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Commentary
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Commentary

# "Electronic Cigarettes" Are Not Cigarettes, and Why That Matters

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## Abstract

As the prevalence rates of cigarette use have declined over the past decade, use of electronic cigarettes (e-cigarettes) continues to increase, and companies are heavily invested in manufacturing new e-cigarette products. Scientists are therefore studying e-cigarette use at a rapid rate, generally by conceptualizing e-cigarettes as similar to traditional cigarettes in their use and effects.Thinking of e-cigarettes as largely comparable with cigarettes, however, fails to capture the unique e-cigarette capabilities, user experiences, and effects on nicotine dependence and even health. Assuming that e-cigarette users puff on their devices as they do cigarettes to attain doses of nicotine comparable in magnitude and asking questions about e-cigarette use modeled after how smoking behavior has been usually assessed (eg, puff number, duration, number of cigarettes per day) may miss important differences. A greater appreciation of the distinct uniqueness of e-cigarettes, as compared with cigarettes, will help to accelerate innovative research on e-cigarettes and other electronic devices, leading to new theoretical models and behavioral measures.

**Implications:** With research about electronic cigarettes (e-cigarettes) rapidly increasing, this commentary addresses the conceptualization of e-cigarettes as similar to traditional cigarettes. The more we attempt to understand and measure e-cigarettes as equivalent to cigarettes, the more likely research may err in conclusions about these unique devices. Our commentary notes how using unique conceptualizations and measures for e-cigarettes will help accelerate new research.

Since the arrival of e-cigarettes to the global market, use of e-cigarettes has steadily increased while use of combustible tobacco products, in particular cigarettes, has decreased. Researchers are trying to understand how individuals interact with these devices and what this means regarding their potential benefits and potential harms. While it is unclear exactly when the term e-cigarette was coined, e-cigarettes, because they resemble and act like cigarettes (at least the so-called cigalike devices), are thought to be a potential substitute. The "substitution" assumption has implicitly and explicitly guided researchers' thinking and framing of study designs and outcomes. This terminology brings with it the assumption that knowledge about conventional combustible cigarettes, such as how they are smoked and how they are related to nicotine dependence, is directly comparable and transferrable to e-cigarettes. There are, of course, superficial similarities, but there are enough key differences between cigarettes and these products, especially newer generation devices, to show that they are not interchangeable nicotine delivery systems. Differences include customized nicotine concentrations (including the ability to have no nicotine), the process of how e-cigarettes are "smoked" (eg, the ability to puff intermittently), production of odorless vapors, mixes of various chemicals, flavoring and nicotine liquids,[1] and use of these products in areas where cigarette smoking is prohibited. Acknowledging device idiosyncrasies is crucial to fully understand e-cigarette use and dependence. It remains unclear whether e-cigarettes will decrease, or increase, nicotine dependence in e-cigarette users or change tobacco dependence in users of both e-cigarettes and other tobacco products.[2,3] These changes could have major implications for public health. Treating all e-cigarette products as though they fall into a uniform class, however, risks mixing products with low

and high dependence potential, which may or may not be able to displace cigarette smoking.

Although these devices have been available for over a decade, validated, specific e-cigarette measurements of use behavior and dependence are still lacking.[4] While unique e-cigarettes use behaviors and dependence are being investigated,[5] few studies have used psychometrically validated e-cigarette measures. The current *modus opperandi* is to take validated cigarette smoking measures and presume that as long as the wording reflects vaping; this would sufficiently capture the same behavioral concepts. However, it might be problematic to assume that asking the same questions between e-cigarettes and cigarettes will capture the same concepts. Without the necessary validation studies, these assumptions could lead to characterizations that misguide research, ranging from e-cigarette pharmacokinetics to policy initiatives. Especially now that the US Food and Drug Administration is planning more regulations for e-cigarettes, it is vital to understand how these products are different from cigarettes, in the same way we understand that cigarette smoking is different from use of other tobacco products and nicotine delivery systems.[2] Other countries are making greater progress in understanding that e-cigarettes are a new class of products that differ from cigarettes. The European Union created the Tobacco Products Directive,[6] enforced as of May of 2016, which included specific regulations which target characteristics that are unique to e-cigarettes, including limiting nicotine concentrations in e-liquid and tank sizes. As a field, it is meaningful to move away from viewing e-cigarettes as equivalent to traditional cigarette products. By focusing on these products as completely new devices, we can develop better, psychometrically validated measures that capture the full extent of use and dependence.

