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Assessing The Opportunity Costs of E-Cigarettes on Public Health: A Comprehensive Analysis on College Students Based in Metro Manila

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Abstract

In recent years, the surge in popularity of electronic cigarettes (e-cigarettes) has ignited a contentious debate about their impact on public health. Advocates argue that e-cigarettes provide a less harmful alternative to traditional tobacco products and can aid in smoking cessation. At the same time, critics express concerns about potential health risks and the potential for smoking to become normalized, particularly among young people. In this complex landscape, a balanced evaluation of the benefits and risks of e-cigarettes is essential. In e-cigarettes, this evaluation involves understanding the concept of opportunity cost. Opportunity cost refers to the benefits sacrificed when one option is chosen over another. In the case of e-cigarettes, understanding their opportunity costs necessitates carefully examining the potential benefits of harm reduction and the associated risks.

The rise of e-cigarettes over the years has made a significant impact on public health; a news report from the US Centers for Disease Control and Prevention shows that the use of e-cigarettes among high school students has tripled in two years (Freudenberg, 2014). E-cigarettes are mass-marketed consumer products promoted by the industry as harmless devices and smoking cessation aids. Whether e-cigarettes help smokers quit smoking cigarettes or undermine public health remains the question of the public and the health community.

A growing number of people, particularly in the college-level age group, are choosing to vape. Vaping is growing in popularity both because of the addictive nature of the substances people place inside e-cigarettes and because of the fun flavoring that is used in these products. The Commercial Determinants of Health (CDH) significantly impact the health of a country's population. The marketing and promotion of products and services by corporations, especially multinational businesses, can dramatically impact individuals and communities positively and negatively. The vaping epidemic in the Philippines is an example of how commercial influences and government policies, in the context of disinformation, can exacerbate public health issues. The Philippines is facing a rising use of electronic nicotine delivery systems (ENDS) among youth. The World Health Organization has maintained its stance on the health dangers brought about by e-cigarettes. The Philippines may be facing an uphill struggle in the vaping epidemic. The Global Youth Tobacco Survey (GYTS), which was done in 2019, showed that the country is facing an alarming prevalence of using ENDS among the youth. One in every seven students aged 13-15 years old is already using e-cigarettes- an age group far less than what is allowed by existing laws.

In health economics, opportunity costs are fundamental in decision-making and resource allocation. Opportunity cost refers to the value of the best alternative for when a choice is made. In other words, it is

the cost of not choosing the next best alternative. Since resources are scarce relative to needs, using them in one way prevents their use in other ways. The opportunity cost of investing in a healthcare intervention is best measured by the health benefits (life years saved, quality-adjusted life years (QALYs) gained) that could have been achieved had the money been spent on the next best alternative intervention or healthcare program. Cost-effectiveness evidence on new healthcare interventions can help us prioritize using scarce resources wisely. However, to interpret the evidence of cost-effectiveness, it may appear that we must make trade-offs between life and money. This is not so. We can quantify the health improvements that resources would or could have generated in alternative use. In that case, a decision about providing or denying treatment can instead be framed as a trade-off between health gained and health forgone (Siverskog, 2022). Cost-effectiveness evidence can help healthcare decision-makers determine the order of priority in a list of potential investments. However, when presented with the decision to provide or deny a single new treatment, they face another popular fact: the value of life is immeasurable.

Keywords: E-Cigarettes, Health Economics, Vaping, Smoking, PLS-SEM

1. INTRODUCTION

E-cigarettes, also known as vaping devices, have emerged as a popular alternative to traditional cigarettes. These devices typically heat a liquid containing nicotine, flavorings, and other chemicals to produce an aerosol that the user inhales. While initially marketed as a smoking cessation aid, e-cigarettes have gained widespread popularity, particularly among youth. This rapid rise in usage has significant socioeconomic implications. E-cigarette-related illnesses, such as EVALI (e-cigarette or vaping, product use-associated lung injury), can lead to increased healthcare costs due to hospitalization, treatment, and long-term care. Furthermore, e-cigarette use can impact work performance, leading to decreased productivity and potential job losses due to health issues or nicotine addiction. These factors contribute to a significant economic burden on individuals, families, and society.

In the contemporary landscape of public health, the emergence and proliferation of electronic cigarettes, or e-cigarettes, have sparked considerable debate and scrutiny. While touted by some as a potential harm reduction tool for smokers seeking alternatives to traditional tobacco products, the widespread use of e-cigarettes has raised significant concerns regarding their long-term impact on public health. Central to this discourse is opportunity costs – the forgone benefits or advantages resulting from choosing one option over another.

This comprehensive analysis aims to delve into the intricate layers of assessing the opportunity costs associated with e-cigarettes on public health. By examining many factors, including but not limited to health outcomes, economic implications, regulatory frameworks, and societal trends, this study seeks to provide a nuanced understanding of the broader implications of e-cigarette usage. This analysis sheds light on the complex interplay between e-cigarettes and public health, ultimately informing evidence-based decision-making and policy formulation in this crucial domain. According to Byrne (2018), Because of the lack of long-term studies, there continues to be no evidence that e-cigarette use is associated with clinical cardiovascular disease.

Amidst conflicting claims about their potential as harm reduction tools versus their risks, there is a pressing need to assess the opportunity costs associated with e-cigarettes on public health comprehensively. This entails the understanding of whether to use vaping as a tool to quit using traditional tobacco cigarettes. According to Balfour (2021), the topic of e-cigarettes is controversial. Opponents focus on e-cigarettes'

risks for young people, while supporters emphasize the potential for e-cigarettes to assist smokers in quitting smoking.

The objective of this research is to:

- To understand the point in a person's life where their body begins to deteriorate in the effect of consuming e-cigarettes.
- To create a model displaying the opportunity cost of vape consumption per unit used.
- To find a direct correlation between vape consumption and health, whether it be longevity of consumption or amount consumed in a specific period.
- To examine the prevalence and patterns of e-cigarette consumption among different demographic groups.
- To explore the potential effects of dual-use (simultaneous use of e-cigarettes and traditional tobacco products) on opportunity costs
- To explore the potential cost savings or cost burdens for healthcare systems resulting from shifts in tobacco-related disease burden due to e-cigarette use

  This study has the potential valuable insights that can inform public health strategies, opportunity costs in health aimed at addressing the challenges and opportunity costs of vaping on health, and benefits associated with the usage of e-cigarettes. Below are the different insights and relevance of this study:
- Informed Decision Making: This study will provide policymakers and public health officials with comprehensive insights into the opportunity costs of e-cigarettes on public health, enabling them to make evidence-based decisions and formulate effective policies.
- Health Promotion and Risk Mitigation: By explaining the potential benefits and risks associated with e-cigarette usage, the study can contribute to health promotion efforts and assist in developing targeted interventions to mitigate potential harms.
- Public Awareness and Education: The study can contribute to public awareness and education initiatives by providing accurate and up-to-date information on the risks and benefits of e-cigarettes, empowering individuals to make informed choices regarding their health behaviors.
- Resource Allocation: Understanding the opportunity costs of e-cigarettes on public health will provide valuable insights into allocating limited resources. By identifying the trade-offs between investing in e-cigarette promotion and traditional tobacco control measures, policymakers can prioritize interventions that yield the most significant health benefits for the population.
- Long-term Health Impacts: Evaluating opportunity costs provides crucial insights into the long-term health impacts of e-cigarettes. By considering factors such as the potential for dual use, renormalization of smoking behaviors, and emerging evidence on health risks, policymakers can implement measures to minimize harm and protect public health over time.

