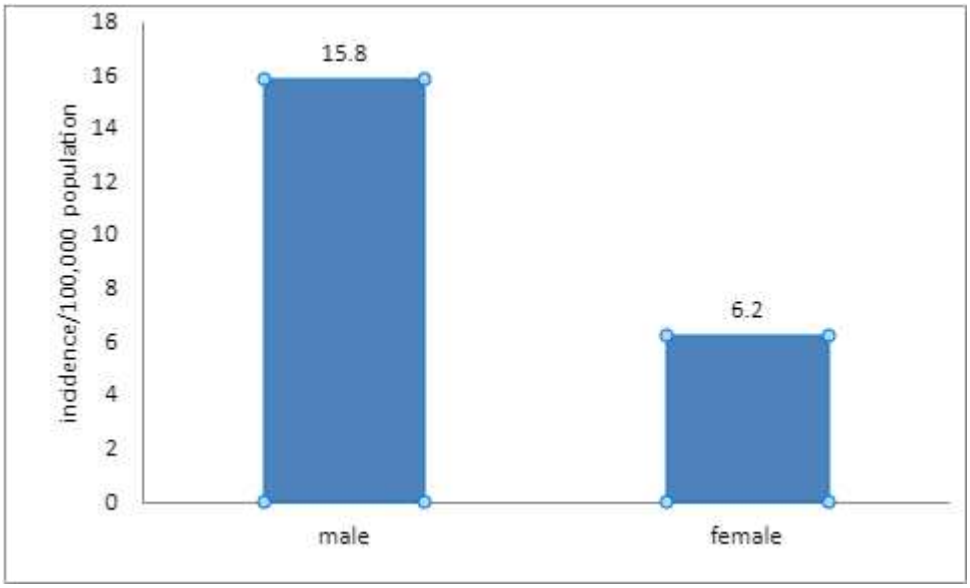

Figure 10. Incidence of suicidal rates compared in male and female population from 2010-2020 in Split-Dalmatia County.

Table 3. Number of suicides from 2010-2020 (pre-COVID and COVID period together) according to age groups in Split-Dalmatia County.

Age groups	Total number of suicides (%) from 2010-2020	Specific suicidal rate/ 100.000 persons/year	Male/female
10-14	1 (0.2)	0.3	1/0
15-19	4 (0.8)	1.3	2/2
20-24	25 (5.2)	7.8	18/7
25-29	28 (5.8)	8.4	21/7
30-34	18 (3.7)	5.4	17/1
35-39	31 (6.4)	9.3	23/8
40-44	36 (7.5)	10.8	25/11
45-49	35 (7.3)	10.0	25/10
50-54	44 (9.1)	11.9	30/14
55-59	50 (10.4)	14.4	36/14
60-64	47 (9.8)	14.5	32/15
65-69	35 (7.3)	17.2	27/8
70-74	35 (7.3)	14.7	21/14
75-79	34 (7.1)	17.7	23/11
80-84	35 (7.3)	28.4	21/14
85+	23 (4.8)	33	15/8

In Table 3 we compared the suicidal rates according to age groups from 2010-2020. According to Table 3 and median value (median: 10,4; Q1-Q3: 6-14,7; min-max: 0,3-33) of specific incidence according to age groups we found that:

In the age groups:

1. 10-14 and 15-19 specific incidence was lower than 3.3
2. 20-39, 40-44 and 45-49 and 50-54 specific incidence was: 5.4-11.9
3. 50-59, 60-64 and 70-74 specific incidence was: 14.4-14.7
4. The highest specific incidence (higher than 17) was in the groups 65-69, 75-79, 80-84 and 85+ (min-max: 17.2-33)

Table 4. Comparison of pre-COVID and COVID period according to number of suicides according to age groups.

