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COMMENTARY

The Effects of Nicotine Vaping on High Schoolers in South Texas

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Introduction

Ironically, vaping was created as an aid to help stop smoking, but it continues to give its users the same life threatening effects that cigarettes have.[1] It seduces its victims with the thousands of different enticing flavors and a false perception that it won't negatively affect your body. The new habit that vaping has become is far from harmless and is becoming a dangerous addiction.[1] This epidemic is booming in the pediatric and youth population since they are being targeted as new consumers instead of what the device was originally intended for, smoking cessation. It has become so normalized that in a Monitoring the Future survey, it was shown that 40% of high school seniors had used it within the past year.[2] The advancements in e-cigarettes retracted the progress that was made in decreasing nicotine in our youth population for the past 5 decades. Vaping has become 2 to 3 times more prevalent in adolescents compared to young adults.[3] This epidemic brings every user some sort of compromise to their health, and since they are starting younger, their addiction will last longer leaving their body weaker in the end.[3] Vaping may seem like a harmless act but it can extremely affect your life. In the wake of this escalating crisis, it is crucial to recognize that every user, irrespective of age, confronts a compromise to their health. Despite recent federal efforts to mitigate youth exposure to e-cigarettes, a pressing need remains for more stringent regulations governing the sale and marketing of these products. Coupled with the imperative development of robust educational, clinical, and public health interventions, this collective approach holds the potential to stem the burgeoning tide of what has become an unprecedented nicotine epidemic among our youth. While the act of vaping may outwardly appear benign, the profound impact it can exert on an individual's life should not be underestimated. In light of the mounting evidence, it becomes evident that the allure of vaping conceals a perilous reality.

History

Nicotine vapes were developed in the 1990's when the first patents for e-cigarettes containing nicotine were filed by tobacco companies and inventors. In 2003, the first commercialized e-cigarette hit the market; it was made by a 52 year old pharmacist, Hon Lik, sold primarily in China.[4] In August of 2006, U.S. Customs and Border Protections filed the first nicotine inhaler imports.[4,5] Three years later, the Food and Drug Administration instructed the U.S. Customs and Border Protection to deny the entry

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of electronic cigarette imports due to their drug-like nature.[6] Recently popularized, the JUUL vape pen was created in 2015 with the goal of having more nicotine delivered to the user. With JUUL's success, more and more companies have developed their own nicotine e-cigarettes and have continuously marketed them towards younger ages. There are now 460+ different brands with 7700+ different flavors.[7,8] Forward to 2019, then U.S. President Donald Trump amended the legislation of the Federal Food, Drug, and Cosmetic Act that raised the federal minimum age of 18 to 21 in the sale of tobacco products, including e-cigarettes.[9] However, that did not stop vaping from getting more popular within the youth population.

Prevalence

The prevalence of e-cigarette utilization has notably surged among young adults, drawing attention to a pressing public health concern. Notably, between 2019 and 2020, sales of e-cigarettes witnessed a dramatic upswing.[10] Moreover, the period spanning 2017 to 2019 witnessed a discernible escalation in cannabis-associated vaping, particularly marked among adolescents from low socioeconomic Hispanic/Latino backgrounds.[11] This trend is underscored by a specific statistic: a significant increase in vaping rates among high school seniors, with 37.3% reporting usage within the past year, as compared to 27.8% in 2017.[12]

The conspicuous escalation of e-cigarette usage within this demographic has reached a critical juncture, assuming the proportions of an epidemic. In fact, there has been a consequential surge in vaping-induced lung injuries across the United States.[13] Tragically, this surge in usage has caused numerous fatalities, with a disproportionate number occurring among teenagers.[14] These e-cigarette products, recognized for their elevated nicotine content, exercise a particularly strong allure over young adults[10]

Evidently, certain regions, including Texas, Wisconsin, and Illinois, have registered alarmingly high mortality rates linked to vaping.[15] Moreover, the ramifications extend beyond immediate fatalities, as vaping has been linked to an array of adverse health effects, most notably its association with lung cancer. Given that lung cancer stands as the foremost contributor to cancer-related mortalities, the imperative to curtail these figures becomes even more pronounced.[16] Although tobacco smoke remains the leading etiological factor, the significant contribution of vaping to the prevalence of lung cancer cannot be undermined.