2. Statement of the Problem

This study aims to identify the current impacts of E-Cigarettes on public health, opportunity costs, and spending. Health Capital, in this context, will specifically focus on quality of life and productivity.

1. To what extent can vaping lead to health capital loss? (Number of Years, Cost spent on E-cigarettes, etc.)
2. How does e-cigarette use among college students in Metro Manila impact their health capital, thus affecting their academic performance and future career prospects?
3. Is E-cigarette consumption a means for a safer alternative to smoking ordinary cigarettes? Or does it

only take longer before its effects occur within its consumers' bodies?

3. Scope and Limitations

Scope

The researchers aim to understand the opportunity costs of consuming E-cigarettes on the health of college students based in Metro Manila. This includes investigating both the benefits and harms associated with vaping, keeping in mind its role as a cessation tool from traditional cigarettes, as a means to lessen harm from tobacco consumption, initiation for non-smokers, and the overall prevalence of tobacco use. This study aims to correlate its respondents' spending patterns, consumption habits, and individual health issues that have appeared after beginning the habit of vaping.

Limitations

Study Longevity: Related literature regarding E-cigarette consumption's implications on health capital has only covered short-term effects. (Fernández et al., 2020) mentioned that the effects of E-cigarette consumption, whether direct or indirect, may take up to 10 years before causing issues to the subject's health capital. The researchers understand that college students (individuals aged 18-24) are less likely to be consumers of E-cigarettes for over 10 years. Despite this, the researchers still aim to find early indications of health deterioration and other effects vaping may deal with in just a few years. The study will focus on the primary changes individuals experience in their health after consuming e-cigarettes.

Data Availability: Most of the related literature gathered by the researchers are past studies conducted in different countries. Although some of these studies cover the same age and demographic as this thesis, multiple factors such as living conditions, financial situations, and healthcare systems differ from these nations and this study's domestic setting. This is why the researchers expect to receive results that may significantly differ from the findings of past studies in their related literature. With this, the researchers understand that this thesis will serve as a pilot study to gather preliminary data on college students based in Metro Manila. This pilot study will also determine the feasibility and significance of delving into health capital and quantifying it in individuals.

Regulation and fairness: The researchers understand that other factors may be the causes of the health detriments of their respondents. This is why the researchers will include questions in their surveys asking if their respondents are affected by other factors (including but not limited to exposure to smoke emissions and cardiovascular or pulmonary diseases before beginning E-cigarette consumption).

Inconsistencies in Vape Products: E-cigarettes come in many forms. This is why the variety of e-cigarette products is too large for the researchers to include in a multiple-choice survey. The study will only focus on the estimated number of inhales a respondent takes daily and the nicotine concentration in their vape juice. This limitation may be mitigated through a qualitative study focused solely on the specific products consumers use.

CHAPTER II. REVIEW OF RELATED LITERATURE

The opportunity costs of e-cigarette use encompass the forgone benefits when resources are allocated towards e-cigarettes instead of healthier alternatives. These include direct and indirect health costs such as medical expenses, lost productivity, and reduced quality of life due to e-cigarette-related illnesses. Financially, users incur the cost of purchasing devices and e-liquids while potentially experiencing lost income due to health issues or reduced productivity. Socially, the widespread use of e-cigarettes can normalize nicotine use, increase the risk of smoking initiation among youth, and lead to secondhand

exposure and potential social stigma. While research on e-cigarettes is ongoing, existing studies, though limited by factors such as the relatively new nature of the product and potential data limitations, provide valuable insights into the potential health and economic consequences of e-cigarette use.

3.1. Understanding E-Cigarettes

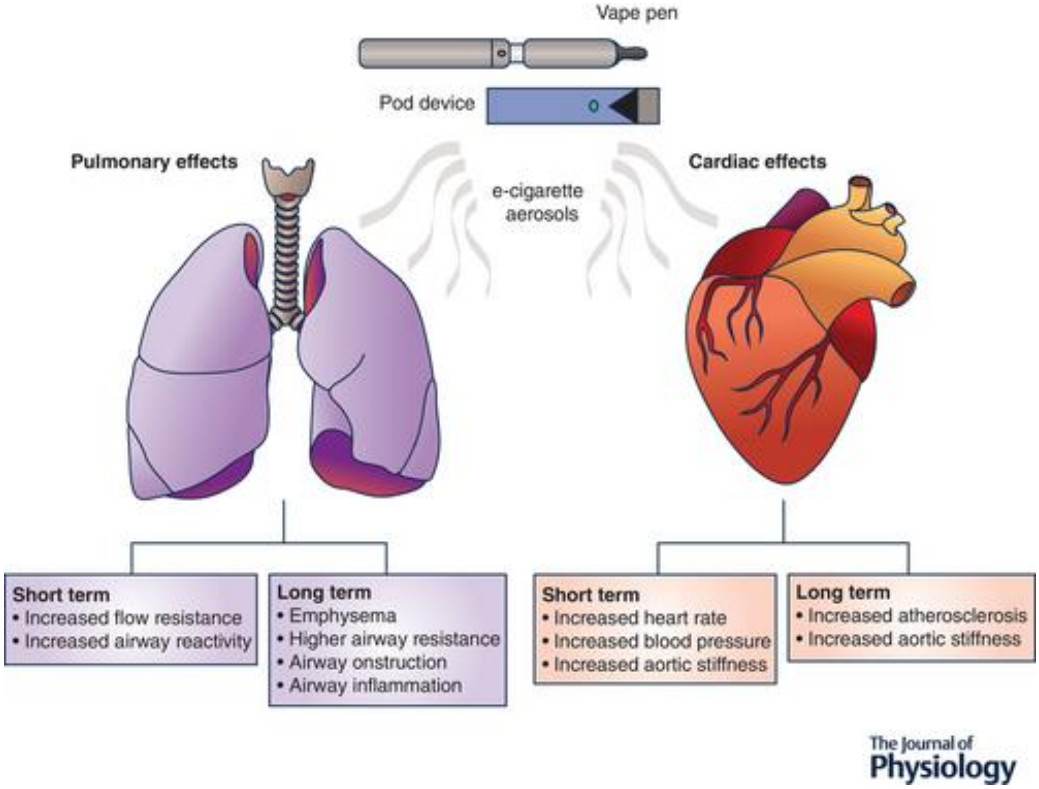
E-cigarettes (Electronic Cigarettes or Vapes) are handheld electronic devices that can simulate the sensation of smoking a conventional cigarette by heating a liquid that frequently contains Nicotine. (Holliday, Chaffee, & Preshaw, 2021) Once heated, the liquid transforms into vapor and is exhaled as an aerosol. E-cigarettes come in different forms and sizes, from pens, pods, disposables, mods, etc, depending on the consumer's preference. A common argument in defense of E-cigarette usage is its role as a harm reduction tool, containing less harmful chemicals compared to conventional cigarettes such as tar. This is proven by a study conducted by (Erku et al., 2020), where they discovered that E-cigarettes are an effective cessation tool, especially for conventional smokers who find it difficult to quit the habit completely. However, it is also stated in the same article that the greatest benefit can be attained by completely halting the usage of tobacco products. Despite being a less harmful option compared to traditional cigarettes, E-cigarettes still deal substantial damage to the user's health over time, especially with continuous usage. Health consequences are still inevitable when consuming a tobacco product, even though it has fewer implications on your health compared to others. (Cao et al., 2020)

