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# The impact of nicotine consumption on driving safety risk of truck drivers - with sleep quality as a mediating variable

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Abstract

**Introduction and aim:** From a sustainable supply chain standpoint, concern for workers' safety on the job is essential. Driving safety is vital since accidents in the trucking industry often result in the deaths of both truck drivers and other road users. We found a potential correlation between nicotine usage and driving safety risk in the literature. Sleep quality also appears to play a mediating role. Combining the exploratory research with a deductive approach to investigate the possible consequences of nicotine intake, which might improve the supply chain's sustainability, was very encouraging.

**H1**: There is a positive relationship between nicotine consumption and driving safety risks.

**H2**: The impact of nicotine consumption on driving safety risks is mediated by sleep quality.

**Methodology:** We used the Dula Dangerous Driving Index and the Pittsburgh Sleep Quality Index to form our questionnaire, collected the questionnaire in both online and offline ways, and finally got 96 valid responses. Data analysis was performed using SPSS 28.0 software and the PROCESS macro extension.

**Results:** The data analysis results confirmed our hypothesis that there is a positive relationship between nicotine consumption and driving safety risks. However, the impact of nicotine consumption on driving safety risks is not mediated by sleep quality. Among the three sub-dimensions of driving safety risk, aggressive driving and risky driving/drunk driving played an essential role in this study.

**Contribution:** This paper links nicotine consumption with the driving safety risk of truck drivers and tries to introduce sleep quality as a mediating variable, providing a

new perspective to understand the mechanism of nicotine consumption on driving safety, which may provide new knowledge for the sustainable supply chain management. This paper also attempts to arouse the industry's attention to the nicotine consumption and sleep quality of truck drivers, providing suggestions to improve the sustainability of the supply chain.

Keywords: truck driver, nicotine consumption, sleep quality, driving safety, sustainable supply chain

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*Ping He & Alban Xhafa*

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# 1. Introduction

The background section will provide general information on our study's subject and highlight the study's primary objectives. In this section, we will discuss the key and relevant components of the study that led to our aim. Our problem statement is a declaration of the gap. In the section called "purpose and research question," we have provided a quick summary outlining the specific characteristics of the topic we want to focus on in our thesis paper. In order to finish this project within the time limits given, various delimitations needed to be defined. Finally, we have outlined the thesis structure to provide a clearer picture of our thesis.

## 1.1 Background

The trucking industry is essential for freight transportation. In 2015, the US transportation system moved an average of 49.3 million tons of freight valued at more than $52.5 billion (Bureau of Transportation Statistics [BTS], 2017). Trucking is one of the main modes of transport. In the European Union (EU), about 77% of inland freight volume was transported by road in 2020 (European Commission, 2022). In the EU, between 2000 and 2018, the performance of road freight transport (measured in billion tonne-kilometers) increased by 27.5 percent (European Automobile Manufacturers' Association [ACEA], 2021), which means road freight transport has an increasing trend. Trucking is also a primary mode of inland transportation in Europe since there are almost 6.2 million trucks in the EU, which carry 73.1% of all freight for land transportation (ACEA, 2021).

Truck drivers are significant for the trade and economy in this given background. According to Williams, Thomas, and Liao-Troth (2017), the efficient and effective flow of products across the supply chain depends on truck drivers. However, the US and Europe suffer from a shortage of truck drivers (Staats, Lohaus, Christmann & Woitschek, 2017). According to American Trucking Associations [ATA] (2020), in 2020, 3.36 million truck drivers were employed, with a decrease of 6.8 percent from

2019. In particular, employers in the European Union's logistics industry are having difficulty attracting long-haul truck drivers or truckers who move products long distances and for extended periods (Staats et al., 2017). In addition, transportation truck drivers are becoming an older generation due to a shortage of young drivers. For example, almost half of the participants in a study of Canadian truck drivers were over the age of 50 (Staats et al., 2017), while 40% of professional drivers in Germany are now over the age of 50 and are likely to retire over the next decade (Staats et al., 2017). Therefore, in EU may suffer a heavier truck driver shortage when those drivers retire.

With the prosperity of road transportation and a truck driver shortage, every truck driver is valuable to society. However, traffic accidents can hurt or even kill truck drivers, which makes truck driving an unpopular job for people. In 2015, there were more than 1 million road accidents in the EU, which led to the total death of 24,000 people (Schindler, Jänsch, Johannsen, & Bálint, 2021). In addition, 4.5 percent of those accidents were caused by trucks, but trucks are responsible for 14.2 percent of all fatal crashes (Schindler et al., 2021), which means truck accidents are more severe than other accidents. Even though the frequency of road accidents and the number of fatalities in road traffic accidents have decreased significantly over the previous two decades in the EU, the traffic safety situation remains dire (Yang, Haddad, Yannis & Antoniou, 2022). As a result, the European Union's "Zero Vision" prioritizes road safety improvement (European Commission, 2022). The objective is to reduce road deaths and severe injuries to zero in Europe.

## 1.2 Problem

Accidents are not only related to the fault of the technology and condition of the vehicle and are also related to human factors. Several reasons can affect driving safety: drunk driving, seat belts, drug-impaired driving, distracted driving, speeding, and drowsy driving (National Highway Traffic Safety Administration [NHTSA], 2022). In addition, truck drivers often suffer from long hours of driving, night driving, less sleep and poorer sleep quality, lack of exercise, and improper diet to complete their tasks, causing

physical and mental health problems for truck drivers (Filtness et al., 2020). It can be concerning because when drivers are sleepy, the risk of an accident happening more than doubles (Bioulac et al., 2017). In addition, the findings revealed that out of all the accidents that lead to injuries, 75.5 percent are related to insufficient sleep quality issues (Gholam Hossein, Reza Jafari, & Azadeh, 2012). Furthermore, sleep quality was lower in drivers who had previously been in accidents than in drivers who had never been in an accident (Gholam Hossein et al., 2012), suggesting that sleepiness could be one of the leading causes of accidents.

In order to stay awake, nicotine is used as a countermeasure for sleepiness among truck drivers (Girotto, Mesas, de Andrade & Birolim, 2019; Labat et al., 2007), with a risk of health problems. However, nicotine consumption may negatively affect sleep quality at night (Kagabo et al., 2020). According to Alryalat et al. (2021), higher nicotine consumption is associated with more sleep disturbances. Another study also shows that smoking cessation can significantly reduce sleep latency (Prosise, Bonnet, Berry & Dickel, 1994), which means smoking can make it hard for people to fall asleep. This can make them more tired and sleepy for the oncoming day and may increase the potential for crashes during the daytime.

People can feel anxious when they want to smoke (Moylan, Jacka, Pasco, & Berk, 2013). In addition, some research showed that regular smokers could get depressed and irritable when they cannot smoke (Becoña, Vázquez, Fuentes, & Lorenzo, 1998; Baddoura & Wehbeh-Chidiac, 2001). According to the National Library of Medicine (NLM) (2020), nicotine withdrawal symptoms can appear within 2 to 3 hours after the last use of nicotine. In addition, it is perilous to be distracted while driving a truck, which means truck drivers may not be able to smoke until they arrive at the next stop, or they may not take nicotine in time due to the tight schedule (Altena et al., 2020). So, truck drivers who have regular nicotine consumption may suffer from nicotine withdrawal symptoms during driving: feel anxious, depressed, and irritable (Hughes & Hatsukami, 1986), and may take risky actions to get to the next stop for a cigarette. In addition, it is more likely for people who consume nicotine a lot to suffer from nicotine

withdrawal symptoms (NLM, 2020), which means truck drivers with higher nicotine consumption are more likely to take risky actions during driving.

### 1.3 Purpose & Research question

In sustainable supply chain management, it is vital to create a safe working environment for employees (Grant, Trautrims & Wong, 2017). Therefore, this study will focus on truck drivers' driving safety to improve the social status of supply chain sustainability.

Recognizing the dearth of study on the problem and being prompted by the proposals of previously cited scholars, investigating the topic is pertinent and adds to academia by advancing academic research on sustainable supply chain management. In previous research, nicotine consumption and driving safety risks have not been linked, which makes this paper meaningful and insightful for continuing exploration. Similarly, this empirical work might benefit practitioners, such as trucking industry managers and transportation policymakers. The issue of driving safety for truck drivers is not only a critical issue in Sweden but also worldwide. Understanding the factors and mechanisms of driving safety for truck drivers is critical, but industry and academia have rarely considered nicotine consumption in the past. Does nicotine consumption affect truck drivers' driving safety? Is this effect positive or negative? What is the mechanism by which nicotine consumption affects the driving safety of truck drivers? This paper will explore these questions in an attempt to answer them.

According to the text above, it is reasonable to claim that nicotine consumption can increase the driving safety risk among drivers. Then this paper poses the following research questions:

**RQ1: What is the relationship between nicotine consumption and driving safety risk among truck drivers?**

**RQ2: How does sleep quality affect the relationship between nicotine consumption and driving safety risk among truck drivers?**

## 1.4 Delimitation

Due to the time constraints imposed by our master thesis, several delimitations had to be established to complete this project. This has altered the project's scope in several ways.

The concerned area must be restricted and specified first to avoid an incoherent approach. This study is limited and was conducted in Sweden only. Our study is mainly based on these logistics companies in Skåne. Nevertheless, truck drivers from other European countries still work for those logistic companies. Therefore, we will still involve European and Swedish truck drivers in our study.

Since we focus on nicotine, the primary way of consuming nicotine is through cigarette smoking. However, since we are doing our study in Sweden, it is necessary to mention that Swedish Snus is also part of nicotine consumption. So, this study will only consider cigarettes and Swedish snus as nicotine consumption.

Since sustainable supply chain management is a vast field to study, we have narrowed our perspective and chosen to focus on the social sustainability of supply chain management.

## 1.5 Structure of the Thesis

In order to make this paper easy to read, the central part of this paper has been divided into five main parts as follows.

**Introduction**

This chapter provides context and problematization and attempts to structure our research questions around the research gap. Additionally, we discussed why we chose this topic and the value of this article to society and academia.

**Frame of reference**

A theoretical discussion accompanies this paper. This section aims to give theoretical context and background knowledge on the subject, which the writers do through a literature review. In addition, hypotheses and models based on literature research will be presented in this chapter.

**Methodology**

This chapter discusses the methodology utilized in this article. This study will employ a quantitative strategy to investigate the association between nicotine usage and truck driver driving safety risk. We will discuss why we chose this strategy, how our study was designed, where we gathered our questionnaire, and how we analyzed that data.

**Result**

The result is based on the findings from our SPSS analysis. We took our findings and then correlated them to current literature and research from other disciplines to conduct this study. This comparison enables a complete picture of the influence of research on academia and industry.

**Conclusion and discussion**

Finally, we have the conclusion and discussion, summarizing the main findings and contributions from our study's theoretical and managerial perspective. This section also discusses the study limitations and potential research directions.

## 2. Frame of reference

An explanation, relation, or prediction may be formed from our hypothesis based on general theories. The theoretical framework is where we discuss and assess scholars' ideas most relevant to our study. We have mainly focused on theories associated with

nicotine consumption, sleep quality, and sustainable supply chain management. We then created testable hypotheses from those theories that may be used throughout the text.

## 2.1 Sustainable supply chain management

Supply chain management (SCM) manages a network of all business processes and activities involving the raw material acquisition, production, and distribution management (Christopher, 2010). On the other hand, sustainable supply chain management (SSCM) ensures environmentally and socially pleasant practices and provides economic gains (Kosanoglu & Kus, 2021). Therefore, there is a need to understand better how these factors affect the sustainability performance of supply chains. Therefore, sustainability in supply chains requires a triple bottom line approach, where performance improvements are pursued in the environmental, economic, and social dimensions (Ahi & Searcy, 2015).

### 2.1.1 Triple bottom line

The triple bottom line (TBL) refers to the three aspects that organizations should consider: social value, environmental value, and economic value (Grant et al., 2017). Social sustainability can be seen as an ethical code of conduct for human survival and outgrowth that needs to be accomplished in a mutually inclusive and prudent way (Grant et al., 2017). Socially sustainable practices can be defined as the product and process aspects determining human safety, welfare, and wellness (Grant et al., 2017). According to the TBL (Figure 1), businesses should concentrate not only on maximizing shareholder wealth or the economic value they add to economies but also on the social and environmental value they create or may destroy in order to achieve long-term environmental security and egalitarian living standards for all people (Grant et al., 2017). Fair and advantageous business practices toward workers and the society and area in which a corporation does business are referred to as people or social

performance. Sustainable environmental practices are referred to as global or environmental performance. A TBL company makes an effort to minimize its adverse effects on the environment and, if feasible, promote the natural order. Profit or economic performance is the ultimate goal of all trade, whether ethical or not. In the original idea, within a sustainability framework, the "profit" element needed to be regarded as the financial gain experienced by the host community and the long-term financial influence the company has on its economic environment (Grant et al., 2017). This is sometimes misunderstood as restricted to a corporation's internal profit. For this reason, a TBL strategy cannot be seen as regular corporate accounting plus social and environmental effects. According to the TBL idea, a company should be accountable to all stakeholders, not just shareholders. In our paper, the people aspects are more attractive because a company needs to be responsible to all individuals involved, not just shareholders (Grant et al., 2017).

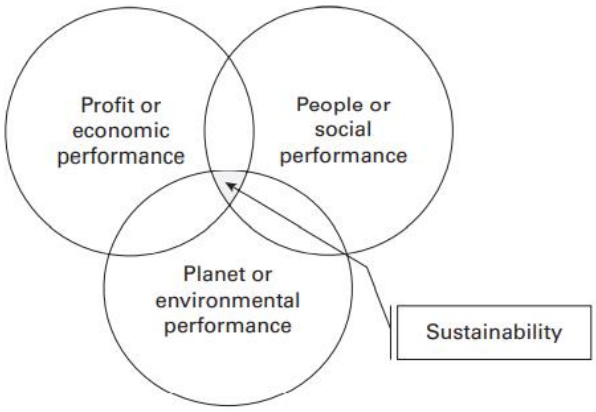


Figure 1. Triple bottom line (Grant, Trautrims & Wong, 2017).