When cigarette use behaviors such as daily cigarette frequency and smoking topography are assessed, it is essential to bear in mind that these behaviors do not translate easily to e-cigarettes. Behavior can differ based on the intake mechanism, where cigarette users inhale smoke from burned tobacco and e-cigarettes users inhale vapor from a liquid. These differences in intake behavior might show that our current understanding of smoking behaviors may not be relevant to vaping behavior and that researchers may not acknowledge more naturalistic vaping behaviors. While e-cigarette puffing volume and duration have been shown to differ from cigarette puff characteristics,[7] assumptions of equivalence between the two continue (eg, 10 vape puffs is equivalent to 10 cigarette puffs[8]). Acknowledging that e-cigarette puffs may not be equivalent to cigarette puffs can help guide other researchers to better interpret e-cigarette use behaviors.

Behaviors that are closely related to puffing include cigarette frequency and consumption. Cigarette frequency is easy to understand because the cigarette unit is an easy-to-measure quantity and allows frequency to be compared across multiple individuals (eg, cigarettes per day). On the other hand, measuring e-cigarette quantity is more difficult when e-cigarettes come in many more sizes that hold a large amount of liquid and store more nicotine than a single cigarette can. E-cigarette users can also restart their device, activating it via a button push or breath control, which allows for far more variability in intermittent use and nicotine dosing compared with a cigarette which is usually consumed in about of 8–10 puffs. This can have major implications for understanding the amount of nicotine consumed. If cues related to continuously grabbing a cigarette can lead to higher nicotine ingestion,[9] it is possible that the behavior of restarting an e-cigarette would mean higher nicotine ingestion. On the other hand, we could have the opposite case, where e-cigarette users are "grazers" who puff occasionally throughout the day, maintaining lower levels of nicotine compared with cigarette smokers that take significantly large amounts of nicotine over short periods of time. The implications of possible e-cigarette puffing patterns could muddle future conclusions about nicotine intake, frequency of e-cigarette use, and engagement with a device. Since researchers already conceptualize distinctions between products like cigarettes, cigars, and hookah, it would make sense to add e-cigarettes as a distinct, unique product. In the United States, e-cigarettes, however, are classified as tobacco products only because the nicotine they contain is derived from the tobacco leaf.

This logic continues to pose problems when we observe broader, product-based issues like understanding how e-cigarettes might influence the development and/or maintenance of nicotine dependence. Much of the literature describing nicotine dependence relies on a combination of measures that tap into use characteristics and behaviors as they relate to tobacco products. However, e-cigarettes represent the first widely used consumer product to administer nicotine independently from other tobacco constituents, where these devices do not specifically address smoking cessation. Because most measures of nicotine dependence are specific to tobacco use, it should not be assumed that our understanding of nicotine dependence is the same for cigarettes and e-cigarettes. While nicotine is the primary addictive chemical in tobacco, there are few studies that describe the addiction potential of isolated nicotine in the form delivered by e-cigarettes. One characteristic includes an individuals' ability to regulate nicotine ingestion through an e-cigarette better than with tobacco products or nicotine replacement therapies. This could lead to active efforts to increase nicotine levels to reduce withdrawal symptoms and/or achieve desired positive effects or mean that individuals can control their nicotine intake to reduce dependence. Researchers have started addressing this gap by noting that e-cigarettes pose less of a dependence risk than other tobacco product dependence.[2] While researchers understand the importance of continuing to assess e-cigarette dependence,[10] emphasis on conceptualizing e-cigarette dependence should be prioritized.

Researchers also typically attempt to measure e-cigarette use behaviors as they do cigarette use behaviors. Cigarettes per day is a common frequency measure assessed via global self-report or recall methods such as the Timeline Followback (TLFB[11]), which looks at daily cigarette use over an extended period of time. Unfortunately, for e-cigarettes, this kind of measurement strategy doesn't easily create a satisfactory parallel concept of "e-cigarettes per day." Attempts to remedy this was to create a similar "e-cigarette per day" measurement that parallels cigarettes per day by using "number of times used per day."[12,13] However, using "number of times used per day" focuses only on frequency and doesn't have the anchor of a more uniform cigarette; this doesn't consider e-cigarette liquid intake, making meaningful comparisons incomplete. And while these issues are being addressed in studies that measure puffs per vaping session, number of times used per day, and e-liquid concentrations, few studies combine many of these characteristics together in a reliable measure that can capture accurate, quantitative consumption of e-cigarettes. Advances in technology that can monitor e-cigarette puff instances and their time signatures, intensity and duration, and store and/or transmit this information to researchers could provide valuable information on variability in use of these devices and how this could relate to cigarette use behavior and health outcomes (eg, exposure to harmful or potentially harmful constituents).