	pre-COVID (2010-2019)		COVID (2020)		*P**
Age groups	Total number of suicides (%) from 2010-2019 (n=438)	Specific suicidal rate/ 100.000 persons/year	Total number of suicides (%) 2020 (n=43)	Specific suicidal rate/ 100.000 persons/year	
10-14	1 (0.2)	0.4	0	0	
15-19	4 (0.9)	1.4	0	0	
20-24	23 (5.3)	7.9	2 (4.7)	6.9	
25-29	21 (4.8)	6.9 (95% CI: 0.8-23.9)	7 (16.3)	23.2 (95% CI: 9.3-47.9)	0.095
30-34	16 (3.7)	5.2	2 (4.7)	6.6	
35-39	31 (7.1)	10.2	0	0	
40-44	32 (7.3)	10.6	4 (9.3)	13.2	0.617
45-49	32 (7.3)	10.0	3 (7)	9.4	
50-54	41 (9.4)	12.2	3 (7)	8.9	0.705
55-59	45 (10.3)	14.2	5 (11.6)	15.8	0.739
60-64	43 (9.8)	14.6	4 (9.3)	16.2	
65-69	32 (7.3)	17.3	3 (7)	16.3	
70-74	30 (6.8)	13.8	5 (11.6)	23.1	0.479
75-79	32 (7.3)	18.3	2 (4.7)	11.4	0.655
80-84	33 (7.5)	29.5	2 (4.7)	17.9	0.655
85+	22 (5)	34.6	1 (2.3)	15.7	0.564
≥65-94	149	26.5 (95% CI: 14.8-44)	13	22.9 (95% CI: 12-39)	0.705

There was no statistically significant difference of suicidal rates according to age groups between pre-COVID and COVID period, except for 25-29 age group. The suicidal rate during the COVID period was 3.4 times higher than during pre-COVID period (*P*=0.095).

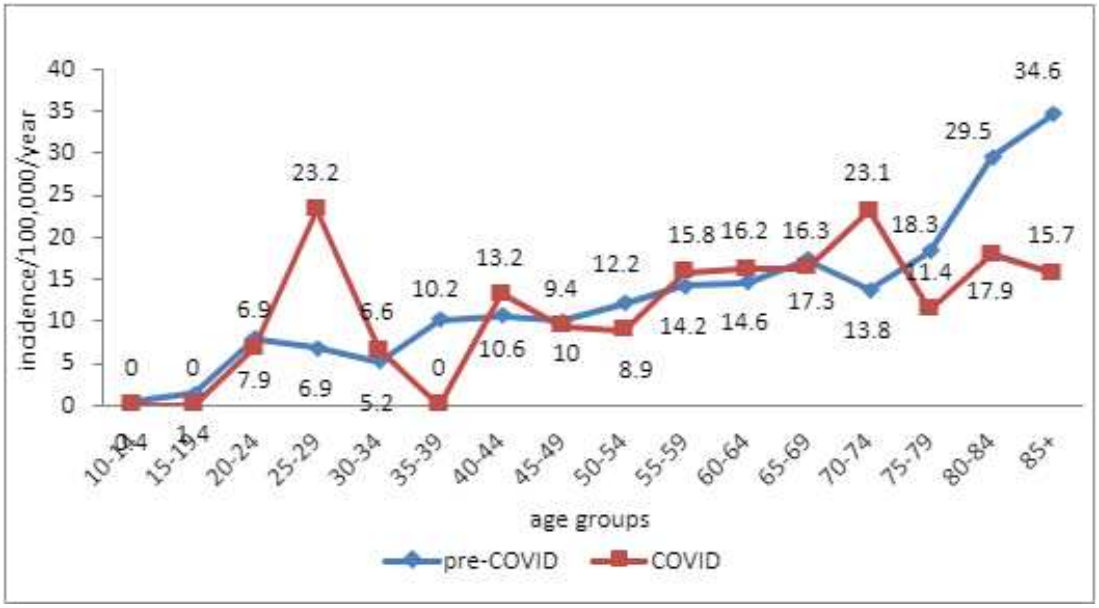

Figure 11. Incidence of suicidal rate in different age groups before the Covid pandemic and during the COVID pandemic in Split-Dalmatia County.

Table 5. Types of suicide according to ICD-10 from 2010 -2020 Split-Dalmatia County.