Over the past decade since the first introduction of E-cigarettes to the public market, the product has significantly grown in popularity, specifically among young adults. (Hammond et al., 2020) One of the reasons why vaping has grown in popularity is because of its variety of flavors, spanning from mints, fruits, sweets, etc. Another factor why vaping is common amongst young adults is due to its lack of odor after consumption. This makes young adults continuously consume E-cigarettes without the need to compensate for the "smoky" odor conventional cigarettes leave on their skin and clothes. Social influence has also played a role in the spread of vaping, with social media being a major player in the lives of the youth today; the visual of vaping and its influence has also contributed to its current popularity. Local policies in the Philippines have also been the cause of the widespread popularity of vaping. Before 2020, e-cigarettes were allowed for individuals aged 18 and above. Some cases have reported that stores do not require validation for consumers to avail of vape products. Consequently, young adults are exposed to e-cigarettes before reaching the proper age according to Philippine law. In conclusion, the rise of e-cigarettes in the market has taken a turn from a cessation product into a gateway for young individuals to experience smoking risk-free.

3.1.1. Health Impacts of E-Cigarettes

E-cigarettes, although being considered by the general public as a "lesser evil" in terms of vices, have sparked controversy and discussion due to their popularity amongst the younger demographic. As (Levy et al., 2019) state, despite being designed to be an outlet for current Cigarette smokers to transition to a less hazardous product, it has also encouraged the youth to initiate smoking conventional Cigarettes through exposure to E-cigarettes. (Tsai et al., 2020) reiterate the dangers of E-cigarettes despite their reputation as a "safer alternative," displaying the multiple short and long-term pulmonary and cardiovascular effects of E-cigarette consumption as illustrated here.

Table 1. Pulmonary and Cardiovascular Effects of E-Cigarette Consumption



Source: https://physoc.onlinelibrary.wiley.com/doi/full/10.1113/JP279754

According to (Beutel et al., 2021), the rising popularity of E-Cigarettes led to increased environmental pollution. Multiple components of a conventional E-Cigarette, such as the battery, heating metal, and juice containers, are classified as one-use. Meaning they are immediately disposed of after consumption. Consequently, disposing of these devices containing Nicotine negatively affects microorganisms, plants, animals (non-mammalian and mammalian), and humans by releasing toxic microbes that further interfere with the internal functions of said subjects. A study conducted by (Fernández et al., 2020) showed that humans who indirectly intake Nicotine (through E-Cigarette aerosols) may also suffer from detriments in their health. These effects may take up to 10 years after the initial intake of the E-Cigarette aerosols. Han, G., & Son, H. (2022) mention that the metallic materials that are used in the body of E-Cigarettes are a cause of toxic metals that can endanger both land and aquatic environments and their organisms when disposed of incorrectly.

A study conducted by (Owen et al., 2019) in Australia measures the negative effects of smoking in three forms: years of life lost, quality-adjusted life years (QALYs) lost, and productivity-adjusted life years (PALYs) lost. After collecting and analyzing data, these individuals have found that around 3.1 Million years of life are lost due to smoking. Quality and Productivity of life are also greatly reduced due to smoking. One of the reasons the quality and productivity of life are lessened is due to deterioration in ocular health, as studied by (Martheswaran et al., 2021). Their study finds that multiple components found in E-cigarettes (such as Aldehydes, flavorings, vapor, and aerosol produced) cause worsening eye stability and even tears and staining.

The health impact of e-cigarettes has become a topic of intense scrutiny in public health discourse. As these devices continue to gain popularity, understanding their implications on health outcomes is

paramount. This concise review provides an overview of current research findings regarding the potential health effects of e-cigarette use. This review aims to contribute to a nuanced understanding of the complex relationship between e-cigarettes and public health by examining potential benefits and risks.

According to Levy (2017), The use of vaporized nicotine products (VNPs), especially e-cigarettes and, to a lesser extent, pressurized aerosol nicotine products and heat-not-burn tobacco products, are being adopted increasingly as an alternative to smoking combusted products, primarily cigarettes. Considerable controversy has accompanied their marketing and use. In the United States, smoking rates have fallen by 50% since their peak in the 1960s as a result of tobacco control policies, but smoking still contributes to high rates of premature mortality. The 2014 Surgeon General's Report stated: 'Cigarettes and other combusted tobacco products overwhelmingly cause the burden of death and disease from tobacco in the U.S.; rapid elimination of their use will dramatically reduce this burden (Levy, 2017).