Data by Races in Our Community

In the state of Texas, a significant proportion of high school students, approximately 18.3%, are engaged in vaping nicotine. Notably, in South Texas, the odds of high school Hispanics and whites engaging in vaping are 2.5-3 times greater than those of any other ethnicity or age group.[17] Over the past five years, the utilization of nicotine has experienced a rapid upsurge, particularly with the emergence of COVID-19. This increase has been so substantial that the prevalence of nicotine use among students has escalated from 1.5% in 2011 to 20.3% in 2018.[18] With the onset of the COVID-19 pandemic in South Texas and subsequent quarantine measures, a considerable number of adolescents turned to vaping as a means of "escaping" the real world, resulting in a swift progression towards addiction. Shockingly, within the last month alone, around 14.1% of students, which equates to roughly 2 million individuals in South Texas, have reported using nicotine products.[19] Amongst teenagers, nicotine consumption has witnessed the most significant growth over the past five years. Moreover, approximately 43.4% of teens in South Texas are grappling with depression and/or anxiety, factors that could potentially contribute to their engagement with substances like nicotine.[18] The escalating trend of vaping in teens is a cause for concern that requires prompt attention and intervention.

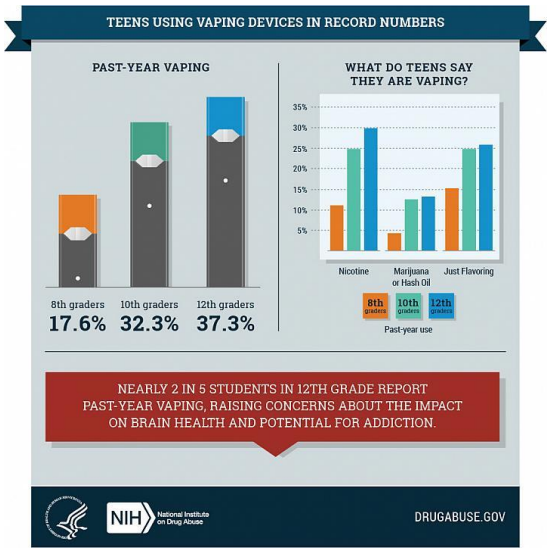

Figure 1: Representation of teens using nicotine.[19]

Types of Vape Pens

The following are vape pens that contain nicotine, either salt-based nicotine or freebase nicotine.[21]

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- **All in One (AIO):** This device comes with a built-in battery and refillable tank containing a substance named e-liquids. The idea behind how nicotine is contained in e-liquids in vapes is that it may exist in the form of scattered particles ranging in nicotine concentrations.[23]
- **Mods:** Vape pens classified as mods are made for the user to be able to modify the levels of freebase nicotine that will be inhaled to reduce irritation from the usage.[21]
    - Pod Mods: A common brand known as JUUL, is known to have the highest percentage of nicotine usage, 80.3% followed by cig-a-likes with 51.4%.[22] Marketing strategies for JUUL has been used to create the verb "juuling" instead of vaping. This branding makes it seem less dangerous and differentiates this pen from the others by containing prefilled pod cartridges.[22]
    - Box mods: These are a more advanced type of vape, with more complex settings, giving more options on the nicotine concentrations that are consumed.[22] They also contain a bigger battery for longer hour duration, along with other settings that control temperature and wattage.
- **Cig-a-likes:** These have a significant figure that resembles a typical cigar. However, since these devices are electronic, they are categorized as e-cigarettes. This type of pen usually comes pre-filled with its own nicotine containing e-liquid.
- **Pen-style Vape Pens:** These devices are known to be the most "under the radar" vape pens, as they don't look as suspicious as others. However, they still contain the same functions as other mods with bigger, newer models.

JUUL and Pod Mods have a greater nicotine dependence and are the most used by youth.[24] As a result of the variety of models available, it makes it easier for the high school population to carry them around without calling too much attention to themselves.