	Number (%) of suicides from 2010-2020, suicidal rate/100.000/year; number (%), suicidal rate/100.000/year according to gender				
ICD-10		Total number (%); suicidal rate n=481	Males (n=337) Number (%); suicidal rate	Females (n=144) Number (%); suicidal rate	*P**
X61-X69	Intentional self-poisoning	31 (6.4); 0.7	16 (4.7); 0.74	15 (10.4); 0.65	0.964
X70	Intentional self-harm by hanging, strangulation and suffocation	234 (48.6); 5.2	172 (51); 7.9	62 (43.1); 2.7	0.022
X71	Intentional self-harm by drowning and submersion	40 (8.3); 0.9	14 (4.2); 0.64	26 (18.1); 1.1	0.602
X72	Intentional self-harm by handgun discharge	11 (2.3); 0.25	10 (3); 0.46	1 (0.7); 0.04	
X73	Intentional self-harm by rifle, shotgun and larger firearm discharge	8 (1.7); 0.18	8 (2.4); 0.37	0;0	
X74	Intentional self-harm by other and unspecified firearm and gun discharge	37 (7.7); 0.83	33 (9.8); 1.5	4 (2.8); 0.17	
X75	Intentional self-harm by explosive material	6 (1.2); 0.13	6 (1.8); 0.28	0;0	
X78	Intentional self-harm by sharp object	23 (4.8); 0.51	20 (5.9); 0.92	3 (2.1); 0.13	
X80	Intentional self-harm by jumping from a high place	81 (16.8); 1.8	51 (15.1); 2.3	30 (20.8); 1.3	
X81	Intentional self-harm by jumping or lying in front of moving object	3 (0.6); 0.07	3 (0.9); 0.14	0;0	
X84	Intentional self-harm by unspecified means	6 (1.2); 0.13	4 (1.2); 0.18	2 (1.4); 0.09	
X87	Pesticide attack	1 (0.2); 0.02	0;0	1 (0.7); 0.04	

*Comparison of two rates, MedCalc

COVID – Covid 19 disease; CI – confidence interval; ICD-10 - International Classification of Diseases, Tenth Revision ICD-10

From distribution of specific suicidal rates according to ICD-10 classification we found that for all specific procedures coded in table 5 the rate was <1 except for X70 (Intentional self-harm by hanging) (specific rate 5.2) and X80 (Intentional self-harm by jumping from a high place) (specific rate 1.8).

The suicidal rate caused by X70 was 2.9 times higher in males than in females (P=0.022).

There was no statistically difference according to X61-69 (Intentional self-poisoning)(*P*=0.964), X71 (*P*=0.602), between males and females from 2010-2020.

As demonstrated in Table 5. no women committed suicide using X73 (Intentional self-harm by rifle, shotgun and larger firearm discharge), X75 (Intentional self-harm by explosive material) and X81 (Intentional self-harm by jumping or lying in front of moving object).

No men committed suicide categorized X87 (Pesticide attack).

We reported that X70 was chosen by men for suicide more often than by women. Although because of small sample size we did not calculate *P* values for all X but we can notice that:

- Specific incidence for Intentional self-harm by drowning and submersion (X71) in women was 1.7 time higher than in men
- Specific incidence for Intentional self-harm by handgun discharge (X72) in men was 11.5 times higher than in women
- Specific incidence for Intentional self-harm by other and unspecified firearm and gun discharge (X74) in men was 8.8 times higher than in women
- Specific incidence for Intentional self-harm by sharp object (X78) in men was 7.1 higher than in women
- Specific incidence for Intentional self-harm by jumping from a high place (X80) in men was 1.8 higher than in women

Table 6. Comparison according to ICD-10; pre-COVID and COVID in Split-Dalmatia County.