### 2.1.2 Driving safety

Even though the frequency of road accidents and the number of fatalities in road traffic

accidents have decreased significantly over the previous two decades in the European Union (EU), the traffic safety situation remains dire (Yang, Haddad, Yannis & Antoniou, 2022). As a result, the European Union's "Zero Vision" prioritizes road safety improvement (European Commission, 2022). The objective is to reduce road deaths and severe injuries to zero in Europe. Several factors can affect driving safety: drunk driving, seat belts, drug-impaired driving, distracted driving, speeding, and drowsy driving (NHTSA, 2022). The factors mentioned above will be discussed in detail.

Distracted driving is defined as any activity that diverts the driver's attention away from the task of safe driving, such as talking or texting on the phone, eating and drinking, conversing with passengers in the vehicle, fiddling with the stereo, entertainment, or navigation system, and so on (NHTSA, 2022). Distracted driving is dangerous, with 3142 fatalities expected in 2020 in the USA (NHTSA, 2022). In this paper, we believe that every truck driver is cautious and does not smoke while driving. However, from a practical point of view, some truck drivers still cannot resist smoking and choose to smoke while driving or use Swedish snus. Distracted driving happens in this situation. Truck drivers can take seconds to light their cigarettes or take out and use Swedish snus, a brief distraction that can be deadly in high-speed driving.

In this research, nicotine withdrawal symptoms may drive truck drivers to rush to the next stop to smoke, which can lead to speeding. Speeding has been responsible for nearly one-third of all motor vehicle deaths for over two decades. Speeding played a role in 26% of all road deaths in 2019 (NHTSA, 2022). Speed has an effect on your safety when you are traveling within the posted speed limit but at a rate that is excessive for the road conditions, such as during inclement weather, while a road is being repaired, or when driving at night in an area that is not well illuminated (NHTSA, 2022). Speeding endangers not just the speeder's life but also the lives of everyone else on the road, including law enforcement authorities. Speeding is a more serious offense than just disobeying the law. The consequences are numerous: increased risk of loss of control of the vehicle; decreased effectiveness of occupant protection equipment;

increased stopping distance after the driver perceives a danger; increased crash severity resulting in more severe injuries; economic consequences of a speed-related crash; and increased fuel consumption and cost (NHTSA, 2022). Speeding is an example of aggressive driving behavior. Various causes have led to an increase in aggressive driving in general. Traffic congestion, running late, anonymity, and disregard for others and the law (NHTSA, 2022).

As mentioned above, low sleep quality can lead to daytime sleepiness, causing drowsy driving. Drowsy driving is a threat to road safety. According to NHTSA (2022), in 2017, over 91,000 police reports indicated that sleepy drivers were involved in crashes in the USA. These collisions resulted in an estimated 50,000 injuries and approximately 800 fatalities (NHTSA, 2022). In our paper, nicotine consumption is suspected of having a negative effect on sleep quality, which can lead to daytime sleepiness and drowsy driving.

## 2.2 Nicotine

### 2.2.1 What is nicotine?

Nicotine is an alkaloid in tobacco plants belonging to the Solanaceae family (Fagerström, 2014). Only in Duboisia Hopwoodii and the tobacco sub-family can found enough nicotine concentration; in various other edible plants, only 2-7 micrograms can be found per kilogram (Fagerström, 2014). Nicotine is created in the roots of the tobacco plant and amasses in the leaves, with the amount varying with the leaves picked from higher twig positions often containing more nicotine than the leaves harvested from lower twig positions (Siqueira, 2017).

### 2.2.2 Nicotine consumption

Cigarettes are the most common way of consuming nicotine. At the same time, there is also nicotine intake through electronic cigarettes, Swedish snus, cigars, chewing

tobacco, snuff, pipe tobacco, shisha, etc. Tobacco/nicotine is widely consumed in all nations, civilizations, and faiths (Fagerström, 2014). Smoking is more common among individuals with low socioeconomic status, low education, and mental illness (Valentine & Sofuoglu, 2018). There are widespread restrictions on nicotine use in the world. In the United States, people must be at least 21 years old to buy and consume nicotine (US Food & Drug Administration [FDA], 2021) and provide proof of age. In most European countries, the minimum age to buy nicotine products is 18 (European Union Agency for Fundamental Rights [FRA], 2014), but most European countries have no minimum age to consume tobacco (FRA, 2014).

Nicotine consumption can enhance human performance to some extent. For example, the nicotine from tobacco stimulates the senses and pleasures while alleviating tension and anxiety (Benowitz, 2009), calming smokers, and staying focused. In addition, smokers develop an addiction to nicotine to regulate their level of alertness and mood regulation in daily life (Benowitz, 2009). This state of vigilance may allow people to react faster and more consciously to events, such as avoiding obstacles in time and driving with greater precision. In addition, a previously published study established that nicotine or smoking substantially influenced six domains: fine motor, alerting attention-accuracy and response time (RT), orienting attention-RT, short-term episodic memory-accuracy, and working memory-RT (Heishman, Kleykamp & Singleton, 2010).

Nicotine, which possesses this property, is popular among truckers, and many are involved in smoking. The National Institute for Occupational Safety and Health [NIOSH](2014) carried out a survey focused on long-haul truck drivers. A total of 1,265 participants completed the survey in its totality, and the results revealed that 51 percent of long-haul truck drivers smoked cigarettes, whereas only 19 percent of the general population in the United States did so (NIOSH, 2014). This demonstrates that the issue of smoking among truck drivers is very significant, more so than the issue of smoking among those working in most other professions.

### 2.2.3 Nicotine addiction and Nicotine withdrawal

Nicotine addiction means the compulsive use of nicotine and tobacco products to regulate emotions (Prochaska & Benowitz, 2019). According to Siqueira (2017), nicotine fits the accepted criteria for a substance that causes addiction symptoms such as habit, withdrawal, and yearning. Cigarette smoking is sustained mainly by nicotine, a highly addictive tobacco ingredient responsible for most of the addiction (Benowitz & Henningfield, 2013). Once people are addicted, it will be harder to escape and return to everyday life (Loud et al., 2022). Authors like Benowitz and Henningfield (2013) also argue that it is tough to cease using tobacco products after developing a nicotine addiction. Statistics show that over 80% of smokers attempt to stop their relapse during the first month of abstinence, and only about 3% stay abstinent after six months (Benowitz, 2009).

The factors that contribute to the development and maintenance of nicotine addiction are numerous and include the pharmacologic effects of the drug and the design of tobacco products; genetics; learned factors, such as conditioning of stimuli through frequent nicotine dosing; and sociocultural exposures, such as family and peer use, pervasive tobacco marketing, and retail availability (Benowitz, 2010). With repeated exposure to many of the effects of nicotine, nicotine tolerance develops, reducing the pleasure derived from each cigarette (Prochaska & Benowitz, 2019). This means people need to consume more nicotine to have the same effect, which can also be a reason for people to keep smoking. While nicotine dependency is required, conditioned behavior also plays a significant role and has significant implications for behavioral therapy (Prochaska & Benowitz, 2019). Typically, a smoker identifies smoking with particular events, feelings, or environmental elements, which serve as cues to smoke (Prochaska & Benowitz, 2019). As a result, smokers frequently smoke following a meal, with coffee or drinks, while driving, or with other smokers. Additionally, exposure to tobacco advertising, which is particularly pervasive at retail points of sale and in popular media (e.g., films, television, and music), as well as exposure to others, might stimulate cravings and smoking habits (Nonnemaker et al., 2016; Siahpush et al., 2016;

Shmueli, Prochaska & Glantz, 2010)

Nicotine withdrawal symptoms occur when a person stops smoking. These include irritability, depression, restlessness, anxiety, difficulties relating to friends and family, trouble focusing, increased appetite and eating, sleeplessness, and a desire for cigarettes (Hughes & Hatsukami, 1986). In the laboratory, deficits in task performance, the associated objective withdrawal sign, have been detected as early as 30 minutes to 2 hours after tobacco deprivation begins (Hendricks, Ditre, Drobes & Brandon, 2006). Clinical reports of concentration difficulties peak a few days following cessation and can extend for many weeks (Hughes, 2007), while smoking, as well as nicotine replacement therapy and other drugs used during a stop attempt, can overcome withdrawal-induced performance deficiencies (Henningfield, Shiffman, Ferguson & Gritz, 2009). As a result, difficulties focusing and resulting losses in performance are considered risk factors for relapse in smokers seeking to quit and as factors in the maintenance of smoking in individuals who are not attempting to quit. In the introduction, we mentioned that truck drivers might not be able to smoke in work scenarios, which may cause the truck driver to have a withdrawal reaction and cause the truck driver to have dangerous driving behaviors.

As a result, the following is the first hypothesis (Figure 2):

**H1: There is a positive relationship between nicotine consumption and driving safety risks.**

**H0: There is no significant positive relationship between nicotine consumption and driving safety risk amongst truck drivers.**

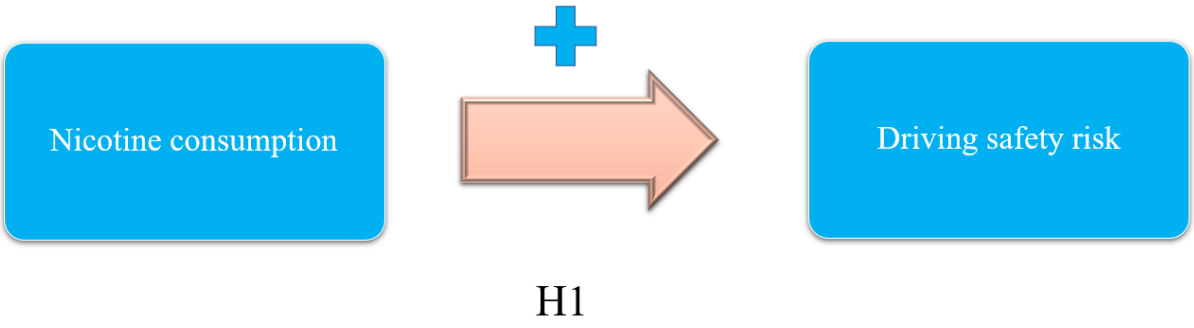


Figure 2. Model of Hypothesis 1.

## 2.3 Sleep quality

### 2.3.1 What is sleep quality?

According to Ae Kyung, Kyung Hye, Chong Mi, and Jin Yi (2021), sleep is a technique for reestablishing biological functioning and preserving energy, health, and, most importantly, a healthy balance between sleep and activity. Although sleep is a crucial regulator of human emotional functioning, its involvement in emotion regulation may explain the relationship between sleep problems and poor mental health as well as the association between sleep disorders and unhealthy lifestyle choices such as smoking (Avvenuti et al., 2021; Sergio Garbarino, Nobili, & Costa, 2014; Palmer & Alfano, 2017).

Good sleep quality is essential for preventing health risks and unhealthy lifestyle choices. Because according to Matricciani et al. (2017) and Claire et al. (2018), cardiovascular disease, stroke, and metabolic syndrome are more likely to occur if sleep duration is reduced. Less sleep is associated with harmful health and risk for more diseases. Therefore, adults should sleep between 7 and 8 hours every night to perceive good sleep quality (Ae Kyung et al., 2021). Despite its critical nature, poor sleep is becoming a universal concern, unfortunately (Ae Kyung et al., 2021). There are some ways to establish and influence good sleep quality. For example, exercise and hobbies were shown in studies to be particularly beneficial in increasing the quality of sleep for adults. Also, positive thinking and exercising positively influenced sleep quality

(Gerber et al., 2014; Otsuka et al., 2017).

### 2.3.2 Factors that can affect sleep quality

Gender, mood, internet, temperature, environment, a rise in body mass index (BMI) and belly circumference, obesity, physical activity, sedentary lifestyle, caffeine, stress, coping style, drinking, smoking, and pain are all factors that affect sleep quality (Avani et al., 2015; Cao et al., 2020; Irish, Kline, Gunn, Buysse, & Hall, 2015). The list of things that might impact sleep quality is lengthy. We will further explain smoking and how BMI is closely related to smoking and driving safety.

**Smoking**

The use of tobacco products is a severe public health hazard that is linked to a variety of ailments (Kung, Wang, & Tseng, 2008). Tobacco products are often associated with cigarettes. Moreover, cigarettes are most often associated with nicotine, and it has been shown that smoking cigarettes harm sleep quality. The study's findings show that smokers have a generally worse quality of sleep (Cohen, Ben Abu, & Haimov, 2020; Jui-Ting et al., 2013). It is primarily due to the nicotine in the cigarettes that people smoke. This is because, according to AlRyalat et al. (2021), the number of individuals who had impaired sleep was statistically substantially more significant than the number of participants who experienced better sleep among those who received a high nicotine dosage. In contrast to earlier research that found a link between cigarette smoking and sleeps or a link between nicotine patches and sleep, the current study is the first to demonstrate that greater nicotine dosages in cigarettes were related to increased sleep disruptions (AlRyalat et al., 2021).

**BMI**

The body mass index (BMI) is an intriguing factor regarding sleep quality. Because truck drivers spend most of their time sitting behind the wheel, delivering items and

goods from point A to point B, this may influence their habit of exercising and eating healthfully. If it occurs, the BMI will increase, and as the BMI increases, the sleep quality of truck drivers with a high BMI will deteriorate. Gildner, Liebert, Kowal, Chatterji, and Josh Snodgrass (2014) reported that more sleep duration was associated with a reduced BMI in both men and women, regardless of gender. This means that the lower a person's BMI is, the greater the chances are of getting more sleep and perceiving better sleep quality. In line with Magee, Reddy, Robinson, and McGregor (2016), they also argue that the healthier a person is, the better his or her sleep is overall because people with poor sleep quality also have the highest BMI.