In a small sample of young, never-smoking, daily EC users who were carefully followed for approximately 3½ years, we found no decrements in spirometric indices, development of respiratory symptoms, changes in markers of lung inflammation in exhaled air or findings of early lung damage on HRCT, when compared with a carefully matched group of never-smoking non-EC users. Even the heaviest EC users failed to exhibit any evidence of emerging lung injury as reflected in these physiologic, clinical, or inflammatory measures (Polosa, 2017). According to Eltorai (2019), E-Cigarettes have been regarded by many as a healthier alternative to combustible cigarettes or traditional tobacco products; he also mentioned that E-cigarettes pose a risk for nicotine exposure, dependence, and combustible cigarette uptake. E-cigarettes and their delivered toxicants appear harmful to multiple organ systems. However, the current body of evidence is limited, especially in terms of long-term effects on smokers and nonsmokers, over the long term. Overall, the current data do not support the efficacy of e-cigarettes for smoking cessation.

3.2. Potential Risks and harms

E-cigarettes contain constituents that are not inert and are likely to have some adverse health effects on their own; e-cigarettes; e-cigarettes emit potentially toxic substances, including delicate particulate matter, metals, and nicotine; these substances are known to cause adverse health consequences such as cardiovascular and respiratory illnesses (Eaton, 2018). Given the host of harmful chemicals released by the combustion of conventional cigarettes, which are absent or present in only trace quantities in e-cigarettes, vaping is likely to be substantially less harmful to health than smoking (Cahn & Siegel, 2011; McNeill et al., 2015). According to Singh (2020), E-cigarette use could, therefore, act as a potential harm-reduction option for adult smokers trying to quit.

Smoking is a risk factor for six of the eight leading causes of death worldwide, including ischemic heart disease, cerebrovascular disease, lower respiratory infections, chronic obstructive pulmonary disease, tuberculosis, and lung cancer (Drummond, 2014). According to Farber (2020), Catastrophic harms of e-cigarette use have been repeatedly reported. Unlike FDA-approved medications, there are no ingredient or manufacturing quality standards for e-cigarettes. Case reports and case series describe burns and severe facial injuries (from product explosions), epiglottitis, acute nicotine poisoning, seizures, liver injury, and severe lung disease, including eosinophilic pneumonia, diffuse alveolar hemorrhage, hypersensitivity pneumonitis, organizing pneumonia, lipoid pneumonia, and severe asthma. The Centers for Disease Control has identified many cases of e-cigarette or vaping product use– associated lung injury (EVALI) leading to hospitalization and death. Although most of the cases were associated with the use of tetrahydrocannabinol-containing products and believed to be from the use of vitamin E acetate in those

products, 29% of fatal cases and 14% of all reported cases describe the exclusive use of nicotine-containing e-cigarette products

3.3 Opportunity Costs of E-Cigarettes in Health Economics

In health economics, opportunity costs refer to the value of the following best alternative forgone when a decision is made. Specifically in the context of e-cigarette use, opportunity costs encompass the health-related benefits and detriments associated with choosing e-cigarettes over other tobacco products or cessation methods. The relevance of opportunity costs to e-cigarette use lies in the trade-offs involved in adopting these devices as alternatives to traditional smoking. Regarding health economics, opportunity cost pertains to the potential health-related benefits or drawbacks forgone when individuals, policymakers, or healthcare systems decide on resource allocation, intervention strategies, or behavioral choices. Specifically concerning e-cigarettes, assessing health opportunity costs involves analyzing the trade-offs associated with choosing e-cigarette use over other alternatives.

In this context, the opportunity cost of e-cigarette use includes the potential exacerbation of nicotine dependence or the renormalization of smoking behaviors, which could undermine public health efforts to reduce overall tobacco use prevalence. This evaluation involves weighing the potential benefits of harm reduction against the risks of increased initiation or continued use among nonsmokers and youth and considering the broader societal implications regarding healthcare costs, productivity losses, and long-term health consequences. Ultimately, understanding the opportunity costs of e-cigarette use in health economics provides valuable insights for decision-making and policy formulation to optimize public health outcomes. One issue of health opportunity costs involves weighing the potential benefits of e-cigarette use, such as harm reduction for smokers who switch from combustible tobacco products to e-cigarettes, against the associated health risks.

Analyzing the opportunity costs involves examining the trade-offs regarding health outcomes, economic implications, and societal benefits of E-Cigarettes. According to Chapman (2006), the best-case scenario with e-cigarettes would be a massive, rapid migration of smokers into vaping; unparalleled declines in disease caused by smoking would occur, starting with cardiovascular and respiratory disease and followed years later by cancer caused by smoking. Economic implications of e-cigarettes include reduced costs on healthcare related to smoking-related diseases if smokers switch to e-cigarettes. However, there might be costs associated with the long-term effects of e-cigarettes, such as nicotine addiction. According to Olubanwo (2018), More 'tobacco smokers and quitters use e-cigarettes in the United States (61%), followed by the United Kingdom (58%), Australia (38%), and Canada (37%), respectively.

Investing in E-Cigarettes over preventive measures can have several potential long-term implications, such as Health Impact, Tobacco Control Effects, and Regulatory Challenges. Most studies so far indicated that e-cigarettes are less harmful, but this applies only to smokers who completely switched to e-cigarettes (Sobczak, 2020). According to Sobczak (2020), E-cigarettes and other noncombustible nicotine delivery products and devices certainly do have the potential to substantially alter the tobacco control landscape and how smokers stop using combusted cigarettes, as more than 50 million living Americans have already done. Mass media advertisements can influence awareness and use of e-cigarettes. The findings from the present study showed that commonly endorsed motivations for current e-cigarette use were to reduce tobacco smoking and because e-cigarettes are considered less harmful than tobacco cigarettes. However, it remains to be seen how many smokers are successful in reducing or quitting smoking due to e-cigarettes (Hummel, 2015). On the side of regulatory challenges, according to Benowitz (2013), a critical question

is when the FDA should begin to require product licensing. A disadvantage of requiring licensing is that regulatory requirements are likely to slow product innovation. The advantage of licensing would be ensuring product quality and consistency. According to Polosa (2013), Future regulatory measures should primarily address quality standards of liquids used in e-cigarettes (e-liquids) and should require:

1. Evidence that good manufacturing practices have been followed
2. Official documentation reporting contents and concentrations in e-liquids to regulators
3. Clear, accurate, and detailed labeling about the contents and possible dangers of inappropriate handling (e.g., accidental poisoning) associated with e-cigarette use.

Purchasing e-cigarettes over alternative preventative measures could have long-term effects on economic factors, regulatory frameworks, behavioral patterns, and public health. To optimize public health outcomes over the long run, decision-makers must carefully weigh the advantages and disadvantages of e-cigarettes in the context of more significant tobacco reduction initiatives and prioritize evidence-based approaches.