		Pre-COVID (2010-2019)		COVID (2020)	
ICD-10		Total number of suicides (%) from 2010-2019 (n=438)	Specific suicidal rate/ 100.000 persons/year	Total number of suicides (%) 2020 (n=43)	Specific suicidal rate/ 100.000 persons/year
X61-X69	Intentional self-poisoning	26 (5.9	0.7	5 (11.69)	1.2
X70	Intentional self-harm by hanging, strangulation and suffocation	213 (48.6)	5.1	21 (48.8)	5.1
X71	Intentional self-harm by drowning and submersion	38 (8.7)	0.9	2 (4.7)	0.5
X72	Intentional self-harm by handgun discharge	10 (2.3)	0.2	1 (2.3)	0.2
X73	Intentional self-harm by rifle, shotgun and larger firearm discharge	8 (1.8)	0.2	0	
X74	Intentional self-harm by other and unspecified firearm and gun discharge	32 (7.3)	0.7	5 (11.6)	1.2
X75	Intentional self-harm by explosive material	6 (1.4)	0.2	0	
X78	Intentional self-harm by sharp object	20 (4.6)	0.5	3 (7)	0.7
X80	Intentional self-harm by jumping from a high place	75 (17.1)	1.7	6 (14)	1.5
X81	Intentional self-harm by jumping or lying in front of moving object	3 (0.7)	0.2	0	
X84	Intentional self-harm by unspecified means	6 (1.4)	0.2	0	
X87	Pesticide attack	1 (0.2)		0	

COVID – Covid 19 disease; CI – confidence interval; ICD-10 - International Classification of Diseases, Tenth Revision;

As already demonstrated in Table 5 the most common method of suicide was Intentional self-harm by hanging, strangulation and suffocation (X70). The same specific suicidal rate of X70 was in pre-COVID and COVID period (5.1).

Specific suicidal rate for Intentional self-harm by jumping from a high place (X80) was 1.7 in pre-COVID group and 1,5 in COVID group. For all other methods of suicide, the specific suicidal rates were ≤1.2.

Table 7. Causes of death according to ICD-10 classification; comparison of pre-COVID and COVID in Split Dalmatia County.

	Number (%) of suicides from 2010-2020, suicidal rate/100.000/year; number (%), suicidal rate/100.000/year according to pre-COVID and COVID period			
ICD-10		Total number (%); suicidal rate n=481	Pre-COVID (n=438) Number of suicides; suicidal rate	COVID (n=43) Number of suicides; suicidal rate
T07	Unspecified multiple injuries	69 (14.3); 1.47 (95% CI: 0.5-3.2)	65 (14.8); 1.5	4 (9.3); 0.98
T71	Asphyxiation	235 (48.9); 5.2 (95% CI: 3.2-7.9)	214 (48.9); 5.2	21 (48.8); 5.2
T75	Unspecified effects of drowning and nonfatal submersion, subsequent encounter	39 (8.1); 0.98 (95% CI: 0.3-25)	37 (8.4); 0.98	2 (4.7); 0.5
S01	Laceration without foreign body of scalp, initial encounter	45 (9.4); 0.98 (95% CI: 0.3-25)	39 (8.9); 0.98	6 (14); 1.5
All others		93 (19.3); 1.96 (95% CI: 0.8-3.9)	83 (18.9); 2	10 (23.3); 2.5

COVID – Covid 19 disease; CI – confidence interval; ICD-10 - International Classification of Diseases, Tenth Revision ICD-10;

The specific suicidal rate was 3.5 times higher for Asphyxiation (T71) than for - Unspecified multiple injuries (T07) (P=0.004), 5.3 times higher than for Unspecified effects of drowning and nonfatal submersion (T75) (P<0.001), 5.3 times higher than for Laceration without foreign body of scalp, initial encounter (S01) and 2.6 times higher than all others.

As demonstrated in Table 7. we could not conclude a difference between pre-COVID and COVID according to mechanisms of death.