Figure 2: Various types of vape pens.[1]

General Effects of Nicotine Vaping

The impact of nicotine vaping unfolds insidiously, often going unnoticed by users. Yet, its consequences can swiftly accelerate, yielding harm that may remain unrecognized. A comprehensive overview of the overarching facets of the various underlying causes is of paramount significance, for these latent triggers possess the potential to evolve into adverse effects in the human body. If the awareness is low on the effects of nicotine vaping, the greater the risk of experiencing the repercussions of vaping. Within this intricate web of effects, a cascade of physiological disruptions emerges, spanning respiratory impairments, cardiovascular anomalies, immune system deviations, and the insidious grip of addiction. Additionally, the pervasive influence of nicotine vaping casts a shadow over cognitive maturation, with repercussions palpably reverberating through brain development, impacting academic achievement, and ultimately yielding profound social consequences.[25] To fully comprehend the intricate tapestry of repercussions borne from nicotine vaping, an exploration into each facet is imperative, uncovering a comprehensive panorama of the toll it exacts upon the individual and society as a whole.

Respiratory System

The integrity of our respiratory system is paramount to our existence. Unfortunately, the act of nicotine vaping poses a substantial risk to the well-being of our lungs, potentially culminating in dire afflictions such as Chronic Obstructive Pulmonary Disease (COPD) and lung cancer.[26] The indispensable role of our lungs in the everyday act of breathing renders them vulnerable to the deleterious influence of nicotine vaping. Compelling research underscores the

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deleterious impact of vaping on our respiratory health, manifesting in symptoms like dyspnea, persistent coughing, and debilitating chest pain.[27] To illustrate, the act of coughing serves as a natural mechanism through which our lungs expel foreign substances, acting as a protective barrier against harm. However, this defense mechanism is compromised in the face of nicotine vaping, as the harmful effects disrupt the harmonious functioning of our respiratory system, thwarting its ability to safeguard our well-being.

Cardiovascular System

The intricate nature of the cardiovascular system, also referred to as the circulatory system, forms a fundamental pillar of the human anatomy, encompassing blood circulation, oxygen dissemination, nutrient conveyance, and an array of indispensable operations.[28] In the context of nicotine vaping, the very underpinnings of this intricate network confront heightened vulnerability, potentially exposing it to adverse outcomes. A comprehensive investigation underscored the profound repercussions of nicotine, unveiling a cascade of deleterious effects.

Evident among these are elevated systolic and diastolic blood pressure, acceleration in heart rate, and pronounced arterial rigidity, collectively exerting a constricting influence upon the optimal functioning of the cardiovascular ensemble.[29] The intricate balance of homeostatic mechanisms within the circulatory system undergoes discernible alterations upon exposure to nicotine, characterized by inflammation and subatomic perturbations.[30] The consequences underscore the imperative of safeguarding cardiovascular health in the face of nicotine-mediated perturbation.

Immune System

The immune system serves as a vital shield, safeguarding the human body against pathogens, diseases, and bacterial threats that could potentially induce illness. A deficiency in this protective mechanism increases susceptibility to germs and viruses, subsequently exacerbating health complications. Notably, the potency of the immune system wanes with age, rendering individuals more vulnerable to potential health risks.[31] The perturbing reality emerges that nicotine vaping, replete with its toxic constituents, exerts a pernicious influence on the immune system. This unsettling nexus becomes particularly pronounced among adolescents who embrace nicotine vaping, a demographic vulnerable to the gradual erosion of their immune defenses.[32] Consequently, the burgeoning prevalence of teen nicotine vaping poses a substantive concern, as it threatens to undermine their immune resilience over time.