A French-based study shows that smokers have a higher BMI among long-haul truck drivers than non-smokers (Josseran et al., 2021). This means that obese truck drivers may have lower sleep quality. In addition, truck operation, which requires sophisticated motor skills, concentration, and focus, may be compromised by obesity (Josseran et al., 2021). However, the relationship between smoking and BMI is complex. Research has discovered a complicated relationship between obesity and smoking, indicating that smoking can lower obesity as an appetite suppressant but that greater degrees of obesity can also increase smoking hazards and smoking intensity (Carreras-Torres et al., 2018).

### 2.3.3 Component of sleep quality

The following components often found in relationship to sleep quality are sleep latency, sleep duration, and sleep disorder (Buysse, Reynolds Iii, Monk, Berman, & Kupfer, 1989).

**Sleep latency**

Another component that is related to sleep quality is sleep latency. The word "sleep latency" refers to the time it takes for a person to fall asleep. As specified by Jung et al. (2013), individuals fall asleep at varying rates, but a typical sleep delay ranges between 10 and 20 minutes. Truck drivers may suffer from sleep latency without realizing it, jeopardizing their safety on the road. According to Muza, Lykouras, and Rees (2016);

Thomas and Anderson (2013), sleep duration of fewer than eight minutes may suggest a sleep condition such as narcolepsy. Those who require more than twenty minutes to fall asleep may have insomnia (Thomas & Anderson, 2013).

Sleep latency is essential since it indicates whether you are receiving enough quality sleep (Vital-Lopez, Balkin, & Reifman, 2021). Individuals are not always fatigued or aware of the effects of sleep loss. Therefore, sleep latency and other objective sleep metrics may offer a more realistic picture of a person's ability to satisfy their sleep demands (Vital-Lopez et al., 2021). Sleep delay may vary significantly among individuals depending on their level of sleepiness. For instance, if individual attempts to sleep sooner than usual, they may suffer from more significant sleep latency. On the other hand, if a person stays up later than usual, he or she is likely to have a shorter sleep latency due to being more tired than usual (Vital-Lopez et al., 2021).

There are a variety of variables that might lead to poor sleep that truck drivers confront in their daily routines that might be considered as this and could have an effect on them, such as a sleep-inducing bedroom environment, social constraints, and the use of caffeinated beverages at the wrong time (Vital-Lopez et al., 2021).

Sleep duration

The amount of time spent sleeping is a factor in determining the overall quality of a person's night's rest (Litsfeldt, Ward, Hagell, & Garmy, 2020). It depends on how much time individuals spend sleeping (Litsfeldt et al., 2020). The length of a person's sleep is often described in terms of how short or lengthy it was. Even though sleep duration is related to how much or how little sleep a person gets on an average basis, it still affects people's health. According to Andreasson, Axelsson, Bosch, and Balter (2021), if you do not get enough sleep, you are more likely to suffer from poor health and sleep-related symptoms like exhaustion. As reported by Md Rifat et al. (2022), poor health and sleep-related symptoms such as tiredness might result if you do not get enough sleep. Sleep duration was also associated with a 13–20% increase in the prevalence of over

weightiness (Guzmán et al., 2022).

Sleep time might be an exciting component when evaluating truck drivers' total reported sleep quality. Since they spend most of their time sleeping in varied locations and primarily in their vehicle when they travel, additionally consider truck drivers' weekly job hours as a factor that may impact their sleep duration over time. Another factor in evaluating is the sedentary lifestyle of truck drivers, which might influence sleep duration, affecting their overweight status.

**Sleep disorder**

The development and maintenance of sleep disorders are influenced by a variety of variables such as the environment, biology, medicine, and psychological factors (Cappuccio, D'Elia, Strazzullo, & Miller, 2010; Smolensky, Di Milia, Ohayon, & Philip, 2011; Wong et al., 2013). These variables may predispose, induce, or prolong a cycle of poor sleep and daytime performance. Additionally, sleep disorders not only impair sleep quality and effectiveness throughout the day but also have a negative impact on society and health.

Obstructive sleep apnea (OSA), sleep apnea syndrome (SAS), circadian rhythm disturbances (CRD), and chronic insufficient sleep are all common sleep disorders that cause significant health and societal harm (Akashiba et al., 2022; Bjornsdottir et al., 2015; Chou et al., 2022; Daniel, Jeffrey, Matt, & Charles, 2018; Sun et al., 2022). They contribute to a loss of personal well-being, the development of chronic disease, decreased work productivity and performance, and an increase in accidents that cause needless injury and death (Akashiba et al., 2022; Bjornsdottir et al., 2015; Chou et al., 2022; Daniel, Jeffrey, Matt, & Charles, 2018; Sun et al., 2022).

Apart from OSA, SAS, and CRD, other factors contribute to sleep disorders. The following factors are insomnia, delayed sleep phase, insufficient sleep syndrome, and sleep apnea. Insomnia is a sleep disorder characterized by difficulty beginning or sustaining sleep, which may be accompanied by anxiety or melancholy (Schwartz et al.,

2020). The delayed sleep phase is another kind of sleep problem that occurs when respondents report a later bedtime on weekends compared to weekdays and can also be seen as a variation in alertness between the evening and morning hours (Schwartz et al., 2020). Insufficient sleep syndrome is described as the difference in sleep length between weekends and weekdays and the disparity in sleep duration between perceived sleep requirements and actual sleep duration (Schwartz et al., 2020). Finally, sleep apnea is characterized by patients reporting loud, frequent snoring or seeing apneic episodes throughout the night, often accompanied by excessive daytime drowsiness (Schwartz et al., 2020).

### 2.3.4 Medicine and Sleep hygiene

When attempting to improve sleep quality, medication is often used. Some of the most commonly prescribed and used sleep aids are benzodiazepines, nonbenzodiazepine omega-receptor agonists (zolpidem), tricyclic antidepressants, selective gamma-aminobutyric acid (GABA) agents, and antihistamines (Chen-Yi et al., 2021). Although the medicine improves sleep quality, there are certain drawbacks to using sleeping pills as a treatment. Other common side effects include diplopia and vertigo (Wang, Bohn, Glynn, Mogun, & Avorn, 2001). However, the sleeping drugs mentioned above have the same function: to help someone sleep when they cannot do so independently. That is why it did not seem essential to go into further detail to describe the tablets and medications in greater detail for this study.

Practicing what is known as "sleep hygiene" is another method for enhancing the quality of your sleep. Sleep hygiene may be seen as a medicine in which the patient serves as the doctor (Hauri, 1991). Good sleep hygiene aims to put yourself in the best possible position to sleep soundly every night (Hauri, 1991; Irish et al., 2015). Optimizing your sleep schedule, pre-bed routine, and every day routines is a critical component of developing habits that make healthy sleep seem effortless (Hauri, 1991). Simultaneously, establishing a pleasant bedroom atmosphere may invite unwinding and

sleep (Hauri, 1991). Due to a hectic work schedule for truck drivers, it might not be easy to maintain proper sleep hygiene. However, dealing with a different sleeping environment while traveling for long periods might also affect a truck driver's sleep hygiene. In any case, maintaining a healthy sleep hygiene routine is beneficial for overall sleep quality.

### 2.3.5 What is sleepiness?

Having difficulties remaining awake or attentive throughout the day, or a more vital need during the day to sleep, is what is referred to as sleepiness, or excessive daytime sleepiness (EDS) (Murray, 2016; Thorarinsdottir et al., 2019). For this reason, if faced with EDS, it might also cause fatigue, exhaustion, and poor energy, according to Murray (2016). Sedentary work is an excellent illustration of what contributes to sleepiness. It is believed by Chervin (2017) that when you are sedentary, you may have more intense symptoms of sleepiness. As previously discussed in the section on sleep quality, sedentary driving is a problem faced by truck drivers. Because they spend most of their workdays in their vehicle, they are more likely to have daytime sleepiness.

Not only may the sedentary factor be an issue for truck drivers, but they may also feel tired or sleepy behind the wheel, which can be an issue or a risk factor. It has been shown that sleepiness is a risk factor for accidents when driving a vehicle. According to Forsman, Anund, Skyving, and Filtness (2021), driver tiredness, which includes both task-related exhaustion and sleepiness, has long been recognized as a factor in road accidents. As Stephanie Bioulac et al. (2017) reported, the probability of a vehicle accident increases more than two-fold for drivers who report feeling sleepy while driving.

As previously shown, sleepiness behind the wheel is one of the most significant risk factors for accidents (Abe, Komada, Hayashida, Inoue, & Nishida, 2010; Bioulac et al., 2017; Connor et al., 2002; Sagaspe et al., 2010). As mentioned above in the section on sleep quality, different sleep disorders, such as sleep apnea, may also trigger sleepiness.

Additionally, combining a stressful work environment and shift work might disrupt sleep and cause sleepiness (Keith et al., 2017). Given that we are examining the safety risk posed by truck drivers, the sleepiness aspect may be worth considering. As prior research indicates (Bioulac et al., 2017), the risk of being involved in a vehicle accident more than doubles for drivers who report feeling tired while driving.

### 2.3.6 Treatments for sleepiness

There are several treatment options for sleepiness, but three of the most frequent will be demonstrated. One is pharmaceutical treatment, the other is primarily concerned with using caffeinated beverages such as coffee and energy drinks, and the third is more concerned with maintaining a healthy sleep hygiene balance. (Filtness et al., 2020; Murray, 2016; Porez-Carbonell, 2019). First, we will focus on the consumption of caffeinated beverages since it is a substance that truck drivers depend on the most when faced with sleepiness and is relatively easy to get their hands on. According to Roehrs and Roth (2008), caffeine is often used to increase alertness and performance. Coffee and energy drinks, two of the most popular caffeinated beverages on the market (Filtness et al., 2020), may help individuals remain awake and focused, but overconsumption is still not healthy and not recommended. Furthermore, to keep sleep disturbances to a minimum, caffeine should be avoided after 3 p.m. to maintain a healthy balance between sleep and productivity (Murray, 2016). The third kind of treatment is sleep hygiene, which has already been covered in the section above on sleep quality. It is when, for example, the truck driver takes on the role of a doctor and optimizes their sleep schedule, pre-bed routine, daily routines, etc. (Hauri, 1991).

The treatments for sleepiness will not be discussed further in detail since our focus is on the consequences of nicotine consumption. However, we wanted to highlight some of the elements that might cause sleepiness in general and emphasize that there are ways to manage sleepiness temporarily but not indefinitely.

Based on the above, we put forward the following hypothesis (Figure 3)：

**H2: The impact of nicotine consumption on driving safety risks is mediated by sleep quality.**

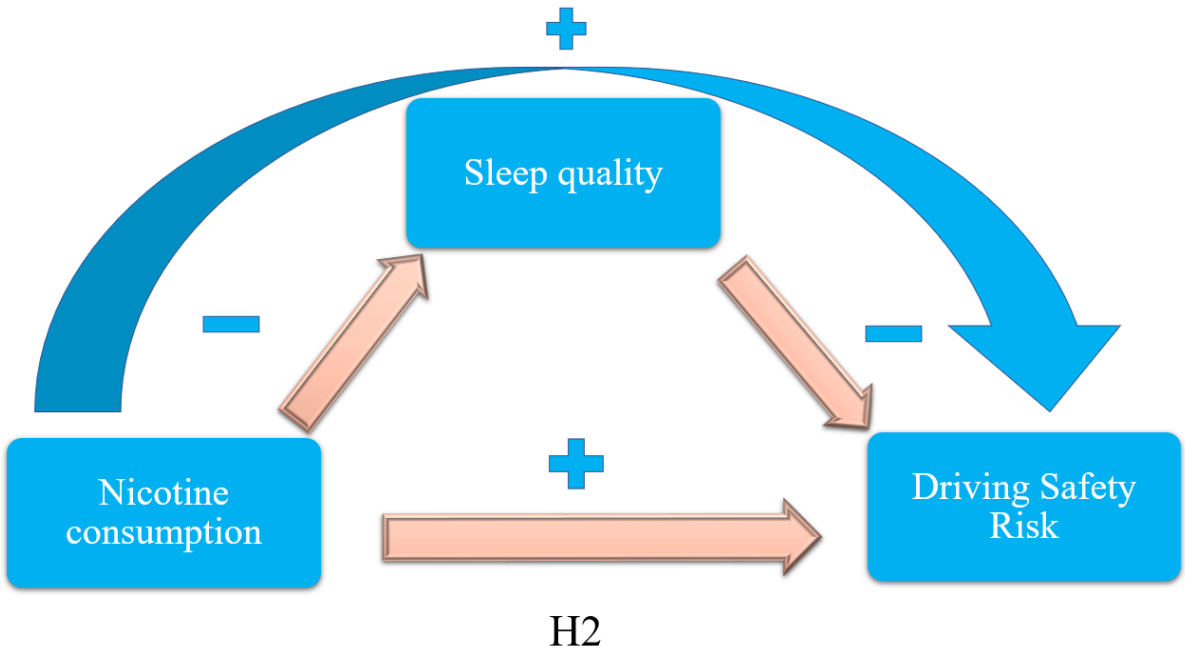


Figure 3. Model of hypothesis 2

## 3. Methodology

Figure 3 illustrates the essential processes involved in quantitative research. This is a very typical-idealized version of the procedure. Although it is unlikely to be discovered in this pure state, it is a helpful starting point for understanding the approach's primary parts and relationships. Although research is seldom as linear and straightforward as the diagram indicates, its purpose is to capture the essential processes and offer a general picture of their linkages. By beginning with the existing theories, we imply that we will adopt a broadly deductive approach to the link between theory and research. According to Bryman (2012), it is customary for summaries of quantitative research's major processes to imply that a hypothesis is derived from the theory and tested. Given that we formed our hypothesis based on the theory section, we felt it would be highly

appropriate to incorporate the deductive procedure in figure 4, proposed by Bryman (2012).