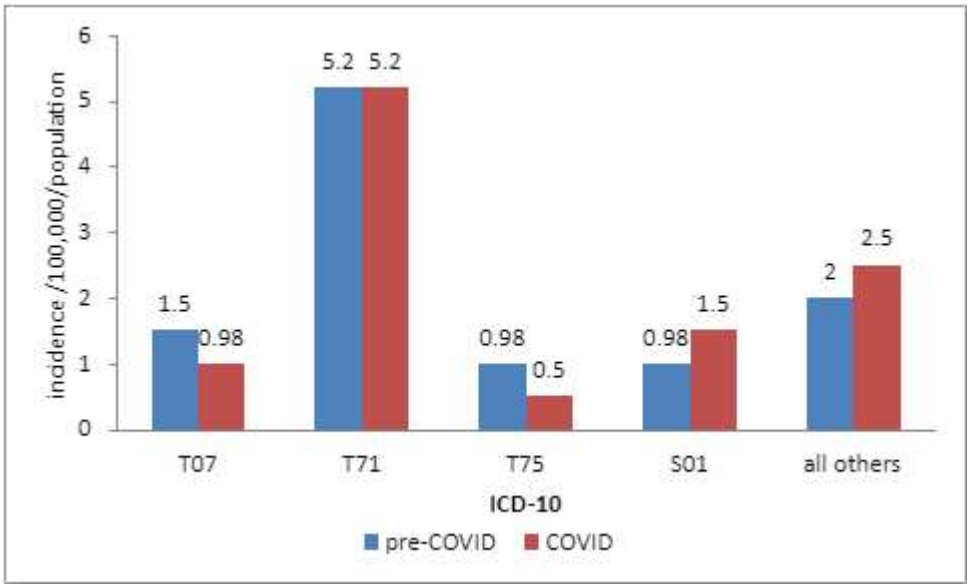

Figure 12. Causes of death compared pre-COVID and during the COVID pandemic in Split-Dalmatia-County.

5. DISCUSSION

This study included the data of all suicides in the period from 01.01.2010 to 31.12.2020 occurring in Split-Dalmatia County. Further we compared the period before the COVID pandemic from 2010-2019 to the COVID period 2020.

The suicidal rate for the pre-COVID period was 10.8/100.000 inhabitants, while the suicidal rate for the COVID pandemic was calculated at 10.6/100.000 inhabitants. Comparing the suicidal rate for the pre-COVID period with the COVID pandemic there was no statistically significant difference in suicidal rates / 100.000 persons / per year between pre-COVID period and COVID-year (P=0.915). The highest suicidal rate reported was in 2018, 13.8/100.000 inhabitants, this rate is still lower than the suicidal rate of 14.2/100.000 inhabitants reported in 2018 in the U.S (46). Also, it is important to notice that the average for Split-Dalmatia County for the year 2019 (7.1/100.000) was noticeably lower than the average of Croatia (16.4/100.000) for the year 2019 (47). The cause of this was not investigated by this study, yet it can be assumed that even during the ongoing pandemic a responsible social interaction was possible due to the Mediterranean weather as well as more possibilities to meet in open spaces.

Comparing the male to female ratio, the incidence of suicides in males was 2.5 times higher than in females in Split-Dalmatia County, with the average for the South of Croatia being 1.94 times higher in males than females (48). There was no statistically significant difference of incidence of men (P=0.799) between pre-COVID and COVID period as well as in women (P=0.683).

Apart from the finding that men commit suicide more often than women we found that the lowest specific incidence was found in the younger age groups. The age group 10-14 and 15-19 had a specific incidence lower than 3.3, compared to the data for 2020 in Germany this low incidence was expected as the smallest number of suicides was reported for the age up to 20 years of life (49). The highest specific incidence of 33 was reported in the age group 85+, 15 men and 8 women committed suicide in this age group during the period from 2010-2020. Women committed suicide most commonly over the age of 60, with 15 women committing suicide in the age group 60-64. Whereas the highest number represented was reported in the age group of 65 years, with 27 men from 2010-2020 (50).

There was no statistically significant difference of suicidal rates according to age groups between pre-COVID and COVID period, except for the age group from 25 to 29. This could be explained by social as well as physical isolation leading to an increase in existential fears and mental health issues. The suicidal rate during the COVID period was 3.4 times higher than during pre-COVID period (Statistical significance: P=0.095). It was reported in literature that the specific suicidal rate was greater in the age groups over 65 years than in groups ≤65 years (51). That is the reason we analyzed specific suicidal rate for these two groups.