Addiction

When nicotine binds to specific receptors in the brain, it leads to the release of different chemicals, with dopamine being the most significant among them.[33] This release of dopamine in the brain's ventral tegmental area and the shell of the nucleus accumbens is crucial in causing the rewarding effects of nicotine and other drugs.[33] This includes feeling pleasure, which reinforces the desire to use them again. The reinforcement of pleasure associated with vaping quickly establishes a cycle of dependence.[33] When humans experience nicotine withdrawal, their brain's reward system decreases. This occurs because of a lack of dopamine being released, which results in a reduced feeling of pleasure.[34] Given these circumstances, quitting vaping becomes extremely difficult. According to a 2020 report, 5.47% of teens reported unsuccessful attempts to quit vaping.[35] Nicotine addiction can manifest differently from person to person. Some signs of nicotine addiction may include feeling anxious, experiencing strong cigarette cravings, or going out of your way to buy it.[36] After quitting nicotine use, individuals who are addicted may also encounter symptoms of nicotine withdrawal, such as feeling depressed or experiencing difficulty sleeping properly.[36]

Brain Development

Throughout the teenage years, the brain continues to grow, and nicotine use during this crucial time can have a variety of negative effects. Genetic studies have shown how nicotine plays a role in how we learn and develop dependence.[33] Nicotinic acetylcholine receptors (nAChRs) are found in both central and peripheral nervous systems.[36] When a molecule known as ligand attaches to these receptors, they function as tiny gates that open.[36] The neuronal nAChR subunits are made up of α-2 to α-10 subunits and β-2 to β-4 subunits.[37] Although these receptors bind to acetylcholine naturally, other molecules such as nicotine can stick to them.[38] Notably, nicotine easily binds to α-4 and β-2 nAChRs, unlike other receptors.[33] As teens grow and their brains develop, nicotine exposure can impact the nAChR receptors in their brain, modify dopamine sensitivity, and alter brain circuits that influence learning, stress responses, and self-control.[36] It may also result in outcomes that affect the brain's reward system, which involves the

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prefrontal cortex, nucleus accumbens, ventral tegmental area, hippocampus, and basolateral amygdala.[39] This can involve addiction and dependence, as well as withdrawal symptoms when not consuming nicotine.[36] These developing brains are at risk of lasting changes from perturbations that result in changes in behavior that continue into adulthood.[39]

Academic Performance

Vaping nicotine can have negative effects on teenagers, primarily because they are susceptible to influence. Many teens start vaping due to peer pressure, seeking acceptance and fitting into societal norms.[40] With the availability of various flavors in vaping products, many teenagers tend to be attracted to them.[40] While electronic cigarettes may provide pleasure through dopamine release, they can also negatively impact students' academic performance. Nicotine's interference with cognitive functions can make it difficult to focus and recall knowledge.[36] As a result, teens can find it difficult to concentrate in class, which could affect their grades. Teenagers are also more likely to skip class or engage in academic dishonesty due to the effects of nicotine on the brain's prefrontal cortex, which regulates their thoughts and behaviors.[39] Notably, vaping nicotine can cause respiratory issues that can prevent a student from attending lessons.[36] The student will likely miss numerous school days due to the importance of attending multiple doctor's appointments to address this health concern. This situation could potentially lead to them being held back a year. With these problems also comes depression, which can cause the person to lose interest in and care less about school.[36] Nonetheless, vaping nicotine can result in restlessness, which would make the learner less alert and tired.[36]

Social Consequence

Among the various possible consequences a vaping teen could inflict, is pressuring their peers into pursuing the need to vape nicotine. When teens have their ‘first vape session’, they were likely pressured into having tried vaping by their friends.[41] Seeing that a lot of teens vape this can affect groups of friends by dividing them between those who vape and those who don’t. From these now separated friend groups they enjoy playing a ‘cat and mouse’ game at school to see who doesn’t get caught vaping.[40] As a teen starts to feel detached from their family, an outsider, they tend to look at vaping as a way to not feel their loneliness.[42] Nicotine gives its user various side effects; such as, mood swings, impaired impulse control, and increased anxiety, all of which cause the user to feel different leading them to withdraw from their family and friends.[42] In romantic relationships, when one of them vapes and the other doesn’t it can lead to disagreements. In these situations it can lead to added stress and tension to a relationship that was possibly a happy one in the beginning. Vaping can have people start breaking down their trust, lying about vaping can lead to an added strain on a relationship coming from dishonesty. These different instances likely come about from the prevalence of people vaping in their social circle.[40]