Because we are doing an explanatory study, we decided to use Forza's (2002) theory testing survey research process to guide us through conducting a successful survey. Forza's (2002) theory testing survey research process will be explained further in the section "Cipriano Forza approach to survey research" in figure 4. Bryman's (2012) deductive process and Forza's (2002) theory testing survey research procedure are used in the remainder of our methodological approach. Apart from the deductive approach and theory testing survey, we will describe our research philosophy and critical evaluation of the methodology.

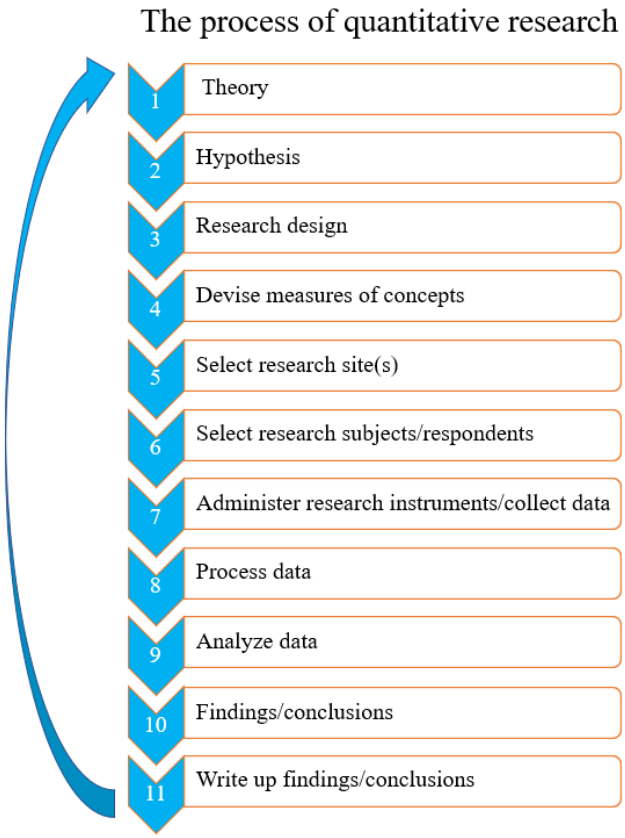


Figure 4. Significant processes are involved in quantitative research (Bryman, 2012).

## 3.1 Research philosophy

Positivism is a philosophical viewpoint that argues for applying natural science approaches to the study of social reality and beyond. Nevertheless, the word encompasses more than this idea, albeit the essential aspects differ according to Bryman (2012). However, positivism is also interpreted to imply the deductive principle. Using the deductive principle, theories aim to develop testable hypotheses that may be used to evaluate alternative explanations for observed phenomena (Bryman, 2012; May 2011; Saunders, Lewis, & Thornhill, 2007). We decided to use a deductive framework for our paper since we touched on areas of proven theory from scholars, such as nicotine consumption, sleep quality, and driving safety risk. From those theories, we then developed testable hypotheses that may be used to evaluate alternative explanations for observed phenomena. The deductive principle will be discussed in further detail in the deductive part. However, within positivism, social facts can be measured and quantified objectively, allowing other researchers to replicate research to check findings. The core idea of positivism is that structural factors impact individual actions, examine the broad picture from a macro viewpoint, and seek objective and quantifiable evidence. Positivists favor quantitative techniques such as social surveys, standardized questionnaires, and official statistics over qualitative approaches such as interviews and focus groups because they are more reliable and representative (Bryman, 2012; May 2011; Saunders et al., 2007).

## 3.2 Deductive approach

Given that we also touched on areas with established theories, such as nicotine consumption, sleep quality, and driving safety risk, we determined that a deductive approach would be appropriate for our study. According to Bryman (2012), the deductive process starts with the researcher developing hypotheses based on what is known about a particular domain and on critical theoretical considerations. Next, the

social scientist must formulate a theory and convert it into an understandable language for the general public. Finally, the social scientist must thus define how data might be obtained concerning the ideas that make up the hypotheses (Bryman, 2012). Because we sought to establish a relationship between nicotine consumption, sleep quality, and how those factors impact driving safety, we needed to be familiar with and understand a great deal of prior knowledge in those areas to build new hypotheses based on the theories we gathered.

The hypotheses drawn from theory come first and serve as the driving force behind the data collection process. Once the data has been gathered, the following stage will determine if the preliminary data can be used to reject or confirm our hypothesis. The last phase is a revision of the theory, in which the researcher employs an induction method, which moves the process in the opposite direction of deduction by concluding the implications of our results for the original idea. This information is then incorporated into the existing theory and research results in that study area (Bryman, 2012).

Bryman (2012) illustrates the process of deductive reasoning in Figure 5. Even if we are following the deduction method, it may be improved. Given that we are doing a quantitative study focusing on online survey research, Forza (2002) is critical in refining the process to fully understand what has been done in this paper.

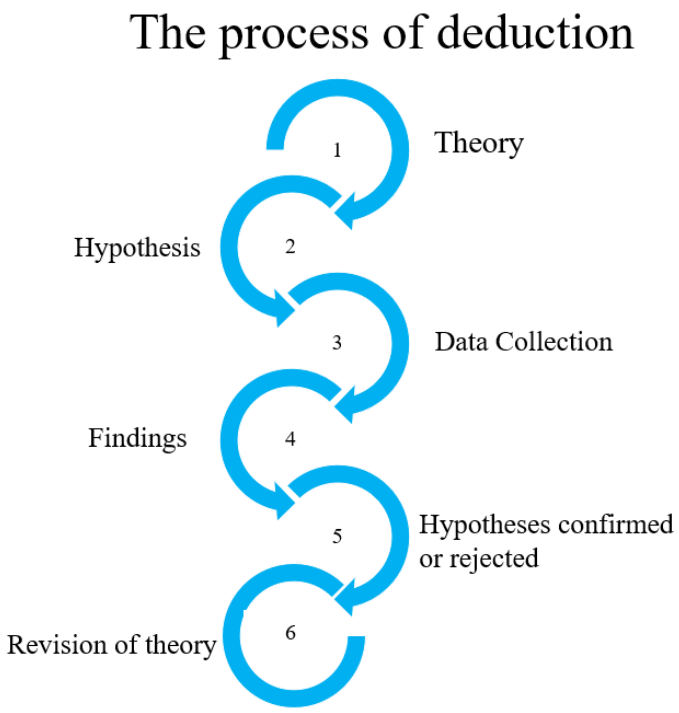


Figure 5. Deductive procedure (Bryman, 2012).

### 3.2.1 Cipriano Forza's approach to survey research

Forza (2002) illustrates our study in a way that is correlated with the deduction process from Bryman (2012) figure 2. Due to our origins in quantitative research and deductive methodology, we continue to gather our primary data through an online survey. For this reason, Forza (2002) is helpful and appropriate to follow because the author explains what is required before designing a survey research study. Theory testing, according to Forza (2002), is a lengthy procedure that requires the presence of a theoretical model or conceptual framework. It entails a variety of connected sub-processes, including the translation of the theoretical domain into the empirical domain, the design and pilot testing phases, the data collection phase for theory testing, the data analysis phase, and the findings interpretation and reports writing phase. The procedure of conducting a survey to test hypotheses is shown in Figure 6 (Forza, 2002).

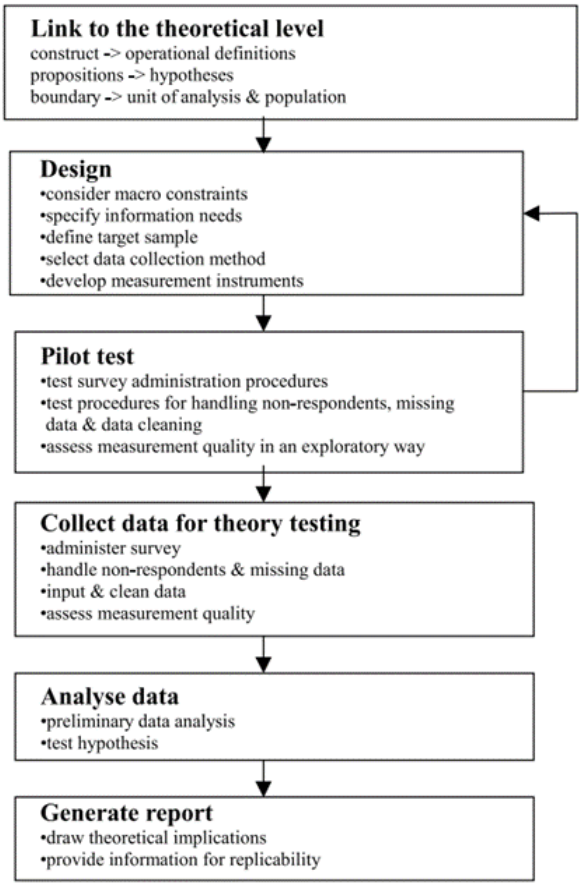


Figure 6. The procedure of conducting a survey (Forza, 2002).

In the subsequent step, we sought to investigate whether we could establish a link between the theoretical level and the empirical expression of hypotheses. As a result, hypotheses may be experimentally tested using observed data and can be rejected if they are not supported by empirical evidence. Naturally, hypothesis testing aims to ascertain the validity of the associated notion. It was possible to connect to the theoretical level using our research question, and from there, we could derive appropriate hypotheses for further investigation into our primary question's perceived replies. After that, we go on to the design phase, during which we will define the target sample, choose a data collection technique, and create measuring tools.

The design was straightforward for our study since a large portion of the questions were derived from pre-reviewed indexes such as the Pittsburgh Sleep Quality and Dula Dangerous Driving Index; a portion of the questions will be detailed in further depth in

the questionnaire design. According to Forza (2002), doing so enables the collection of data that can be used to improve the definition of the sample and the sufficiency of measurements for the sample.

According to Forza (2002), the data you acquire from a pilot test may help you better define the sample and create measurements that are more precise when compared to the sample. According to Forza (2002), several issues may be found even if all prior stages have been taken with utmost care. That is why pre-testing a questionnaire before disseminating it for data collection is critical. Additional information about our pilot testing will be included in the pilot testing section of our method.

For our analyzing section, choosing and implementing an appropriate statistical test is only one step in the data analysis process for hypothesis testing. Additionally, the statistical tests' results must be evaluated. When the researcher interprets the findings, he or she shifts from the empirical to the academic arena. This procedure involves inference and generalization (Meredith, 1998).

According to Forza (2002), the last procedure is when you, the researcher, do a quality check on the method to see if our findings have internal validity, are acceptable, or apply to other populations. This way, we may determine if we should be able to replicate the study exactly. If the findings are consistent throughout time, the conjectures will not be supported or eliminated only based on chance.

The design, pilot test, data collection, analysis section, and quality check for hypothesis testing are discussed in further detail below.

### 3.3 Research Strategy

Quantitative and qualitative research are two distinct modes of inquiry in the academic world (Bryman, 2004). Choosing quantitative versus qualitative research as a strategy affects the techniques used to gather data for the study and the data processing process and consequently affects the research outcomes (Bryman, 2004). Therefore, the choice between quantitative and qualitative research is contingent upon the study questions

and objectives of the researchers (Bryman, 2004; May 2011).

Quantitative research is the examination of social reality with the primary objective of determining how questions (e.g., how many/how much) should be answered (Biggam, 2018) in order to comprehend how information about the social world should be developed (Bryman, 2004). For instance, to determine how many people spend more than 10 hours each day studying. Typically, researchers adopt an outsider's perspective to establish a link between theory, hypothesis, and research. Structured research is conducted, and the resulting data is rigorous and trustworthy (Bryman, 2004). Qualitative research is a method for describing and analyzing human culture and behavior (Bryman, 2004), which also refers to the process of answering why questions (Biggam, 2018). Conducting qualitative research entails seeing things from the inside, i.e., from the perspective of the subjects; providing rich and detailed descriptions of the social setting under investigation; and interpreting what occurs in terms of an understanding of events, behavior, and so on in the context of the participants (Bryman, 2004). Additionally, qualitative research is adaptable due to its open and unstructured nature (Bryman, 2004). This openness increases the likelihood of encountering an unanticipated topic that may be of interest (Bryman, 2004).

Since the research questions indicate the need to examine the correlations between certain variables, an explanatory study was done, and quantitative data were acquired, analyzed, and evaluated (Saunders et al., 2007). Utilizing quantitative research is the logical outcome of all the elements influencing the choice (Bryman & Bell, 2015). According to Bryman (2004), one of the primary strategies for gathering data in quantitative research is through surveys. Its purpose is to describe and explain the features of a population's ideas using a representative sample (May, 2011). Thus, a survey can provide quantifiable data on a large number of people considered to be representative of a larger community to test ideas or hypotheses (Bryman, 2004). Given the limited scope of this thesis due to time and financial constraints, a survey employing a questionnaire is the primary technique for collecting primary data for the whole study.

Because indicators of theoretical constructs are drawn from the literature, they are also used to develop the study's questionnaire.

## 3.4 Data collection

### 3.4.1 Sampling

When selecting a study sample, it is critical to ensure that the sample chosen is representative of the population (May, 2011). There are two distinct sampling techniques: probability sampling and non-probability sampling. Probability samples are drawn randomly from a population, ensuring that the sample most closely resembles the population. Calculating the likelihood of people being chosen to participate in non-probability sampling is almost impossible. This selection method is significantly more efficient in terms of time and money and makes responders much more accessible, but it has drawbacks because it is not random and hence may not be properly representative of the population (Bryman & Bell, 2015).