Regarding the types of suicide according to ICD-10 from 2010-2020 for Split-Dalmatia County we found that all types of suicide had a rate less than one, except X70 (Intentional self-harm by hanging, strangulation and suffocation) with a specific rate of 5.2 and X 80 (Intentional self-harm by jumping from a high place) with a specific rate of 1.8. The suicidal rate for Intentional self-harm by hanging, strangulation and suffocation was 2.9 times higher in males than in females (P=0.022) There was no statistically difference according to X 61-69, Intentional self-poisoning (P=0.964), X71, Intentional self-harm by drowning and submersion (P=0.602), between males and females from 2010-2020. We reported that X70 (Intentional self-harm by hanging, strangulation and suffocation) was chosen by men for suicide more often than by women. Although because of small sample size we did not calculate p values for all types of suicide, but we can notice that the specific incidence in women was 1.7 time higher according to X71 (Intentional self-harm by drowning and submersion) than men, whereas the specific incidence in men was 11.5 times higher according to X72 (Intentional self-harm by handgun discharge) than women. Intentional self-harm by other and unspecified firearm and gun discharge was reported to have 8.8 times higher specific incidence in men and a 7.1 higher specific incidence for X78 (Intentional self-harm by sharp object) in men. The last difference observed was a 1.8 times higher specific incidence for X80 (Intentional self-harm by jumping from a high place) in men than in women. As already stated above the most common method of suicide was X70. The same specific suicidal rate of X70 was in pre-COVID and COVID period (5.1). Specific suicidal rate for X80 was 1.7 in pre-COVID group and 1.5 in COVID group. All other methods of suicide were ≤1.2. Comparing the causes of death pre-COVID and during the COVID pandemic in Split-Dalmatia County the highest suicidal rate was reported for X71 being 3.5 times higher than for T07 and even 5.3 times higher than S01 (Laceration without foreign body of scalp, initial encounter). No difference between pre-COVID and COVID according to cause of death could be concluded.

Due to the small sample size causes by a lack of provided data only a limited insight could be gained on the comparison of suicide rates during the COVID-19 pandemic. Thus, a more extensive time period including the year 2021 would be necessary to assess a qualitative review of suicidal incidence in Split-Dalmatia County.

6. CONCLUSION

1. According to the obtained data, we concluded that was no statistically significant difference in suicidal rates / 100.000 persons / per year between pre-COVID period and COVID-year.
2. The incidence in males committing suicide was 2.5 times higher than in females.
3. There was no statistically significant difference between pre-COVID and COVID in suicidal rates.
4. The lowest suicidal rate was reported for the younger age groups, lower or equal to 15 years. The highest suicidal rate was reported in group 85+.
5. There was no statistically significant difference of suicidal rates according to age groups between pre-COVID and COVID period, except for 25-29 age group. The suicidal rate during the COVID period was 3.4 times higher than during pre-COVID period.
6. The most common type of suicide chosen was X70. The suicidal rate for X70 was 2.9 times higher in males than in females.
7. We could not conclude a difference between pre-COVID and COVID according to mechanisms of death.

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8. SUMMARY

Objectives: The aim of this study was to investigate and compare suicide rates in regard to age groups, gender, place, cause of death and type of suicide, during the COVID-19 pandemic and the 10 years prior in Split-Dalmatia County, Croatia. Additionally, we aimed to investigate overall suicide incidence during pre-COVID and the COVID pandemic .

Subjects and methods: This retrospective epidemiological study included 481 subjects, which were categorized by age groups, gender, place, type of suicide and cause of death in Split-Dalmatia County from January 1st 2010 to December 31st 2020. Causes of death and mechanism of suicide were coded according to International Classification of Diseases, Tenth Revision (ICD-10).

Results: In Split Dalmatia County 481 suicides were reported from 2010 to 2020. The youngest person committing suicide was in the group from 10-14 years of age, the oldest was older than 85 years. There was no significant difference in suicidal rates / 100.000 persons / per year between pre-COVID period and COVID-year (*P*= 0.915). The incidence of suicides in males was 2.5 times higher than in females with the rate difference of 9.5 (*P*=0.003). There was no significant difference of incidence of men (*P*=0.799) between pre-COVID and COVID period as well as in women (*P*=0.683). There was no statistically significant difference of suicidal rates according to age groups between pre-COVID and COVID period, except for 25-29 age group. The suicidal rate during the COVID period was 3.4 times higher than during pre-COVID period (*P*=0.095). The most common method of suicide was X70, with the same specific suicidal rate in pre-COVID and COVID period (5.1). There was no difference between pre-COVID and COVID according to mechanisms of death.