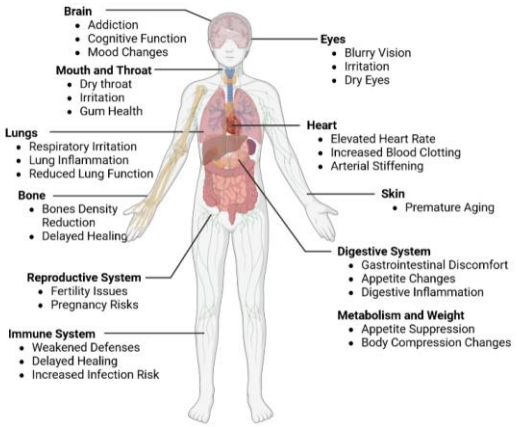

Figure 2: Effects of vaping on human health. Created with BioRender.com.

Policies and Regulations

Enforcing stringent regulations is imperative to effectively mitigate the proliferation and accessibility of vaping devices. The pervasive exposure of vaping advertisements to children and adolescents, often through easily accessible mediums such as social media, underscores a concerning trend.[43] This demographic is particularly susceptible to environmental influences, rendering them more susceptible to the allure of these campaigns, even as purported alternatives to traditional cigarette smoking.[44]

Notably, numerous vaping advertisements feature characters and themes that conspicuously cater to a younger audience, accentuating the need to acknowledge the strategic targeting of these ads.[45] The strategic placement and marketing techniques employed hold significant sway over the purchasing decisions of teenagers, warranting heightened attention.[46]

Several nations, including India since 2019, have taken a resolute stance by prohibiting the marketing and sales of vaping products.[47]

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Furthermore, the efficacy of specific regulatory measures has been demonstrated in curbing vaping and tobacco consumption. Notably, the imposition of taxes on such products has effectively diminished their allure, thereby reducing demand.[3] This insight substantiates the proposition of implementing additional taxes on vaping products across all states, serving to curtail their prevalence and concurrently channel funds into vital research aimed at preventing nicotine addiction among adolescents.

A seminal study investigating the impact of the Truth Initiative campaign on vaping-related choices revealed a marked reduction in tobacco-related beliefs and overall support for vaping, especially among African American youth followed by white and Hispanic counterparts.[48] This campaign's resonance with the youth is an encouraging stride, though further research is imperative to gauge its lasting effectiveness.

Conversely, disconcerting findings highlight a glaring lack of due diligence by companies in verifying the age of purchasers, with a staggering 95% of deliveries failing to implement any form of age verification.[49] This laxity extends to online platforms, where minimal regulations allow unfettered access to vaping devices, often exploited by adolescents.[50] Even establishments that impose age restrictions exhibit lapses in enforcement, contributing to the ease with which high school students acquire these harmful products, thereby exposing them prematurely to the perils of nicotine addiction.

A potent recommendation to mitigate this crisis involves reducing the prevalence of websites neglecting age restrictions and enforcing punitive measures against those in contravention.[3] This approach envisages a multi-pronged strategy, encompassing regulatory fines and penalties, to dissuade non-compliance and foster a safer environment for adolescents. By harmonizing stringent regulations, targeted interventions, and sustained research endeavors, a comprehensive framework can be established to safeguard the vulnerable youth from the detrimental consequences of vaping.

Prevention of Nicotine Addiction

Parents wield significant influence over their children's decisions throughout their developmental journey. Extensive research underscores that adolescents who experience consistent respect and unwavering support exhibit diminished propensities for substance abuse encompassing drugs, smoking, and alcohol when contrasted with their counterparts lacking such nurturing conditions.[51] In pursuit of curtailing adolescent vaping, a contemporary concern, parental intervention strategies can be strategically employed.

Exemplify Prudent Behavior

Parents serve as pivotal role models in their children's lives, and by refraining from smoking, parents inherently diminish the allure of this behavior for their offspring.

Foster Open Discourse

Engaging in candid conversations with adolescents about the physiological risks associated with vaping and smoking is imperative. Sustaining such dialogue over time, while embracing your child's perspective, remains crucial even as they transition into later stages of adolescence.