3.4 Policy Implications and Recommendations

According to Jin (2017), The Philippines enacted the E-cigarettes or Vape Regulation Act 2014. This Act banned the sale of e-cigarettes to minors (Section 3), required health warnings on the products (Section 4), imposed restrictions on advertising and flavorings of e-cigarettes (Section 5), required registration of the manufacturers (Section 6-7), and allowed local governments to impose taxes on e-cigarettes (Section 8). It was one of the most comprehensive regulations concerning e-cigarettes in the Southeast Asian region. The Philippines also issued an administrative order by the Department of Health in 2014: Rules and Regulations on Electronic Nicotine Delivery System (ENDS) or Electronic Cigarettes. This Rule stipulated that e-cigarettes were not conventional tobacco products and should be regulated as medicinal products under the U.S.U.S. Food and Drug Administration (FDA) jurisdiction. According to the study by Puteh (2022), Increased regulations on flavored tobacco products can reduce teen cigarette and e-cigarette usage. E-cigarettes may have distinct smoking cessation effects when used as consumer and therapeutic goods, underscoring the importance of the regulatory framework in outcomes associated with nicotine and tobacco use. State and local governments should establish strict licensing policies and practices that limit youth access to all tobacco and nicotine products.

Potential policy intervention targeting various factors of e-cigarette usage, such as enforcing strict age verification for customers of e-cigarettes. According to Warner (2022), The FDA should develop a comprehensive set of regulations on tobacco product flavors that reduce the attraction for young people but maintain the potential for flavored substitutes, such as e-cigarettes, to aid adults in quitting smoking; the FDA should establish product standards that reduce smoking and make e-cigarettes effective, reduced-risk substitutes for adults who cannot or will not otherwise quit smoking—also mentioned in the study, to minimize unintended effects. Therefore, deficient nicotine regulation should be accompanied by regulations ensuring the availability of alternative products, such as e-cigarettes, reviewed and authorized by the FDA to meet standards for the appropriate protection of public health. By implementing evidence-based and coordinated policy initiatives, policymakers may defend the welfare of individuals and communities, minimize the opportunity costs associated with e-cigarettes, and advance public health.

According to Puteh (2022), It is recommended that countries with lax rules, significant populations, and high smoking rates control e-cigarettes before their usage becomes established in their cultures, especially among the younger generation. Governments must find the right balance of levers that discourage the uptake of smoking and encourage people who smoke to quit. Clear messages that give people accurate

information about the risks/benefits of e-cigarette use are also likely to help smokers switch to vaping and discourage uptake among nonsmokers. Policies that act to improve product safety will also help ensure that e-cigarettes are as low-risk as possible.

Policymakers can encourage research projects to determine the efficacy of policy interventions, analyze the financial and health effects of e-cigarette use, and provide information for evidence-based decision-making. Healthcare Providers can include screening for e-cigarette use in regular clinical procedures and have conversations with patients who use or are thinking about using e-cigarettes about the possible dangers and advantages; they can also advocate for comprehensive tobacco control policies and collaborate with policymakers, public health agencies, and community organizations to promote tobacco cessation and prevent tobacco-related diseases. Policymakers, healthcare professionals, and researchers may collaborate to reduce the adverse health economic effects of e-cigarette use, safeguard the public's health, and enhance the well-being of individuals and communities by taking a coordinated and evidence-based approach.

3.5. Health Capital and How it Deteriorates Due to E-Cigarettes

Measuring health capital involves a combination of quantitative and qualitative approaches to assess various dimensions of health and well-being. According to Grossman (1972), we define health capital as the present value of a person's lifetime health; some surveys ask people how good they feel, whether their health has improved or worsened, and for a self-evaluation of some critical aspects of their health status. From this information, we can use different methods to estimate an implicit exchange rate for a year of life with perfect health. According to (Moreno, 2006), The surveys included questions on the state of health, the habits of life–including feeding, physical exercise, and tobacco and alcohol consumption–and the utilization of the health services managed by the regional government.

Vaping Habit pertains to how often an individual consumes E-Cigarettes. According to (Kim, 2024), the rate of daily smokers in New Zealand (NZ) fell to 8%, a historical low that reflects the efficacy of efforts and regulations to meet the NZ government's Smokefree 2025 goal. Recently, however, the prevalence of e-cigarette/vaping has been shown to increase rapidly - according to a recent Ministry of Health survey, e-cigarette use rapidly began rising in 2019 and overtook cigarette use in 2021. According to (Bourdon, 2019), The study highlights that the use of e-cigarettes is increasing among first-year college students. (Byth, 2023), The increasing use of vape devices, particularly among young people, has become a public health concern, leading the Centers for Disease Control and Prevention (CDC) to declare vaping an epidemic in 2020.

According to (Leventhal, 2017), Researchers have found no significant differences in daily smoking quantity between youths who did not vape nicotine and youths who vaped low or medium nicotine concentrations at baseline in adjusted models, compared with youths who did not vape nicotine at baseline, those who vaped high nicotine concentrations smoked 14.17 times as many cigarettes per day. In this cohort study of 181 adolescent electronic cigarette users, the use of electronic cigarettes with higher nicotine concentrations at baseline was associated with greater levels of combustible cigarette and electronic cigarette use in the past 30 days.

4. CHAPTER III. METHODOLOGY

4.1. Research Methodology and Design

The researchers have decided to conduct a quantitative study in the pursuit of data collection. The data

will be collected through Google Forms and distributed through snowball sampling. The questionnaire will contain questions regarding the research respondents' spending habits, vape consumption (mg of Nicotine contained in juice, number of years vaping, general vaping patterns), smoking patterns, and health complications received after vaping. The data collected will go through data analysis in the form of Regression Analysis to find a correlation between the factors in the respondents' consumption habits and the health consequences they experience. This will be further analyzed to conceive a substantial conclusion concerning vaping and its implications on physical health. The data will be processed through multiple WarpPLS, a program specializing in Structural equation modeling (SEM) to find significant correlations between the variables. With this in mind, the following regression model will be used during data analysis:

$$\hat{Y} = b_0 + b_1 X_1 + b_2 X_2$$

Given this Regression formula, the researchers then adjust this to be:

HC = β_0 - β_1YV - β_2VC - β_3VH - β_4VA + $\in$

Where:

Y = The respondent's current health capital

β_0 = The intercept; value of HC when all independent variables are = 0

β_1 = The coefficient of Years of Vaping

β_2 = The coefficient of Vape Concentration

β_3 = The coefficient of Vaping Habits

β_4 = The coefficient of Vaping Addiction/Satisfaction

$\in$ = Error coefficient

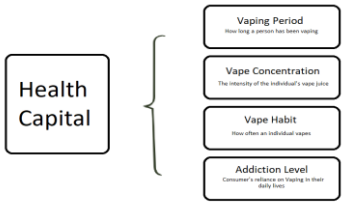
4.2 THEORETICAL FRAMEWORK

This theoretical framework provides a comprehensive approach to assess the opportunity costs of e-cigarettes on public health. By integrating the health impacts of e-cigarettes, potential risks and harms, opportunity costs on health economics, policy implications, and recommendations, understanding the nature of e-cigarettes, and employing both quantitative methodologies, researchers can better understand the complex impacts of e-cigarettes and inform public health policies.