Conclusion: Our results showed that there was no statistically significant difference in suicidal rates / 100.000 persons / per year between pre-COVID period and COVID-year. The incidence in males committing suicide was 2.5 times higher than in females.

There was no significant difference between pre-COVID and COVID in suicidal rates in men, as well in women. The lowest suicide rate was seen in ages lower than 15 years old. Subsequently, the highest suicide rate was seen in the age group over 85 years. The most common type of suicide was X70, which has not changed since pre-COVID. We could not conclude a difference between pre-COVID and COVID according to mechanisms of death.

9. CROATIAN SUMMARY

Naslov: Usporedba stopa samoubojstava tijekom COVID-19 pandemije i 10 godina prije u Splitsko-dalmatinskoj županiji

Ciljevi: Cilj ovog istraživanja bio je usporediti stope samoubojstava tijekom COVID-19 pandemije i 10 godina prije u Splitsko-dalmatinskoj županiji, Hrvatska. Usporediti razdoblje prije COVID-a u trajanju od 2010. do 2019. s razdobljem COVID-a 2020. Dodatni cilj ove studije bio je istražiti je li došlo do porasta ili čak smanjenja broja samoubojstava prije COVID-a i tijekom pandemije COVID-a te je li bilo promjena u ukupnoj incidenciji samoubojstava.

Subjekti i metode: Ovo retrospektivno epidemiološko istraživanje obuhvatilo je 481 ispitanika/sudionika koji su kategorizirani prema dobnim skupinama, spolu, mjestu, vrsti samoubojstva i uzroku smrti u Splitsko-dalmatinskoj županiji od 1. siječnja 2010. do 31. prosinca 2020. Uzroci smrti i mehanizam samoubojstva su kodirani prema Međunarodnoj klasifikaciji bolesti, deseta revizija (ICD-10).

Rezultati: U Splitsko-dalmatinskoj županiji od 2010. do 2020. godine prijavljeno je 481 samoubojstvo. Najmlađa osoba koja je počinila samoubojstvo bila je u skupini od 10 do 14 godina, a najstarija je bila starija od 85 godina. Nije bilo značajne razlike u stopama suicida /100.000 osoba/ godišnje između razdoblja prije COVID-a i godine COVID-a (P= 0,915). Učestalost samoubojstava kod muškaraca bila je 2,5 puta veća nego kod žena s razlikom u stopi od 9,5 (P=0,003). Nije bilo značajne razlike u incidenciji muškaraca (P=0,799) između razdoblja prije COVID-a i COVID-a, kao ni kod žena (P=0,683). Nije bilo statistički značajne razlike u stopama suicida prema dobnim skupinama između razdoblja prije COVID-a i razdoblja COVID-a, osim u dobnoj skupini od 25 do 29 godina. Stopa suicida tijekom razdoblja COVID-a bila je 3,4 puta veća nego tijekom razdoblja prije COVID-a (P=0,095). Najčešća metoda samoubojstva bila je X70, s istom specifičnom stopom suicida u razdoblju prije i tijekom COVID-a (5,1). Nije bilo razlike između pre-COVID-a i COVID-a prema mehanizmima smrti.

Zaključak: Naši rezultati su pokazali da nije bilo statistički značajne razlike u stopama suicida /100.000 osoba/ godišnje između razdoblja prije COVID-a i COVID-godine. Učestalost samoubojstava kod muškaraca bila je 2,5 puta veća nego kod žena. Nije bilo značajne razlike između prije COVID-a i COVID-a u stopama suicida kod muškaraca, kao ni kod žena. Najniža stopa samoubojstava zabilježena je u dobi ispod 15 godina. Najveća stopa zabilježena je u dobnoj skupini iznad 85 godina. Najčešći tip samoubojstva bio je X70 prije i za vrijeme pandemije. Nismo mogli zaključiti razliku između pre-COVID-a i COVID-a prema mehanizmima smrti.

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