In this instance, the researcher chose to employ a non-probability sample owing to study restrictions. The highest amount of unpredictability feasible was ensured. *Purposive sampling* was used to define the research population in this thesis. Purposive sampling's strength is its capacity to choose subjects for examination, which helps researchers collect data effectively (Wrench et al., 2013). However, one problem with this sample strategy is that if respondents are aware of the research, they may not be completely candid and will provide responses that they believe are expected. As a result of the subjectivity, it may be challenging to justify the sample's representativeness (Wrench et al., 2013).

In this paper, truck drivers from logistics companies in and around Skåne (Sweden) are our samples. First, our paper concerns nicotine consumption and driving safety risks among truck drivers. Other types of drivers are excluded. Secondly, one of the authors in this paper has connections among logistic companies in Skåne. As a result, it is both

convenient and rational to concentrate on data collection from those samples. However, survey respondents' responses are uncontrolled regarding the number of surveys they reply to and the legitimacy of their responses. In addition, since our questionnaire includes more than 30 questions, it can be annoying for those truck drivers. Since truck drivers have to fight with their tight schedules (Altena et al., 2020), not many drivers will choose to spend 5 minutes on a survey. Those participants in this survey may have similar personalities, like patience or kindness, which may affect the result. Fewer patient drivers may give up before finishing all the questions since this survey is voluntary.

### 3.4.2 Questionnaire design

According to Wenemark (2017) and Berntson et al. (2016), it is critical to devote much work and attention to the survey's questions. The type of survey question might be descriptive or analytical (Berntson et al., 2016). Wenemark (2017) argues that communication theory may be utilized to design a successful survey and discusses Grice's (1989) four criteria of style, quality, quantity, and relationship.

The term "manner" relates to the respondent's ability to comprehend the question in terms of the language used and the accompanying instructions (Wenemark, 2017). This has been considered in this study through the use of the native language of seven nations and the use of terminology recognizable to the group of professionals. The "quality'" principle applies not only to the presumption that the respondent will answer truthfully but also to the researcher's obligation to provide the respondent with the opportunity to reply honestly (Wenemark, 2017). This approach was included in the survey by allowing respondents to add alternatives if they did not think the provided options were relevant and by including specific text answer questions that allowed respondents to submit extra or other information. One example of this principle is that Swedish Suns are used in this questionnaire as an alternative to cigarettes. The third principle of quantity is to provide the respondent with the resources to reply with the appropriate

amount of subtlety; for some questions, the responder may have a vague sense of the answer, while for others, they are better knowledgeable and capable of providing a more nuanced response (Wenemark, 2017). This feature was controlled in the study by using the appropriate question structure for each question. The last principle, the relational principle, relates to the question's significance in the respondent's eyes and how this individual understands the question within the context in which it is presented (Wenemark, 2017). Our question is strongly related to our research question, which is presented below.

In order to answer the research question of this paper, several indexes and questions were used to compose this questionnaire, and the questionnaire was divided into several sections. First, demographic information: age, gender, weight (kg), and height (cm). This information helps understand the truck driver and truck driver shortage in the EU. Further exploration can be employed through age, gender, BMI, etc. Second, for sleep quality and daytime sleepiness, this paper chooses several components of the Pittsburgh Sleep Quality Index (PSQI): *subjective sleep quality*, *sleep latency*, *sleep duration,* and *daytime dysfunction* (Buysse et al., 1989). Options are provided for the participants. The scores are calculated and added together to obtain the final score according to the participants' answers. In addition, the Dula Dangerous Driving Index (DDDI) (Willemsen, Dula, Declercq & Verhaeghe, 2007) is used in this questionnaire to calculate factors that can make driving dangerous: *Negative Cognitive/Emotional Driving*, *Aggressive Driving,* and *Risky Driving*. This questionnaire uses a standard Likert scale, giving participants options and calculating scores for each dimension of driving safety risks. At the end of this questionnaire, two questions were set up to count the consumption of cigarettes (units) and Swedish Snus (units), respectively. An additional question of traffic accident statistics (number of accidents) is proposed to verify whether a high traffic accident rate accompanies the high driving risk.

### 3.4.3 Pilot test

Wenemark (2017) suggests that testing a survey before its distribution is a low-cost way to ensure the survey's success. In this study, the questionnaire was sent out to four logistic company managers, both English and Swedish. Through interviews with those four managers, the readability of the questionnaire was discussed, and some suggestions were obtained. They believe that this questionnaire is relevant to this research question and suggest we include more languages in the questionnaire. Logistics companies in Sweden have many truck drivers that come from different nationalities. Therefore, language barriers can decrease their willingness to fill out the questionnaire and the accuracy of their understanding of the content of the questionnaire.

In order to break down language barriers as much as possible, we translated our questionnaire into German, Polish, Turkish, Bulgarian, and Romanian according to their suggestions. Those translations are done with *Google Translate*, and native speakers are invited for proofreading. The native speakers invited to the proofreading were former classmates or colleagues of the authors; they revised the text to varying degrees. Unfortunately, no suitable proofreader was found for Bulgarian for this study. However, according to the other language proofreaders, *Google translat*e did an excellent job on those translations since those questions are all short sentences, and possible grammatical errors do not misinterpret the original intent of the questionnaire.

### 3.4.4 Questionnaire Collection

The online questionnaire was chosen in this paper for data collection; the advantage of this strategy is that it enables you to quickly contact a large number of participants in a short period and at a reasonable cost (Wright, 2005). Actual data was gathered using an online survey with a questionnaire created on the widely used Internet-based platform *Google Form*. Since this survey has questions in 7 languages, online surveys can be more convenient. Participants can choose their preferred language at the beginning of

the survey. All the data collected will automatically be stored in the Google sheets, which can be further transferred to SPSS software for analysis.

In order to get permission and help to spread the online survey, several meetings with managers in logistic companies (GDL, Intime express, DHL, etc.) were organized, as well as phone calls and emails to other logistic companies (ESL, LBC, DB Schenker, DSV, SYD LOG, Börjesson åkeri, Ekol logistics, PostNord, Calderys). This study is generally divided into two batches of communication. The first batch of interviews and emails is to explain the purpose and theme of the study and to show a sample of the questionnaire. After obtaining the research permission and feedback, we improved the questionnaire and formally attached the questionnaire link by email, which the logistics company managers helped spread to the truck drivers. In addition, we got permission from the GDL to place paper questionnaires at the company to be filled out voluntarily by truck drivers.

80 responses were obtained through online questionnaires; 18 were obtained through paper questionnaires, for 98 responses. Before SPSS analysis, the data should be exported to EXCEL and converted into English format uniformly. Furthermore, some data cleaning operations are needed, for example, changing '20 mins' to plain number format '20'. Alternatively, use '0' to replace 'no' in the answers. For the question "During the past month, how long (in minutes) has it usually takes you to fall asleep each night? ". Some of the answers range rather than a specific value, like '40-60'; this paper takes the average o "50" as the value for this answer. After data cleaning, 2 invalid answers were found. One of the truck drivers had difficulty answering the question, 'During the past month, how many hours of actual sleep did you get at night? (This may be different from the number of hours you spend in bed.), he wrote down 'Vet inte,' which means 'do not know .'Since this question is supposed to be a number, we consider this answer invalid. In addition, another invalid answer was recognized. A truck driver claims to be only 130 cm tall in our responses. From a practical standpoint, we do not think it is tall enough to drive a large truck, so we consider this one an invalid response.

As a result, this paper will use these 96 valid responses for data analysis. The survey data were examined using the advanced computer program SPSS (Statistical Package for the Social Sciences). All questions in the questionnaire have been pre-coded in SPSS as distinct variables. After completing the survey data collection, SPSS was used to code the responses of each respondent.

### 3.5 Reliability and validity

When doing quantitative research, it is essential to consider the reliability and validity of the research methodologies and measuring devices. Establishing reliability and validity in studies is fundamental to ensure that data is sound and reproducible and that the findings are correct. A measuring instrument's integrity and quality can only be ensured if its validity and reliability can be demonstrated (Kimberlin & Winterstein, 2008). The rule of thumb is that you can have reliability without validity, but you need validity for reliability (Bryman, 2012; May, 2011; Salkind, 2010; Saunders et al., 2007). For our study, both validity and reliability will be considered for our method part.

#### 3.5.1 Reliability

The term "reliability" refers to the consistency with which a technique measures something. When the same procedure is applied to the same sample under the same circumstances, the results should be identical (Bryman, 2012; Salkind, 2010; Saunders et al., 2007). Otherwise, the measuring technique may be unreliable. There are three reliability classifications: test-retest, alternative form, and internal consistency (Saunders et al., 2007).

In this paper, the internal reliability of multi-item constructs is enhanced by measuring items produced through a rigorous approach in prior research. We will also confirm the internal consistency of the questionnaire in subsequent SPSS analysis. In addition, a web-based questionnaire with closed questions eliminates bias in data translation by researchers among respondents and enables more precise response recording.

### 3.5.2 Validity

The validity tells us the extent to which the results measure what they are supposed to measure. It is also evaluated by comparing the results to established theories and other measures of the same concept. They rely on valid and usually trustworthy measurements; if a test generates correct findings, they should be repeatable. Essentially, validity refers to the degree to which a technique properly measures what it is designed to measure. If a study has a high degree of validity, it delivers conclusions consistent with the physical or social world's genuine traits, characteristics, and changes (Bryman, 2012; May, 2011; Salkind, 2010; Saunders et al., 2007). Some of the subcategories of validity will be included construct validity, content validity, criterion-related validity, internal validity, external validity, and face validity (Bryman, 2012; LeCompte & Goetz, 1982; May, 2011; Salkind, 2010; Saunders et al., 2007). Saunders et al. (2007) note that a questionnaire's validity is often discussed in terms of content validity, face validity, criterion-related validity, and construct validity, which is all related concepts. Using a questionnaire, we will examine our study's validity in terms of content validity, face validity, and construct validity since we are conducting a survey.

**Content validity and face validity**

A test's content validity determines if it reflects the whole concept. A test, survey, or measuring method's content must include all critical aspects of the issue being measured to obtain accurate findings. If dimensions are omitted from the measurement or outside dimensions are added, the measurement's validity is jeopardized (Salkind, 2010; Saunders et al., 2007). Therefore, it is vital to ensure that the measuring instrument, in this instance, the survey questions, adequately covers sleep quality, nicotine consumption, and driving safety risk for the investigational questions to ensure content validity. It is also possible to utilize a panel of people to determine if each measurement item in the questionnaire is vital, beneficial but not crucial, or not required (Saunders et al., 2007). Since we used mature scales widely used in the industry, PSQI, and DDDI, they have high content validity. For our pilot test, we sent out our questionnaire to the

managers of other logistics firms and asked them for their feedback before sending it out. One of the managers was a former truck driver who smoked, and with the manager's support, we once again confirmed the content validity of the questionnaire.

Face validity evaluates how appropriate the content of a test seems on the surface (Bryman, 2012). While face validity is related to content validity, it is a more casual and subjective examination. Due to the subjective nature of face validity, it is often regarded as the least reliable kind of validity. However, it helped us immensely during the early phases of method development. Therefore, before formally communicating with the logistics company, we first subjectively believe that these two scales meet our study. Second, we showed the questionnaire contents to our supervisor, who agreed that our questionnaire seemed to fit the study. Therefore, the study had a high degree of face validity, as indicated efforts were made to ensure that instruments were suitable for the ideas being studied.

**Construct Validity**

The evidence for construct validity is provided by theory evidence, which means that behavior corresponds to theoretical notions. Construct validity is the degree to which your questions measure the constructs that are meant to be assessed (Bryman, 2012; Saunders et al., 2007). Due to the wide range of topics we address, such as nicotine consumption, sleep quality, and the dangers of driving. Then several observable or measurable indicators are required to measure those components. According to Salkind (2010), based on the conception of construct validity and its dimensions, it is vital to operationalize constructs into actual, quantifiable features. Therefore, before collecting or analyzing data, it is essential to clearly understand how you define your construct and how its dimensions connect (Bryman, 2012; Salkind, 2010; Saunders et al., 2007). Our quantifiable indicators are derived from two indexes, the PSQI and the DDDI. These two scales are widely used in the industry. Each scale has division and scoring rules for the sub-dimensions of the items in the scale and has high construct validity.

## 3.6 Objectivity

Objectivity means that there is a reality out there that we may record and analyze without regard to other people's perceptions of it (May, 2011). In our paper, we did not deliberately guide truck drivers to fill out the questionnaire to come to the conclusion we wanted. All questionnaires were anonymous and completed without starting pressure, meaning they were not in direct contact with us while filling them out. Instead of being pressured to change their minds, they fill inaccurate data based on their situation. This design can ensure the objectivity of the study.

The positivist concept of objectivity in social research holds that researchers should keep a distance from the subjects they examine to ensure that the conclusions are based on the content of the research rather than the researcher's values, views, and personality (May, 2011). Most of the questionnaire data were automatically collected by Google to generate the datasheet, and we transcribed only a few responses into the datasheet through the paper questionnaire. In our study, all questionnaire data was recorded honestly, and we did not change the data for our purposes.

## 3.7 Ethical consideration

In research and studies, it is always vital to address ethical considerations while collecting and analyzing data, particularly concerning specific participants. In some instances, the nature of the research subject necessitates collecting sensitive data, which is not the case in this study. Nonetheless, care was taken not to request information that was not strictly necessary (Bryman, 2012; May, 2011; Salkind, 2010; Saunders et al., 2007). For example, demographic data is obtained without evident application to the study. This might give the impression that the researcher is unreliable. However, very few demographic data were gathered in this paper, and total anonymity was established, such that not even the researcher knew which responder data belonged to which person. Contacting potential responders and getting permission to use their data is a crucial ethical consideration. Due to the nature of the survey, this paper did not develop issues

with acquiring access.