The opportunity cost of e-cigarettes is the loss of potential gain from other alternatives when one alternative is chosen. In this context, it refers to the potential public health benefits or harms foregone by promoting or discouraging e-cigarette use that they refer to as a safer alternative to traditional tobacco cigarettes.

The health outcomes of a group of individuals, including the distribution of such outcomes within the group. This includes morbidity, lung diseases, mortality, quality of life, and healthcare costs. The rapid rise in the use of e-cigarettes has caused great concern for the modern youth as it has become a widespread activity among teenagers.

4.3 CONCEPTUAL FRAMEWORK



4.4 Ethical Considerations

Before proceeding with the data collection, the researchers ensured that the online form would ask for consent from each respondent and maintain each respondent's anonymity throughout the process. The researchers also secured an ethical clearance from the Research Ethics Center of the Polytechnic University of the Philippines.

5. CHAPTER IV. RESULTS AND DISCUSSION

5.1 Descriptive Analytics

This chapter presents the findings regarding the effects of Vaping Habits, Vaping Period, Vape Addiction, and Vape concentration on an individual's overall Health Capital. The variables and their impact on Health Capital will be highlighted through the gathered responses from the researchers' online survey, alongside quantitative analytics. The researchers hope that this study will reach the attention of current consumers of e-cigarettes and guide them towards a healthier lifestyle.

E-cigarettes have surged in popularity among both young adults and adults in recent years, mainly due to their perceived convenience and reduced harm compared to traditional smoking. With appealing flavors, sleek designs, and the allure of less harmful alternatives, e-cigarettes have become a trendy choice for many. However, concerns about their potential health risks, particularly for younger users, have sparked ongoing debates and regulatory scrutiny. Despite these concerns, the growing use of e-cigarettes continues to raise questions about their long-term impact on public health.

Table 4.1. R^2 Value

	R-Squared	Adjusted R-Squared
HealthCa	0.349	0.343

Wherein: HealthCa = Health Capital, VPeriod = Vaping Period, VAddi = Vape Addiction, and VHabit = Vape Habit

R-squared ranges from 0 to 1. It is a statistical measure in a regression model that determines the proportion of variance in the dependent variable that the independent variable can explain. R-squared explains how the data fits the regression model. Adjusted r-squared serves as the basis to avoid bias towards complex models.

As for Health Capital (0.249), the value represents the proportion of variance in the outcome variable (unknown in this case) that the model explains. In this case, the R-squared of 0.349 suggests that the variables used in the model can account for approximately 34.9% of the variability in the outcome. The Adjusted r-squared value is a modified version of R-squared that considers the number of predictors in the model. It penalizes models with many predictors that may not contribute significantly to explaining the variance. Here, the adjusted R-squared of 0.343 is slightly lower than the regular R-squared, indicating that some of the predictors in the model may not add much value to the explanation.

Cronbach's Alpha

Reliability Statistics	
Cronbach's Alpha	Number of items
0.80	20

Discriminant Validity (Heterotrait-Monotrait Ratio)

	HealthCa	VPeriod	VAddi	VConcen	VHabit
HealthCa					
VPeriod	0.927				
VAddi	0.472	1.080			
VConcen	0.594	1.224	0.693		
VHabit	0.472	0.919	1.150	0.648	

Wherein: HealthCa = Health Capital, VPeriod = Vaping Period, VAddi = Vape Addiction, and VHabit = Vape Habit

This table displays the heterotrait-monotrait ratios (HTMT) used to assess discriminant validity in structural equation modeling (SEM). Discriminant validity is crucial because it ensures that the constructs (variables) measured in the model are genuinely distinct and do not simply reflect the same underlying factor.

HTMT values should be less than 0.85 or 0.90 to indicate adequate discriminant validity. This threshold is not universal and can vary depending on the study context.

HealthCa: The HTMT values for HealthCa with VPeriod, VAddi, VConcen, and VHabit are all below 0.90, suggesting that HealthCa is distinct from these other constructs.

VPeriod: The HTMT values for VPeriod with VAddi, VConcen, and VHabit are all below 0.90, indicating that VPeriod is also distinct from these constructs.

VAddi: The HTMT values for VAddi with VConcen and VHabit are below 0.90, suggesting that VAddi is distinct from these constructs. However, the HTMT value for VAddi with VPeriod is 1.080, above the recommended threshold. This suggests that VAddi and VPeriod might not be sufficiently distinct.

VConcen: The HTMT values for VConcen with VAddi and VHabit are below 0.90, indicating that VConcen is distinct from these constructs. However, the HTMT value for VConcen with VPeriod is 1.224, well above the recommended threshold. This suggests that VConcen and VPeriod might not be sufficiently distinct.

VHabit: The HTMT values for VHabit with VAddi and VConcen are below 0.90, suggesting that VHabit is distinct from these constructs. However, the HTMT value for VHabit with VPeriod is 0.919, which is close to the threshold and might indicate concerns about discriminant validity.

The table provides HTMT values to assess discriminant validity. The results suggest that HealthCa, VAddi, and VHabit are generally distinct, but there are concerns about the discriminant validity between VPeriod and VAddi, VPeriod and VConcen, and VPeriod and VHabit.

Structural Equation Modeling (SEM)

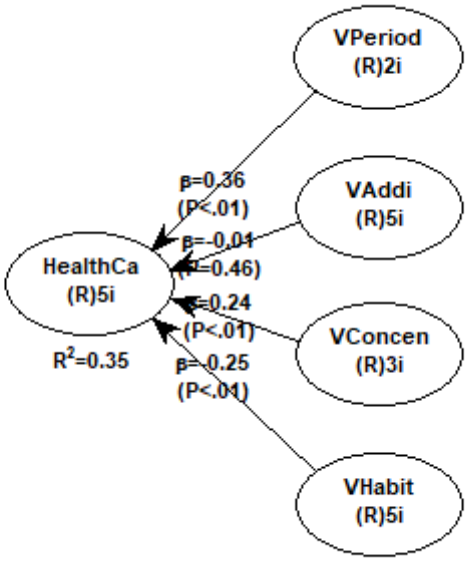


Figure 1. Structural Equation Model

The following figure displays the relationship between an individual's e-cigarette consumption patterns and overall health capital. The figure provides a comprehensive representation of the model fit, indices, and correlations that reinforce the proposed hypotheses in the study.