Measurement inefficiencies continue when making conclusions about nicotine dependence and craving for e-cigarettes, where there is a lack of tools specific to e-cigarette addiction potential.[14] One of the "gold standard" measurements of nicotine dependence is the Fagerstrom Test for Nicotine Dependence (FTND[15]), which was renamed to the Fagerstrom Test for Cigarette Dependence (FTCD[16]) because it was recognized that "nicotine is a strong determinant for dependence, but dependence to cigarette smoking is a multifaceted and broad dependence." While there are measures adapting the FTCD to vaping, problems related to reliability of new measurements[17] still exist. In the Electronic Fagerstrom Test for Nicotine Dependence (FTND-E[18]), the researchers make conclusions based on a previously stated assumption of puffing equivalence between cigarettes and e-cigarettes. These, and other, assumptions continue as researchers create new measures related to nicotine dependence that also include craving measurements. The scientists who started developing a vaping cravings assessment[19] used items adapted and reworded from the Questionnaire of Smoking Urges, which was sampled from cigarette smokers. Dowd et al. acknowledge that their study "suggest[s] vaping craving may be distinct from tobacco cigarette craving." A next possible step is to move away from adapting current measures that might be unable to tease apart cigarette and e-cigarette characteristics. A move forward would be to recognize unique behaviors, their relation to nicotine dependence, and create newer methods to measure them.

Problems measuring e-cigarette nicotine dependence are not isolated to the FTCD. The Nicotine Dependence Syndrome Scale (NDSS) and the Wisconsin Inventory of Smoking Dependence Motives (WISDM) are examples of measures that have been used on e-cigarette users without controlling for the variability accounted for by e-cigarette-only nicotine dependence. Many current e-cigarette users are also smoking cigarettes, making it difficult to measure the effect of e-cigarettes on nicotine dependence. Minor word changes to these measures may fail to account for these differences. Items from the WISDM like "I frequently light cigarettes without thinking about it" may not measure the same concept for e-cigarettes when an individual can restart an e-cigarette more easily. This conceptual difference could also mean that these items are not measuring an equivalent e-cigarette use behavior, and currently adapted e-cigarette measures acknowledge that psychometric properties may not be fully assessed.[18] Understanding nicotine dependence for e-cigarette users relies on measurements that truly capture their uniqueness to better account for nicotine dependence and not cigarette dependence.

### Summary and Next Steps

Research on e-cigarettes is making great strides in assessing use characteristics and dependence. An initial approach was to adapt validated cigarette-related measures to e-cigarette use. At the current stage, however, it is important to not let assumptions about how cigarettes are smoked hinder our ability to understand characteristics that are unique to e-cigarettes. We need to continue to move away from adapted measures and focus on new measures that are specific to e-cigarettes. Given that e-cigarette devices are customizable, these devices can offer unique user experiences. Vaping technology is advancing rapidly, and it is vital to understand how individuals interact with these devices before we extrapolate conclusions about their effects on health, cessation, and addiction.

Researchers have also struggled with nomenclature for these new devices, having settled generally on the term "Alternative Nicotine Delivery Systems (ANDS)." This labeling is a small but important step in moving away from thinking about these devices as equivalent to cigarettes and may help guide our understanding of ANDS. Labeling is an important issue, especially when we observe how users view terms like "e-cigarette" and "vaping."[20] Observing how users in other countries understand terms like vaping and the translation into other languages will result in a better understanding of ANDS use behaviors. Another major step in the United States is the new creation of a standardized research e-cigarette. Now, researchers in the United States will be able to use a standardized device that controls for various manufacturing differences in ANDS to accurately measure device use characteristics. It is important to continue to prioritize and emphasize various ANDS devices as unique and separate from tobacco devices. As policy initiatives are implemented, researchers need to be more aware of how public and policy perceptions might influence true knowledge about ANDS. As our understanding of ANDS devices evolves, this will better inform researchers to prioritize the creation of accurate, valid measures to glean how ANDS shape the future nicotine and tobacco market and better prepare for all future ANDS.

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## Declaration of Interests

*None declared.*

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