In contacting respondents, we guaranteed to offer truthful information about the survey length, the eventual aim of the respondents' data, and how to complete anonymity would be maintained (May, 2011; Salkind, 2010). In order to acquire the respondents' confidence and agreement, which they expressed by filling out the questionnaire, it is essential that they fully understand the purpose of the data collection and how it would be safeguarded. A comprehensive debriefing accompanied our questionnaire. Thus, participants were not subjected to humiliation, damage, or disadvantage (Bryman, 2012; Saunders et al., 2007). The study was performed so that everyone who took part knew they were being subjected to it. In this scenario, it would have been a waste of time and effort to survey without the participants' knowledge. At no point was any information gathered, shared, or made available to anybody outside the study team. Therefore, there was no need to save the data beyond the study period. All aspects of this investigation were conducted following a stringent ethical and moral standards.

# 4. Result

This chapter has provided a summary of the data from the online survey and an interpretation of those results in connection to the pertinent theoretical frameworks. This section also explains how the hypotheses were answered. The tables and graphs below show the findings of our descriptive analysis, reliability tests, independent samples T-test, correlation, linear regression, mediation test, and additional research.

## 4.1 Descriptive analysis

The categories in Table 1 represent the characteristics of 96 respondents. The language chosen by the subjects is somewhat representative of their background. In our study, most questionnaire participants chose Swedish and English, accounting for 37.5% and 26% of the total, respectively, more than half of the total. This is expected as we are

conducting a study in Skåne, Sweden. In addition, the participants who chose Polish and Turkish also accounted for a particular proportion, 12.5%, and 10.4%, respectively. This shows that most of the foreign truck drivers in Skåne, Sweden, are from Poland. The participants who chose the other three languages (German, Bulgarian, and Romanian) were smaller in number and all at a similar level, 4.2% German, 4.2% Bulgarian, and 5.2% Romanian.

Table 1. Descriptive information of respondents

Descriptive information of respondents

| Variable | Categories | Frequency | Percentage |
|---|---|---|---|
| Language | English | 25 | 26% |
| | Swedish | 36 | 37.5% |
| | German | 4 | 4.2% |
| | Polish | 12 | 12.5% |
| | Turkish | 10 | 10.4% |
| | Bulgarian | 4 | 4.2% |
| | Romanian | 5 | 5.2% |
| Age | 18-30 | 10 | 10.4% |
| | 31-40 | 35 | 36.5% |
| | 41-50 | 36 | 37.5% |
| | >50 | 15 | 15.6% |
| Gender | Male | 92 | 95.8% |
| | Female | 4 | 4.2% |
| BMI | Normal | 17 | 21.9% |
| | Fat | 68 | 78.1% |
| Nicotine Consumes | no | 43 | 44.8% |
| | yes | 42 | 55.2% |

Among the truck drivers participating in the survey, most of them are middle-aged. The age groups of '31-40' account for 36.5% and '41-50' account for 37.5% of the total.

Truck drivers over the age of 50 also account for a certain proportion. In our sample, 15 people account for 15.6% of the total. However, our data shows that a new generation of truck drivers faces a shortage. There are fewer truck drivers under the age of 30. In our sample of 96 people, only 10 truck drivers are younger than 30 years old, accounting for 10.4% of the total. This is in line with the background we mentioned earlier. Europe is facing a shortage of truck drivers, which makes it less attractive to young people. In addition, our data show that the vast majority of truck drivers are male, a total of 92, accounting for 95.8%. There are only 4 female drivers, accounting for the remaining 4.2%. This shows that the truck driver's profession is less attractive to young people and female groups. Based on the height and weight provided by the subjects, we calculated their BMI using the formula and divided them into weight groups according to their BMI level. In our interviews, there were no underweight truckers, and only 21.9% of the truckers were at an average weight level, while 78.1% were overweight. We counted two items for nicotine use: Swedish snus and cigarette use. For any type and quantity of nicotine users, we refer to them as "nicotine users." Among the truck drivers who participated in the survey, "nicotine users" accounted for 55.2%. In other words, more than half of the truck drivers driving in Sweden are not consuming cigarettes or Swedish snus.

## 4.2 Reliability test

A reliability analysis is used to evaluate the reliability and stability of the questionnaire. It can detect the consistency of the results obtained after repeated measurements of the same transaction by the scale. The primary reference index for reliability analysis is Cronbach's coefficient. When Cronbach is more significant than 0.8, the reliability is outstanding. When the value is between 0.7 and 0.8, the reliability is acceptable. If the coefficient is less than 0.6, the reliability of the questionnaire is not strong enough. If the question is not answered, the questionnaire needs to be re-edited. In order to verify whether the reliability of each measured variable meets the standard, this paper used SPSS 28.0 to analyze the four dimensions of sleep quality: negative

cognitive/emotional driving, aggressive driving, and risky driving/drunk driving. The specific measurement results of Cronbach's value are shown in Table 2.

Table 2. Internal reliability

**Reliability Statistics**

| | Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|---|
| Sleep Quality | .825 | .830 | 4 |
| Negative Cognitive/Emotional Driving | .806 | .806 | 9 |
| Aggressive Driving | .849 | .848 | 7 |
| Risky Driving/Drunk Driving | .925 | .926 | 12 |

As shown in the table above, Cronbach's alpha index of all items is more significant than 0.8, which indicates that the scale has acceptable reliability. In addition, the Cronbach's alpha index of risky driving/drunk driving exceeds 0.9, indicating that this item has strong reliability. To sum up, the data on sleep quality, cognitive/emotional driving, aggressive driving, and risky driving/drunk driving all have high reliability, high internal consistency, and stability, and the reliability of the questionnaire is good. In the previous section, we explained the validity of this questionnaire in detail. The questionnaires used in this survey are all mature scales that are widely used and recognized in the industry and can be considered to have good validity.

### 4.3 Independent Samples T-Test

In order to know whether smokers have a higher driving safety risk than non-smokers, an independent sample T-test was applied to this paper. Before doing an independent sample T-test, several assumptions must be satisfied: Independent observations, Normality, and Homogeneity. For the first assumption that each case represents a

separate person, we assume that these are independent observations. Second, in the independent samples T-test, there is no need for variables to follow a normal distribution if each subpopulation is more significant than 25. In this study, the populations of smokers and non-smokers were 53 and 43, respectively (Table 3), so we assume that the second assumption is satisfied. Thirdly, the variances of the two subgroups on the dependent variable should be equal; otherwise, a Levene's test may be used for testing the homogeneity.

Table 3 Group statistic

**Group Statistics**

| | Nicotine consume or not | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Driving safety risk | 0 | 43 | 75.60 | 24.549 | 3.744 |
| | 1 | 53 | 91.70 | 18.229 | 2.504 |

Table 4 Result of independent samples test

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| Driving safety risk | Equal variances assumed | 11.177 | .001 | -3.684 | 94 | .000 | -16.093 | 4.369 | -24.768 | -7.419 |
| | Equal variances not assumed | | | -3.573 | 75.739 | .001 | -16.093 | 4.504 | -25.064 | -7.123 |

According to Table 4, Levene's test "sig."<0.05, we should report the 'Equal variances not assumed' t-test results. According to the result (p = 0.001), we conclude that there is a significant difference in driving safety risk between smokers and non-smokers. Furthermore, smokers have a higher driving safety risk than non-smokers (Table3). However, we still need a linear regression test to explore whether heavier smokers have a higher driving safety risk than other smokers.

## 4.4 Correlation test

Before doing regression analysis, it is necessary to do correlation analysis to understand the magnitude and direction of the relationship between nicotine consumption and

driving safety risks. Correlation analysis is a statistical method to study the correlation between random variables, to determine whether there is a specific connection between things and phenomena, and to count this connection. This paper mainly refers to the Pearson correlation coefficient for testing. Its value is between -1 and 1, and the sign means the positive or negative of the linear correlation. When the Pearson coefficient is greater than 0, there is a positive correlation between variables.

Before looking at Pearson's correlation, we should look at a scatterplot of the variables to get an idea of what to expect. In particular, we need to determine whether it is reasonable to assume that our variables have a linear relationship. For example, as shown in Figure 7, a scatterplot of nicotine use and driving safety risk shows a positive relationship between the two. As nicotine use increases, so does the risk of driving safety.

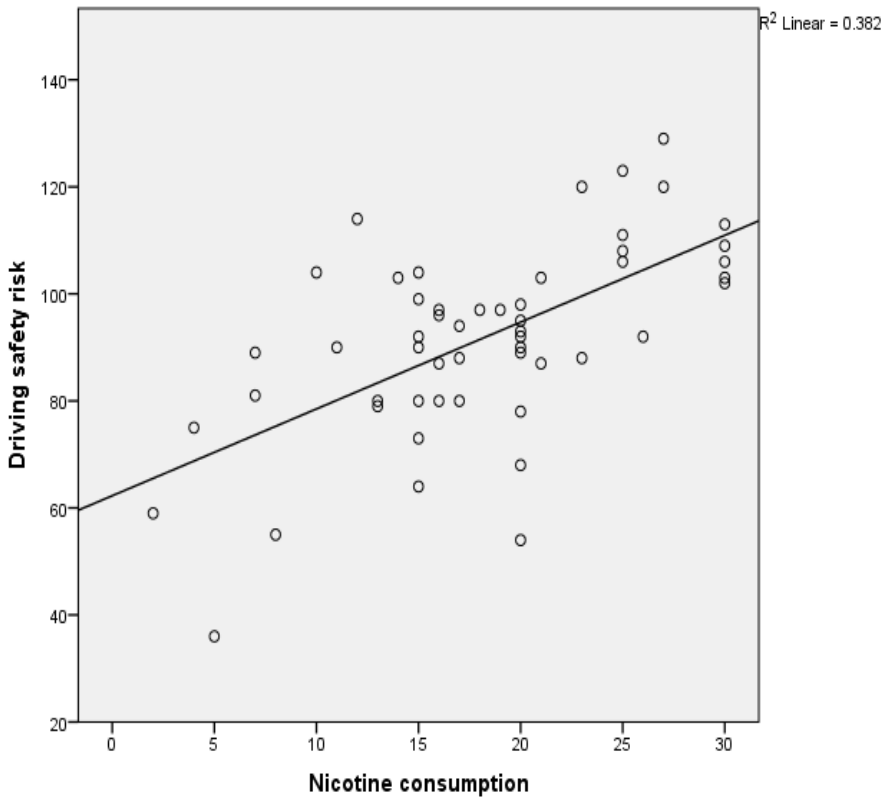


Figure 7. Scatter plot of driving safety risk by nicotine consumption.

Table 5 shows a significant positive relationship between nicotine consumption and Driving safety risk (r=.618, p<.001).

Table 5. Correlation between Nicotine consumption and Driving safety risk

**Correlations**

| | | Driving safety risk | Nicotine consumption |
|---|---|---|---|
| Driving safety risk | Pearson Correlation | 1 | .618** |
| | Sig. (2-tailed) | | .000 |
| | N | 53 | 53 |
| Nicotine consumption | Pearson Correlation | .618** | 1 |
| | Sig. (2-tailed) | .000 | |
| | N | 53 | 53 |

## 4.5 Linear regression

In order to test our **H1**, a linear regression between nicotine consumption and driving safety risk should be executed. Therefore, when we choose to analyze our data using linear regression, part of the procedure entails verifying that the data we wish to analyze is amenable to linear regression analysis. This is crucial because linear regression is only applicable if the data "passes" the six assumptions required for linear regression to produce a valid result. The six assumptions necessary for acceptable linear regression results are listed below.

1. **Linear trend.** There is a linear relationship between the dependent and independent variables, and a simple judgment is generally made through a scatter plot (simple linear correlation) or a scatter plot matrix (multiple linear regression). In addition, residual analysis can also examine linear trends, and partial residual plots are a more professional judgment method. If the relationship is not linear, the variable transformation should be corrected, or another analysis should be used.

2. **Independence.** The observations of the dependent variable are independent of each other; that is, the covariance of the residuals of any two observations is 0. The Durbin-Watson test can be used to test for the existence of autocorrelation.
3. **Normality.** The dependent variable obeys a normal distribution for any linear combination of independent variables. The normal distribution here means multiple identical values are taken for an independent variable, and the corresponding observed values of multiple dependent variables are typically distributed.
4. **Homoscedasticity.** Similar to the normal distribution, the model needs to use the residual plot to check whether the residuals satisfy the homogeneity of variance.
5. The dependent variable is **continuous**, and the independent variables can be defined as continuous variables.
6. **There should be no outliers of significance.** An outlier is a data point for which the observed value of the dependent variable is significantly different from the predicted value by the regression equation.

For assumption 1, the results of our previous correlation analysis and the scatter plot have demonstrated a significant linear correlation between nicotine use and driving safety risk. For assumption 2, the Durbin-Watson test value was 1.702 (Table 7). In general, Durbin-Watson test values are distributed between 0-4, the closer to 2, and the more likely the observations are independent of each other. That is, the observations of the simple linear regression in this study are independent of each other, satisfying assumption 2.

For assumption 3, the normality of variables was tested through skewness and kurtosis. According to Table 6, all variables' Skewness Statistic and Kurtosis Statistic are within ±1, which means those variables are normally distributed.

Table 6. Skewness Statistic and Kurtosis Statistic.