The SEM illustrates a model where "HealthCo" (likely health concerns related to e-cigarette use) is predicted by four variables: "VPeriod" (vaping frequency or duration), "VAdd" (additives or flavors), "VConcen" (nicotine concentration), and "VHabit" (vaping habits). The model indicates that "VPeriod," "VConcen," and "VHabit" have statistically significant positive relationships with "HealthCo," suggesting that higher vaping frequency, nicotine concentration, and certain vaping behaviors may be associated with increased health concerns. "VAdd" shows a weak negative relationship with "HealthCo," possibly indicating that some additives or flavors might mitigate health concerns. The model explains 35% of the variance in "HealthCo," it's important to note that correlation does not equal causation.

Table 4.3 Model fit and quality indices for SEM

Fit Indices	Quality Indices	Criterion
Average path coefficient (APC)	0.214, P<0.001	Acceptable if P<0.05
Average R-squared (ARS)	0.349, P<0.001	Acceptable if P<0.05
Average adjusted R-squared (AARS)	0.343, P<0.001	Acceptable if P<0.05
Average block VIF (AVIF)	1.499	Acceptable if <= 5, ideally <= 3.3

Average full collinearityVIF (AFVIF)	2.846	Acceptable if <=5, ideally <= 3.3
Tenenhaus GoF (GoF)	0.418	Small >= 0.1, medium >= 0.25, large >= 0.36
Sympson's paradox ratio (SPR)	1.000	Acceptable if >= 0.7, ideally = 1
R-squared contribution ratio (RSCR)	1.000	Acceptable if >= 0.9, ideally = 1
Statistical suppression ratio (SSR)	1.000	Acceptable if >= 0.7
10. Nonlinear bivariate causality direction ratio (NLBCDR)	0.875	Acceptable if >= 0.7

Table 4 summarizes the SEM results' model fit and quality indices, indicating a valid and acceptable fit. The indices include an Average Path Coefficient (APC) of 0.131 ($P < 0.001$), an Average R-squared (ARS) of 0.397 ($P < 0.001$), an Average Adjusted R-squared (AARS) of 0.389 ($P < 0.001$), an Average Block Variance Inflation Factor (AVIF) of 1.799, and an Average Full Collinearity VIF (AFVIF) of 1.800. Additionally, the Tenenhaus GoF (GoF) is 0.402, the Sympson's Paradox Ratio (SPR) is 0.833, the R-squared Contribution Ratio (RSCR) is 0.964, the Statistical Suppression Ratio (SSR) is 1.000, and the Nonlinear Bivariate Causality Direction Ratio (NLBCDR) is 1.000, all of which support the model's validity and acceptability. These findings indicate a structural relationship between motivation, encompassing its five dimensions, and user intention. The results underscore the importance of sustainability, functional value, risk perception, social benefit behavior, normative views, and possessive desires as potential predictors of user intention, establishing a robust structural relationship model.

Table 4.3 Effect Sizes for Path Coefficients

	HealthCa	VPeriod	VAddi	VConcen	VHabit
HealthCa		0.157	0.001	0.097	0.093
VPeriod					
VAddi					
VConcen					
VHabit					

Wherein: HealthCa = Health Capital, VPeriod = Vaping Period, VAddi = Vape Addiction, and VHabit = Vape Habit

This table displays the effect sizes associated with the path coefficients in a structural equation model (SEM). Effect sizes quantify the magnitude of the relationships between variables. In this context, the variables are:

- **HealthCa:** Health Capital
- **VPeriod:** Vaping Period
- **VAddi:** Vape Addiction
- **VConcen:** Vape Concentration
- **VHabit:** Vape Habit

HealthCa:

- The effect size for VPeriod is 0.157. This indicates a small to moderate positive relationship between the Vaping Period and Health Capital.
- The effect size for VAddi is 0.001. This suggests a negligible relationship between Vape Addiction and Health Capital.
- The effect size for VConcen is 0.097. This indicates a slight positive relationship between Vape Concentration and Health Capital.
- The effect size for VHabit is 0.093. This indicates a slight positive relationship between Vape Habit and Health Capital.

Table 4.4 Path Coefficients and P-Values

Path Analysis	Path Coefficients	p-Value	Hypothesis
VPeriod -> HealthCa	0.363	<0.001	H1
VAddi -> HealthCa	-0.005	0.457	H2
VConcen -> HealthCa	0.244	<0.001	H3
VHabit -> HealthCa	-0.245	<0.001	H4

Wherein: HealthCa = Health Capital, VPeriod = Vaping Period, VAddi = Vape Addiction, and VHabit = Vape Habit

Path coefficients represent the strength and direction of the relationships between the variables. A positive coefficient indicates a positive relationship, while a negative coefficient suggests a negative relationship. The P-value assesses the statistical significance of the path coefficients. A p-value less than 0.05 (typically denoted as <0.05) is considered statistically significant, suggesting that the relationship is unlikely to be due to chance.

VPeriod -> HealthCa: The path coefficient is 0.363, and the p-value is <0.001. This indicates a statistically significant positive relationship between the Vaping Period and Health Capital. In other words, a more extended vaping period is associated with a lower health capital.

VAddi -> HealthCa: The path coefficient is -0.005, and the p-value is 0.457. This indicates that there is no statistically significant relationship between Vape Addiction and Health Capital.

VConcen -> HealthCa: The path coefficient is 0.244, and the p-value is <0.001. This suggests a statistically significant positive relationship between Vape Concentration and Health Capital.

The table also lists hypotheses (H1-H4) likely tested in the path analysis. Based on the path coefficients and p-values, we can infer that:

- **H1** likely tested the relationship between VPeriod and HealthCa, and it was supported.
- **H2** likely tested the relationship between VAddi and HealthCa, and it was not supported.
- **H3** likely tested the relationship between VConcen and HealthCa, and it was supported.
- **H4** likely tested the relationship between VHabit and HealthCa, and it was supported.

This table presents the results of a path analysis, showing statistically significant relationships between the Vaping Period, Vape Concentration, Vape Habit, and Health Capital. These findings suggest that the duration of vaping, the concentration of vaping used, and vaping habits may influence health outcomes.