Prepare Youth against Peer Pressure

Equipping your children with informed responses and actions to counter potential offers of vaping or cigarette usage from peers is vital, thereby empowering them to make sound decisions in challenging social situations.

Incorporating these preventive measures within the parental sphere not only bolsters the prospects of deterring adolescent vaping but also establishes a foundation for comprehensive health-oriented decision-making.[52]

Nicotine Addiction Treatment

In instances where nicotine addiction has taken hold and necessitates intervention, an array of treatments stands poised to address this challenge. These treatment modalities can be thoughtfully combined and are viable options for individuals under the age of 18, albeit requiring a health professional's prescription to commence.

Nicotine Replacement Therapy (NRT)

NRT emerges as a cornerstone, offering an enhanced likelihood of efficacious outcomes by combating smoking cravings. Within this domain, Nicotine Patches command a notable 50 to 60 percent

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efficacy compared to alternative interventions.[53] Available in strengths of 7mg, 14mg, and 21mg, patch selection hinges upon current smoking habits.[54]. Typically worn for 24 hours on clean, hair-free skin, precise placement on the upper body aligns with manufacturer guidelines. Nicotine Gum, having a 15 to 20 % effectiveness, holds promise for those who sustain its use for a year or beyond.[55] This therapeutic option presents in 2mg and 4mg dosages, contingent upon the temporal patterns of habitual cigarette consumption.[56] The Nicotine Lozenge surfaces as another viable recourse, progressively demonstrating its potential to amplify smoking cessation prospects.[57] Offered in standard and mini sizes (2mg and 4mg), dosage determination hinges on the quantum of daily nicotine intake.[58]

Prescription Medications

Further options encompass prescribed medications, necessitating the authorization of a medical practitioner.[59] Notably, Bupropion, initially an antidepressant, has evolved to counter nicotine cravings with positive results.[60] It is paramount to reiterate that all intervention avenues should remain under the vigilant oversight of a medical expert, affording both safety and optimal chances of success. This comprehensive approach underscores the commitment to comprehensively combatting nicotine addiction and fostering enduring well-being.

Conclusion

A proliferation of vaping among high school students has culminated in an alarming epidemic, characterized by staggering numbers that underscore its gravity. This phenomenon, however ironic, reveals a disheartening truth: vaping, initially designed to curtail smoking addictions, now surpasses traditional smoking in its adverse impact on the human body. The proliferation of vaping among high school students has culminated in an alarming epidemic, characterized by staggering numbers that underscore its gravity. An unfortunate consequence of this burgeoning crisis is the surge in injuries and fatalities among high school users. An intricate interplay of cardiovascular, respiratory, and cognitive effects contributes to the escalating toll inflicted by vaping. High school students under the age of 21 should not be able to acquire vapes due to the federal law. Despite federal legislation stipulating an age requirement of 21 for vape purchases, the prevalence of access within high schools remains a disconcerting norm, facilitated by clandestine transactions among students during and after school hours. This trade is exacerbated by the camouflage of vaping devices as everyday objects, further evading detection by vigilant educators. A staggering statistic emerges from Texas, where an accelerating 18.3% of high school students have embraced vaping. This surge is partially attributed to advertising strategies that conspicuously target impressionable teenagers, compelling them to partake in this perilous practice. Even with age restrictions in place, certain vape vendors prioritize profit over ethical considerations, willingly selling to underage clientele. Mitigating this crisis necessitates a multi-faceted approach. Education emerges as a powerful tool, empowering children with knowledge to make informed decisions. Prescribed medications, nicotine gum, and patches offer potential avenues for treatment. The collective effort to disseminate awareness, alongside these prevention and treatment measures, kindles hope for a future where the tide of vaping recedes, inching us closer to its eventual eradication. Looking into the future, armed with an arsenal of interventions, heightened awareness, and collaborative endeavors, the prospect of diminishing these disconcerting statistics comes into view, fostering the aspiration of ultimately vanquishing vaping's grip on our youth.

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