**Descriptive Statistics**

| | N | Mean | Std. Deviation | Skewness Statistic | Skewness Std. Error | Kurtosis Statistic | Kurtosis Std. Error |
|---|---|---|---|---|---|---|---|
| Overall sleep quality | 53 | 4.17 | 2.164 | .329 | .327 | -.222 | .644 |
| Driving safety risk | 53 | 91.70 | 18.229 | -.619 | .327 | .921 | .644 |
| Nicotine consumption | 53 | 18.13 | 6.942 | -.176 | .327 | -.253 | .644 |
| Valid N (listwise) | 53 | | | | | | |

Assumption 4 is a basic assumption of simple linear regression and can be tested by a scatter plot between residuals and regression fitted values or standardized residuals and standardized predicted values. If there is equal variance, the residuals for different fitted values should be approximately the same. Each point in figure 8 is evenly distributed, and no particular distribution shape will appear. If the residual points are not evenly distributed, forming a funnel or sector, then the regression will not have equal variance.

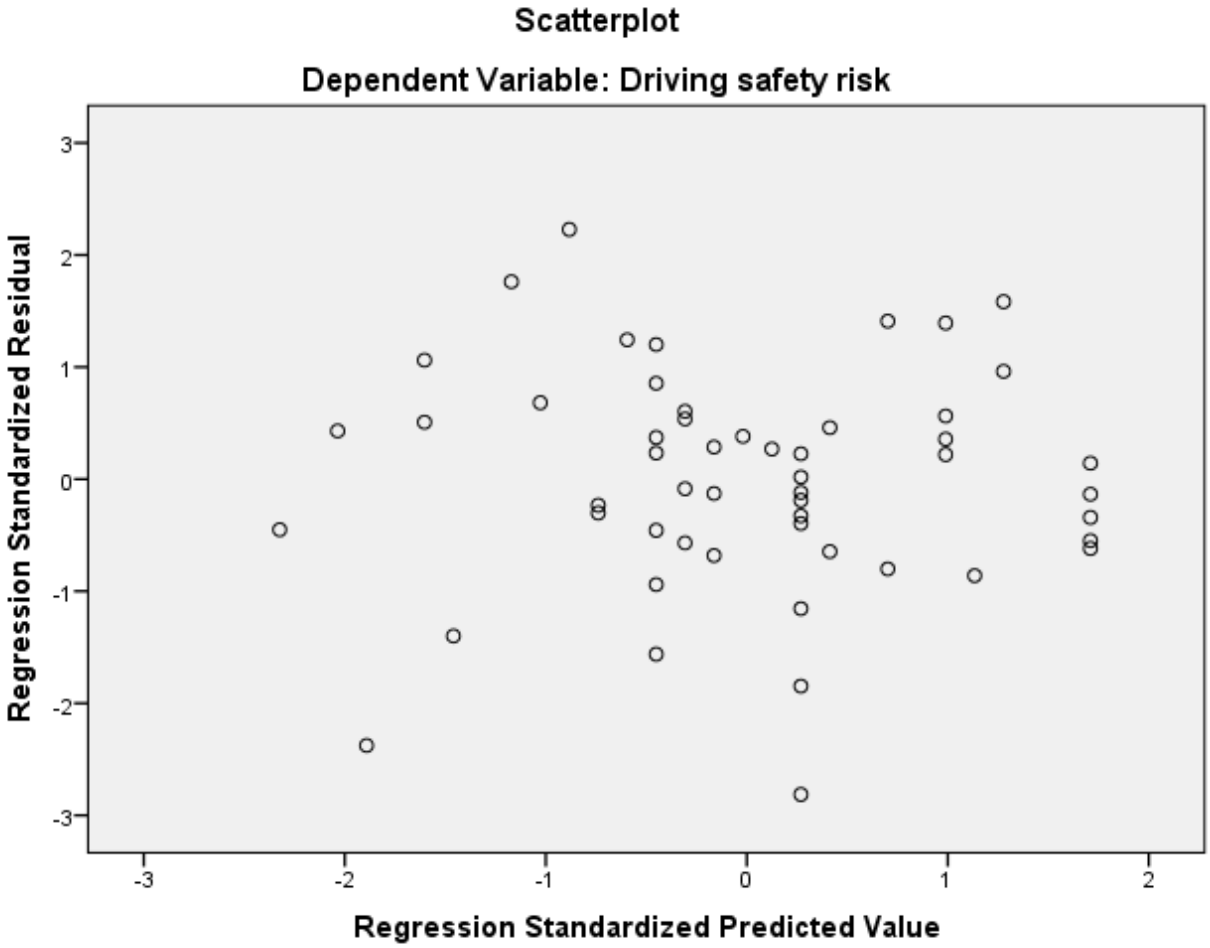


Figure 8. Scatter plot for homoscedasticity test

These results show that the points in the scatterplot of standardized residuals and standardized predicted values are uniformly distributed, although relatively concentrated in the middle, but not very serious. Accordingly, we believe that the regression conforms to the basic assumption of equal variance; assumption 4 is satisfied.

For assumption 5, each dimension of the scale is calculated as a score for this survey, so the following analysis uses 'nicotine consumption,' 'sleep quality, and 'driving safety risk' as continuous variables. Therefore, we believe that assumption 5 is satisfied. We used the Casewise Diagnostics test to find outliers, but no outliers appeared. This means assumption 6 is satisfied.

After satisfying the above assumptions, we performed a linear regression between nicotine consumption and driving safety risk. The results of the analysis are explained in detail below.

Table 7. Model summary

**Model Summary[b]**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|---|---|---|---|---|---|
| 1 | .618[a] | .382 | .369 | 14.475 | 1.702 |

a. Predictors: (Constant), Nicotine consumption

b. Dependent Variable: Driving safety risk

R is the regression's multiple correlation coefficient, representing the degree of correlation between the two variables (Table 7). For example, R = 0.618 in this study, suggesting that nicotine consumption is moderately related to driving safety risk. R Square represents the degree to which the independent variable in the regression model explains the variance of the dependent variable. In this study, R Square = 0.382, suggesting that the independent variable (nicotine consumption) could explain 38.2% of the variance of the dependent variable (driving safety risk).

Table 8. ANOVA

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 6594.033 | 1 | 6594.033 | 31.473 | .000[b] |
| | Residual | 10685.136 | 51 | 209.512 | | |
| | Total | 17279.170 | 52 | | | |

a. Dependent Variable: Driving safety risk

b. Predictors: (Constant), Nicotine consumption

Table 8 showed that the regression model of this study was statistically significant, F(1, 51)=31,473, P=0.000, indicating a linear correlation between the dependent and

independent variables.

Table 9. Result of linear regression

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95.0% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | 62.286 | 5.607 | | 11.109 | .000 | 51.029 | 73.543 |
| | Nicotine consumption | 1.622 | .289 | .618 | 5.610 | .000 | 1.042 | 2.203 |

a. Dependent Variable: Driving safety risk

According to Table 9, the regression equation of this study can be expressed as driving safety risk = 62.286+1.622*nicotine consumption, with a vital significance (P = 0.000). According to this equation, we can assume that even without the involvement of nicotine, there is a particular risk to driving safety. Furthermore, for every extra cigarette or Swedish snus used, the driving safety risk score rose by about 1.622. This result confirms our first hypothesis (Figure 9). **H1**: There is a positive relationship between nicotine consumption and driving safety risks.

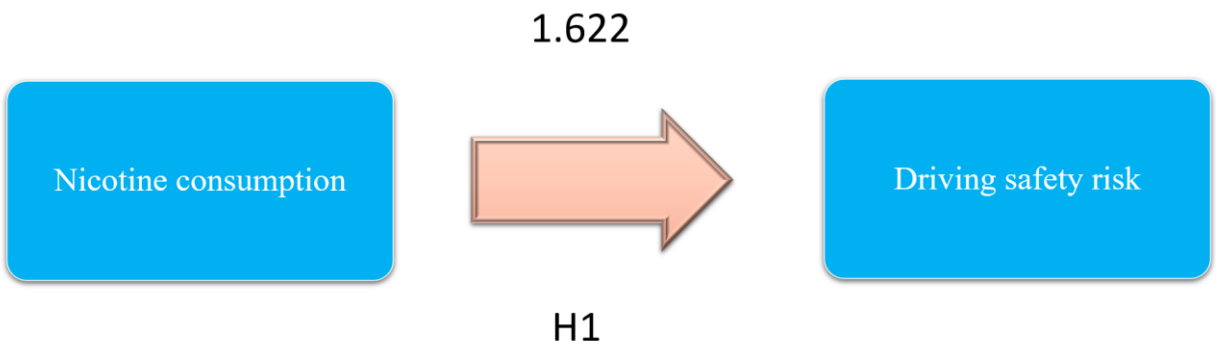

Figure 9. Model of Proven H1.

### 4.6 Mediation test

In order to answer **H2**, it is necessary to do a mediation effect test on the three variables to test if the relationship between nicotine consumption and driving safety risk is mediated by sleep quality.

This paper uses the PROCESS macro extension in SPSS 28.0 to do the mediation test. The result of the mediation test is shown in Table 10.

Table 10. Relationship between nicotine consumption and sleep quality

| Sleep quality | | |
|---|---|---|
| | coeff | p |
| Constant | 5.9510 | .0000 |
| Nicotine consumption | -.0982 | .0026 |

For the variable sleep quality, we get a linear regression result with an intercept of 5.9510 and a slope of -0.0982, which is strongly significant ($p=0.0026<0.05$). This means that there is an inverse relationship between nicotine consumption and sleep quality, with sleep quality decreasing as nicotine consumption increases. However, our result show nicotine consumption has little effect on sleep quality.

Table 11. Relationship between sleep quality and driving safety risk

| Driving safety risk | | |
|---|---|---|
| | coeff | p |
| Constant | 62.7729 | .0000 |
| Nicotine consumption | 1.6141 | .0000 |
| Sleep quality | -.0818 | .9343 |

It can be seen from table 11 that there is not a significant negative correlation between the variable sleep quality and the variable driving safety risk ($p = 0.9343 >0.05$).

Table 12. Result of mediation test

Mediation test

| | Effect | P |
|---|---|---|
| Direct effect of X on Y | 1.6141 | .0000 |
| Indirect effect of X on Y | .0080 | -.2916 |

X: nicotine consumption.

Y: driving safety risk.

Indirect effect of X on Y = (-0.982)*(-0.0818) = 0.0080

It can be seen from Table 12 that the direct influence of the independent variable on the dependent variable is significant (p=0.0000<0.05), which means that the direct influence coefficient of nicotine consumption on driving safety risk is 1.6141.

However, the indirect influence of the independent variable on the dependent variable is insignificant (p=-.2916).

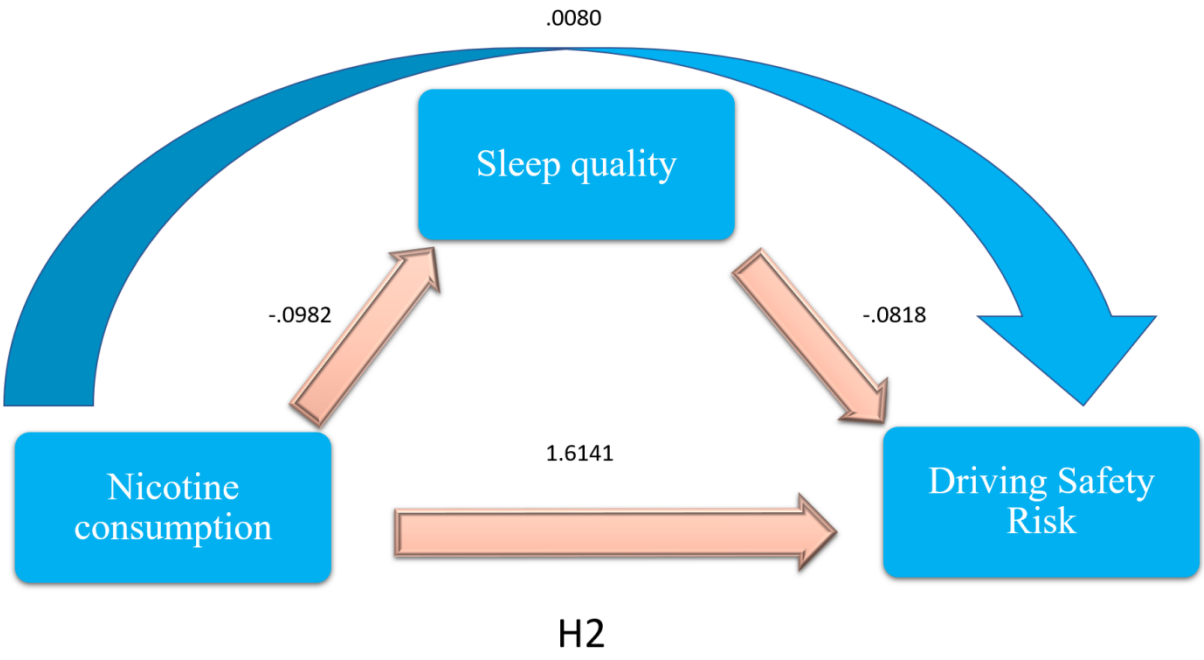


Figure 10. Model for H2.

According to our results, we have unfortunately rejected our:

**H2**: The impact of nicotine consumption on driving safety risks is mediated by sleep quality.

### 4.7 Further exploration

In conducting all the above analyses, we have some related questions and continue to use SPSS analysis to get the answer.

1. Of the three sub-dimensions of driving safety risk (Negative Cognitive /Emotional Driving[NCE], Aggressive Driving[AD], Risky Driving/Drunk Driving[RDDD]), which sub-dimension does nicotine consumption have the most significant impact on?

Through correlation analysis, the following table is obtained.

Table 13. Correlation between nicotine consumption and three sub-dimensions of driving safety risk.