Table 4.5 p-Values for Correlations

	HealthCa	VPeriod	VAddi	VConcen	VHabit
HealthCa	1.000	<0.001	0.008	0.045	<0.001
VPeriod	<0.001	1.000	<0.001	<0.001	0.010
VAddi	0.008	<0.001	1.000	<0.001	<0.001
VConcen	0.045	<0.001	<0.001	1.000	<0.001
VHabit	<0.001	0.010	<0.001	<0.001	1.000

Wherein: HealthCaa = Health Capital, VPeriod = Vaping Period, VAddi = Vape Addiction, and VHabit = Vape Habit

This table displays the p-values associated with the correlation coefficients between different variables. P-values are statistical measures that indicate the probability of observing a correlation as strong as the one found in the data if there were no authentic relationships between the variables. A standard threshold for statistical significance is a p-value of 0.05. If the p-value is less than 0.05, it suggests that the correlation is statistically significant, meaning there is strong evidence to suggest a proper relationship between the variables.

VPeriod significantly correlates with VAddi, VConcen, and VHabit (p-values < 0.001, 0.010).

VAddi significantly correlates with VPeriod, VConcen, and VHabit (p-values < 0.001 for all).

VConcen significantly correlates with VPeriod, VAddi, and VHabit (p-values < 0.001 for all).

VHabit significantly correlates with VPeriod, VAddi, and VConcen (p-values 0.010, < 0.001, < 0.001, respectively).

This table shows that there are strong statistical correlations between "HealthCa" and each of the other variables ("VPeriod," "VAddi," "VConcen," and "VHabit"). Additionally, there are also significant correlations among the other variables themselves.

Table 4.6 Standard Error for Path Coefficients

	HealthCa	VPeriod	VAddi	VConcen	VHabit
HealthCa		0.047	0.050	0.048	0.048
VPeriod					
VAddi					
VConcen					
VHabit					

Wherein: HealthCaa = Health Capital, VPeriod = Vaping Period, VAddi = Vape Addiction, and VHabit = Vape Habit

Standard errors provide an estimate of the precision or variability of the path coefficients. The smaller the standard error, the more precise the estimated path coefficient is and the less likely it is due to chance. The larger the standard error, the more it suggests that the estimated path coefficient has more uncertainty associated with it.

HealthCa: The standard error for HealthCa is 0.047. This suggests that the estimated path coefficient for HealthCa is precise.

VPeriod: The standard error for VPeriod is 0.050. This indicates that the estimated path coefficient for VPeriod is slightly more uncertain than HealthCa's.

VAddi: The standard error for VAddi is 0.048, suggesting a moderate level of precision.

VConcen: The standard error for VConcen is also 0.048, indicating a similar level of precision as VAddi.

VHabit: The standard error for VHabit is 0.048, indicating a similar level of precision as VAddi and VConcen.

The table presents standard errors for path coefficients in an SEM analysis. These standard errors provide information about the precision of the estimated coefficients.

CHAPTER V Conclusion and Analysis

The researchers' model correlates factors such as Vaping Period (VPeriod), Vaping Addiction (VAddi), Vape Habit (VHabit), and Vape Concentration (VConcen) and how much these variables would affect Health Capital (HealthCa). This study brings light to e-cigarette consumption and its effect on overall health.

As shown in the figures presented, the consumption of e-cigarettes does indeed negatively impact overall health capital. According to the data extracted, Vaping Period (VPeriod), Vape Habit (VHabit), and Vape Concentration (VConcen) all had a significant negative relationship with Health Capital. Vape Addiction (VAddi) showed no significant correlation with health capital in the Effect Size test (with a value of 0.001). Multiple reasons can be attributed to this, with the method of quantifying an addiction being the most likely reason for the outcome.

The most significant variable affecting health capital was the Vape Period (VPeriod), with a $p = <0.001$ significance. Consumers experience more negative changes in their health as they consume e-cigarette products for years.

The Vaping Period (VPeriod) showed the most significant negative relationship with health capital. This implies that the longer an individual vapes, the more likely they are to experience negative health consequences.

Vape Habit (VHabit) showed that specific vaping habits, such as frequency, intensity, or the type of e-liquid used, also negatively impact health capital.

Vape Concentration (VConcen) shows that Higher concentrations of nicotine or other substances in e-liquids were associated with a more significant negative impact on health.

Vaping Addiction (VAddi) Surprisingly, the study did not find a significant correlation between vaping addiction and health capital. The researchers attribute this to the challenges in accurately quantifying addiction in this context.

Upon careful analysis of the data collected, the researchers found that the independent variables present [Vaping Period (VPeriod), Vaping Addiction (VAddi), Vape Habit (VHabit), and Vape Concentration (VConcen)] could possibly have indirect correlations with each other. This matter will be further discussed in the Recommendations chapter.

The findings of this study highlight the potential health risks associated with e-cigarette use. While further research is needed to understand the long-term consequences of vaping entirely, the negative associations found between vaping frequency, habits, and nicotine concentration with health capital should be a cause for concern.

While e-cigarettes were originally designed as an alternative to regular cigarettes, it has seemed to attract the attention of the wrong market, causing college students to experience deterioration in health.

CHAPTER VI POLICY IMPLICATIONS AND RECOMMENDATIONS

Drawing on the presented data, the researchers aim to share and recommend several key insights designed to spread awareness about the long-term effects of vaping and the daily inconveniences that consumers may experience the longer they continue to consume e-cigarette products through the backed and significant data collected.

With the study's target demographic being college students (ages 18-24), the use of social media as a medium to spread awareness about the long-term effects of vaping. They emphasize the daily inconveniences that consumers may experience as they continue to consume e-cigarette products. The researchers recommend leveraging social media as a primary medium for disseminating information and raising awareness.

The researchers' possible strategy is to utilize social media platforms among college students, such as Instagram, TikTok, and Snapchat, to use infographics to represent data on the health risks of vaping. Also, short videos/reels of engaging content can highlight real-life stories of individuals affected by vaping-related health issues. The researchers also support policies that restrict access to e-cigarettes for minors and regulate their marketing and advertising. Some respondents from the online survey revealed that they began the vaping habit before turning 19, indicating that e-cigarettes are easily accessible to minors in the Philippines. Smoking cessation programs can work and help individuals stop the habit. Those who can stop smoking responded positively and positively toward the activity (Kim et al., 2022).

Another recommendation for future studies would be to study the correlation between the variables in the research model. The researchers focused too much on the direct effects of Vaping Period (VPeriod), Vaping Addiction (VAddi), Vape Habit (VHabit), and Vape Concentration (VConcen) on Health Capital that they no longer investigated the correlation of these variables themselves. Apart from this, improvements in quantifying Vaping Addiction are essential in improving this study.

By implementing these recommendations, the researchers hope to effectively communicate the risks of e-cigarette use to college students and empower them to make informed decisions about their health. It's important to remind them of the gradual effects vaping can have on your health stock.

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