**Correlations**

| | | Nicotine consumption | NCE | AD | RD/DD |
|---|---|---|---|---|---|
| Nicotine Consumption | Pearson Correlation | 1 | .527** | .560** | .560** |
| | Sig. (2-tailed) | | .000 | .000 | .000 |
| | N | 53 | 53 | 53 | 53 |

It can be seen from table 13 that nicotine consumption is significantly correlated with the three sub-dimensions of driving safety risk ($P<0.05$), among which nicotine consumption has the strongest correlation with aggressive driving (AD) and risky driving/drunk driving.

2. Does higher driving safety risk mean higher traffic accident rates?

We conducted a correlation analysis on the variable driving safety risk and the variable 'How many accidents have you been involved in the last 5 years? Furthermore, found a strong correlation between the two ( $R^2$=0.279,p<0.001). The subsequent linear analysis results are as follows.

Table 14. Relationship between driving safety risk and accidents in the last 5 years

**Coefficients[a]**

| Model | B | Sig. |
|---|---|---|
| (Constant) | -7.385 | .103 |
| Driving safety risk | .212 | .000 |

a. Dependent Variable: How many accidents have you been involved in the last 5 years? (Number of accidents in total)

Table 14 shows that as the driving safety risk increases by 1, the predicted value of the number of traffic accidents in the past five years will increase by about 0.212. Therefore, we can assume that a higher driving safety risk means a higher actual number of traffic accidents.

3. Which of the three sub-dimensions of driving safety risk (NCE, AD, RDDD) contributes more to actual traffic accidents?

Through correlation analysis, the following table is obtained.

Table 15. Correlation between three sub-dimensions of driving safety risk and 'accidents in the last 5 years

**Correlations**

| | | NCE | AD | RD/DD |
|---|---|---|---|---|
| Traffic accidents | Pearson Correlation | .326* | .510** | .544** |
| | Sig. (2-tailed) | .017 | .000 | .000 |

It can be seen from table 15 that the three sub-dimensions of driving safety risk are significantly correlated with the actual number of traffic accidents (P=0.000). Among them, the sub-dimension of Risky Driving/Drunk Driving strongly influences the actual

number of traffic accidents, with the Pearson coefficient of 0.544.

# 5. Conclusion and discussion

This section summarizes the findings responding to the RQ and the hypothesis motivating the study. Additionally, the contributions and suggestions are outlined. Lastly, the limitations of the findings of this study are listed, and future research directions are suggested.

## 5.1 Conclusions

This article explores the relationship between nicotine consumption and driving safety risk, and the possible role sleep quality may play in this relationship. Our paper is based on a deductive approach, using a questionnaire to conduct the study. We collected 98 questionnaires through a combination of online and offline methods. After data cleaning, we got 96 valid questionnaires.

We made two hypotheses based on the theoretical basis provided by the literature and scholars.

**H1**: There is a positive relationship between nicotine consumption and driving safety risks.

**H2**: The impact of nicotine consumption on driving safety risks is mediated by sleep quality.

Only smokers are considered for those hypotheses, so 53 questionnaires are valid for this research. Our results confirm H1 and reject H2. At the same time, our research question was also answered.

In the end, we did further exploration among those factors potentially relevant to the research topic in the study. First, we found that among three sub-dimensions of driving safety risk, nicotine consumption strongly correlates with risky driving/drunk driving

and aggressive driving. Second, we confirmed that higher driving safety risks could lead to more actual traffic accidents. This means that nicotine consumption can be converted into driving safety risks in a significant proportion and then into actual traffic accidents in a certain proportion. Because of this result, the general public should remain aware. Third, we found that risky driving/drunk driving can mainly contribute to actual traffic accidents.

## 5.2 Discussion

Our study corroborates the truck driver shortage mentioned in previous studies, and the younger generation makes up a small percentage of the truck drivers surveyed. Second, the participation of females is low, and the vast majority of truck drivers are male. Third, our study shows that 55.2 % of truck drivers consume nicotine. There is only a 4.2% difference between our study and NIOSH's conclusions, which is that 51% of truck drivers smoke. Even though we only had 96 valid respondents, the findings are nearly identical to those of NIOSH's investigation, which had 1265 respondents. We consider the small gap between the two survey results acceptable.

Nicotine consumption was positively associated with driving safety risks. The limited degree of explanation of our model further confirms that many factors contribute to the safety risk of truck drivers, and the effect of nicotine is only a part of them. This is consistent with the general perception in the industry that speeding, drunk driving, driving safety technology, and other factors jointly affect driving safety. The results of our linear regression also confirm this. In our formula, even without nicotine consumption, there is still a certain risk factor for driving safety. In other words, non-smokers also have a degree of driving safety risk, which the above reasons may cause.

In this study, the relationship between sleep quality and nicotine consumption is significant but weak. It means nicotine consumption can decrease the truck drivers'

sleep quality, but the effects are weak. The reason behind this can be truck drivers are fatigued after work; even though they consume nicotine, they can still fall asleep. In addition, sleep quality is not associated with driving safety risks in this study, which is different from previous findings. The reason for this can be the limited samples (N=53) of smokers in this study since there is a significant negative relationship between sleep quality and driving safety risks if we select all participants (N=96).

Among the three factors that constitute driving safety risk, aggressive driving and risky driving/drunk driving played a vital role in this study. In addition, the more nicotine people consume, the stronger the withdrawal response and the greater the chances of trying to take risks by smoking in the truck. The frequency of traffic accidents was shown to have a strong association with the risk of driving safety. This means that the nicotine ingested by truck drivers, through the mechanism described in this study, increases the risk of driving safety, ultimately contributing to traffic accidents. Therefore, this paper has theoretical and practical significance since the accidents caused by trucks are more severe than ordinary traffic accidents.

## 5.3 Contribution

**Theoretical implication**

This paper provides a new perspective for studying the driving safety of truck drivers. The industry has generally paid attention to factors such as drunk driving, speeding, fatigued driving, seat belts, and other automotive assistive technologies (NHTSA, 2022). In addition, most of the literature on nicotine consumption discusses the pathological changes and possible damage brought about by nicotine smoking behavior (Benowitz, 2009; Fagerström, 2014; Prochaska & Benowitz, 2019).

Before this paper, there was no literature linking nicotine consumption with the driving safety risk of truck drivers. This paper confirmed the effect of nicotine consumption on

the driving safety risk of truck drivers and tried to introduce sleep quality as a mediating variable to explain further the mechanism of nicotine consumption on the driving safety risk of truck drivers.

Furthermore, this study confirms that truck drivers who consume much nicotine are more likely to take risky and aggressive actions on the job. Unlike previous studies that show smoking can help people stay awake and perform better (Benowitz, 2009), this study focuses on the adverse effects of nicotine consumption on driving safety.

**Managerial implication**

From the perspective of the social sustainability supply chain, this paper provides new knowledge to understand the driving safety risk of truck drivers, which may contribute to creating a safer working environment for truck drivers.

As shown in the results, the probability of accidents increased for each additional cigarette or Swedish snus consumed. Therefore, excessive nicotine usage may raise the risk of a car accident. Not only is it a danger for truck drivers, but it may also cause the number of damage to the vehicle and the number of collisions on the roads.

Our results also show that the sub-dimensions of driving safety risk, Aggressive Driving, and Risky Driving/Drunk Driving are more essential causes of actual traffic accidents.

## 5.4 Limitations

This research investigates the association between truck drivers' nicotine consumption and driving safety risks in Sweden. However, there are a few limitations to this study that need to be clarified to the reader to avoid any confusion.

Our initial limitations stem from the reliance on convenience sampling. We had difficulties doing this study in a broader range since we had limited time to finish this project. In addition, we have difficulties getting any foundation to get more participants since our questionnaire has rich content, and truck drivers have limited patience to finish the questionnaire. Compared to the number of truck drivers on Sweden's roadways, the present study's good sample size of 96 respondents may be relatively modest. For our study, we only collected 53 respondents who were smokers, and this sample size is not strong enough to support our findings. Furthermore, all the subjects were from Europe, so the conclusion has limited generality.

Another limitation of this study is that we utilized an online survey that featured a questionnaire in seven different languages to obtain accurate data from people across the companies in Sweden. Our second limitation consists of inadequate translations for German and Bulgarian. This may impact truck drivers from such nations who wished to participate in our survey but thought it was not correctly translated and may not fill out the online survey.

A further limitation is that there are other ways to consume nicotine. We have solely considered cigarette smoking and snus for our study. However, there are other ways to consume nicotine, and these must be included in this study for a more accurate generalization. In addition, in our study, cigarettes were roughly combined with Swedish snus to calculate the total amount of nicotine consumed. However, the reality is that cigarettes and Swedish snus have different nicotine levels, and there are also differences between brands of nicotine products.

### 5.5 Future research

Future research could consider increasing the sample size of truck drivers in a broader context. Therefore, we recommend that future researchers broaden their data collection to get a more accurate generalization for their research.

Future studies could additionally include a more accurate method of calculating

nicotine consumption. Because various kinds of cigarette packets and snus packages contain varying amounts of nicotine, this is an important distinction. Using more precise nicotine statistics, the conclusions drawn are more realistic, but a more incredible difficulty of realization also accompanies them.

Potential variables could play a role in nicotine consumption and driving safety in future research. For example, BMI, former scholars suggest that BMI can affect sleep quality, and studies have mentioned a relationship between BMI and driving safety, but the relationship is not clear. Future studies may further explore the role of BMI between nicotine consumption and driving safety risk, mediating or moderating, which would be interesting to study.

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Appendix

This questionnaire is anonymous. No one will be able to identify you or your answers, and no one will know whether or not you participated in the study. There are no known risks if you decide to participate in this research study. There are no costs to you for participating in the study. The questionnaire will take a maximum 5mins to complete. The information collected may not benefit you directly, but the information learned in this study should provide more general benefits.

Select one option that fits you most, or write your answers. Please answer all the questions below. If you have difficulties answering some of the questions, just answer them according to your will.

Age: [ ]

Gender: Male [ ], female[ ] or [ ]

Weight: [ ] kg Height: [ ] cm

1. During the past month, how would you rate your sleep quality overall? [ ]

Very bad(0)-Very good (3)

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night? [ ]

3. Cannot get to sleep within 30 minutes.

Not during the past month [ ], Less than once a week[ ]

Once or twice a week [ ], Three or more times a week [ ]

4. During the past month, how many hours of actual sleep did you get at night? (This may be different from the number of hours you spend in bed.) [ ]

5. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

Not during the past month [ ], Less than once a week [ ]

Once or twice a week [ ], Three or more times a week [ ]

6. During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?

No problem at all [ ], Only a very slight problem [ ]

Somewhat of a problem [ ], A very big problem [ ]

7. How often do you engage in these situations/behaviors? Choose one

1 (never), 2 (less possibility), 3 (sometimes), 4 (often), 5 (always)

- I drive when I am angry or upset. [1] [2] [3] [4] [5]
- I lose my temper when driving. [1] [2] [3] [4] [5]
- I consider the actions of other drivers to be inappropriate or "stupid." [1] [2] [3] [4] [5]
- I flash my headlights when I am annoyed by another driver. [1] [2] [3] [4] [5]
- I make rude gestures (e.g., giving "the finger";yelling curse words) toward drivers who annoy me. [1] [2] [3] [4] [5]
- I verbally insult drivers who annoy me. [1] [2] [3] [4] [5]
- I deliberately use my car/truck to block drivers who tailgate me. [1] [2] [3] [4] [5]
- I would tailgate a driver who annoys me. [1] [2] [3] [4] [5]
- I "drag race" other drivers at stop lights to get out front. [1] [2] [3] [4] [5]
- I will illegally pass a car/truck that is going too slowly. [1] [2] [3] [4] [5]
- I feel it is my right to strike back in some way, if I feel another driver has been aggressive toward me. [1] [2] [3] [4] [5]

- When I get stuck in a traffic jam I get very irritated. [1] [2] [3] [4] [5]
- I will race a slow moving train to a railroad crossing. [1] [2] [3] [4] [5]
- I will weave in and out of slower traffic. [1] [2] [3] [4] [5]
- I will drive if I am only mildly intoxicated or buzzed. [1] [2] [3] [4] [5]
- When someone cuts me off, I feel I should punish him/her. [1] [2] [3] [4] [5]
- I get impatient and/or upset when I fall behind schedule when I am driving. [1] [2] [3] [4] [5]
- Passengers in my car/truck tell me to calm down. [1] [2] [3] [4] [5]
- I get irritated when a car/truck in front of me slows down for no reason. [1] [2] [3] [4] [5]
- I will cross double yellow lines to see if I can pass a slow moving car/truck.[1] [2] [3] [4] [5]
- I feel it is my right to get where I need to go as quickly as possible. [1] [2] [3] [4] [5]
- I feel that passive drivers should learn how to drive or stay home. [1] [2] [3] [4] [5]
- I will drive in the shoulder lane or median to get around a traffic jam. [1] [2] [3] [4] [5]
- When passing a car/truck on a 2-lane road, I will barely miss it. [1] [2] [3] [4] [5]
- I will drive when I am drunk. [1] [2] [3] [4] [5]
-
- I feel that I may lose my temper if I have to confront another driver. [1] [2] [3] [4] [5]
- I consider myself to be a risk-taker. [1] [2] [3] [4] [5]
- I feel that most traffic “laws” could be considered as suggestions. [1] [2] [3] [4] [5]

8. How many previous traffic accidents in the last 5 years? (Number) [ ]

9. How many cigarettes do you consume per day? [ ]

10. How many Swedish Snus do you consume per day? [ ]

**Link for this questionnaire:**

https://docs.google.com/forms/d/e/1FAIpQLSfq83fubRFfW0XrtZxI7F8MbStLvpzprtMAe1QzJmgURqm6Ag/viewform?usp=sf_link