

# **A Reasoned Action Approach to Pregnant Smokers' Intention to Switch to E-cigarettes: Does Educational Attainment Influence Theory Application?**

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## **Abstract**

Social determinant research has noted educational attainment to be among the strongest influencing factors for tobacco use during pregnancy. Concurrently, maternal e-cigarette use has doubled in recent years, with some citing it as a safer alternative to combustible cigarettes. To better understand the decision-making practices of pregnant persons based on educational attainment, the reasoned action approach (RAA) was used to evaluate factors that may be associated with the intention to switch from cigarettes to e-cigarettes. A sample of U.S. pregnant persons ( $n = 267$ ) between 18-40 years of age, who smoked at least one cigarette in the past 30 days, completed an online survey about switching from cigarettes to e-cigarettes. RAA constructs (e.g., intentions, instrumental attitudes, etc.) were measured using a pre-validated scale. Using structural equation modeling, the variability of latent variables (i.e., RAA constructs) and their interaction with one another were analyzed by educational attainment via two regression models: one for those who had college experience or had completed a college degree and another for those who had not attended college. Instrumental attitudes, experiential attitudes, and descriptive norms were significantly associated with intention to switch from cigarettes to e-cigarettes among both groups; however, autonomy was only significantly associated with intention among those who had not attended college. The RAA offers a valuable framework for understanding pregnant persons' decision to switch from cigarettes to e-cigarettes during pregnancy; however, the RAA constructs may be related to intentions differently based on upstream factors, such as educational attainment.

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## **Introduction**

Smoking remains the number one risk factor for death and disease worldwide, including poor pregnancy outcomes due to smoking while pregnant (U.S. Department of Health and Human Services, 2014). Despite reductions in smoking among other groups, smoking during pregnancy has not declined in the United States for more than 10 years, as current rates stand between 7 and 15% (Agrawal et al., 2019; Do et al., 2018; Drake et al., 2018). While younger women (< 20

years of age), those who have completed more than a high school education, and those who live in urban areas are more likely to quit during pregnancy compared to their counterparts (Nighbor et al., 2018; Tong et al., 2013), it is important to note that about half of women who smoke when they become pregnant completely quit (Hansen et al., 2018). Social determinant research has noted educational attainment to be among the strongest influencing factors for tobacco use during pregnancy (Cornelius et al., 2020;

Härkönen et al., 2018). Currently, 12.2% of pregnant persons who have a high school diploma or GED report smoking any time during pregnancy, while rates drop to 7.9% among those who have some college or an associate degree, and rates continue to drop to as low as 1% of those who have at least a bachelor's degree (Drake et al., 2018). Thus, it is important for researchers to understand factors that may influence pregnant persons' use and quitting practices of cigarettes by educational attainment so that interventions can be tailored to the needs of the most vulnerable populations.

Some research suggests electronic cigarettes (e-cigarettes) can provide an effective cessation option for smokers (Hajek et al., 2019), and it was recently reported that past 30-day use of e-cigarettes during pregnancy did not significantly influence adverse birth outcomes (Cohn et al., 2022). While no studies have found e-cigarettes help with smoking cessation during pregnancy (Siu, 2015), some pregnant persons report trying to switch to e-cigarettes to either assist with smoking cessation or because they believe e-cigarettes are a safer alternative to cigarettes (Bowker et al., 2018; Fallin et al., 2016; Kurti et al., 2020; Kurti et al., 2017; McCubbin et al., 2017; Wagner et al., 2017). Data also shows the increasing popularity of maternal e-cigarette use, as rates doubled from 2016-2018 (1.9% to 3.8%) (Obisesan et al., 2020). However, little research has demonstrated whether social determinants may influence switching from cigarettes to e-cigarettes (Cohn et al., 2022). Given that lower-educated women are also more likely to smoke and less likely to switch to e-cigarettes (Park et al., 2017), there is a need to understand potential differences in factors that influence the decision-making processes of switching to e-cigarettes, particularly among pregnant persons, given the large burden that smoking has on maternal and infant health (U.S. Department of Health and

Human Services, 2014). Such information will help public health program planners target and tailor interventions that can help pregnant persons who smoke make informed decisions about their behavior.

## **Theoretical Framework**

Most behavior change interventions are driven by theoretical frameworks such as the theory of planned behavior and the health belief model (Schilling et al., 2019; Stroud et al., 2019). The RAA is the most recent iteration of the theory of reasoned action (TRA), theory of planned behavior (TPB), and the integrated behavior model. The reasoned action approach (RAA) recognizes that intentions, identified as the immediate predecessor to behavior, are influenced by attitudes, perceived norms, and perceived behavioral control (Fishbein & Ajzen, 2010). The RAA is differentiated from the TRA and TPB by further expanding the definitions of attitudes to include cognitive and affective elements, perceived norms to include injunctive and descriptive elements, and the perceived behavioral control (PBC) construct to include both capacity and autonomy (Fishbein & Ajzen, 2010). Therefore, an individual's attitude toward a behavior can rely on their cognitive evaluation, representing the instrumentality (i.e., instrumental attitude) of the behavior (smoking cigarettes while pregnant is harmful) or their affective evaluation, representing the experience (i.e., experiential attitude) of the behavior (smoking while pregnant is unpleasant). Perceived norms, or perceived social pressure, refers to whether the person or people most important in a person's life would agree or disagree with the action in which they are partaking (i.e., injunctive norms), as well as the perceived behaviors of important referents in their life (i.e., descriptive norms) (Fishbein & Ajzen, 2010). Further broken down, injunctive

norms represent perceptions of what others think someone should do (your doctor thinks you should not smoke while pregnant), while descriptive norms represent what they observe being done (my friends who were pregnant smoked while they were pregnant). Lastly, perceived behavioral control, or the idea you can overcome obstacles or barriers associated with the health behavior is paramount to the upkeep of that behavior. For example, if a pregnant person desired to stop smoking but did not believe they had the willpower (i.e., autonomy) or the necessary resources to do so (i.e., capacity), they may not cease smoking.

Preliminary research has suggested the RAA is an effective theory to explore pregnant persons' intention to use e-cigarettes for the purpose of smoking cessation, or switching from cigarettes to e-cigarettes for the duration of the pregnancy (Dobbs et al., 2021; Middlestadt et al., 2020). However, researchers have not explored the influence that social determinants, such as educational attainment, can have on the application of this theory. Exploring a sensitivity analysis of pregnant smokers' educational attainment and the influence it may have on the application of the RAA is important given that educational attainment has been identified as the strongest predictor of smoking during pregnancy (Härkönen et al., 2018). Further, prior research that explored switching behaviors among pregnant persons who smoked using the RAA did not account for this potential relationship (Dobbs et al., 2021). Such information may add an additional layer in the application to the RAA. For example, in a previous study using the theory of reasoned action to explain smokers' intention to quit, constructs from the theory contained different relationships when stratified by ethnicity (i.e., Hispanic and non-Hispanic) due to cultural differences between participants (Marin et al., 1990). While these

analyses can provide a sensitivity assessment of the theory's application, it is important to explore the application of variables independently when multicollinearity may exist (e.g., annual income and education attainment). Therefore, the purpose of the current study is to explore whether factors that influence pregnant persons' intention to switch from cigarettes to e-cigarettes differ between those of different educational attainment (i.e., those who had college experience vs those who had not attended college).

## Methods

### Participants and Procedures

Pregnant U.S. women ( $n = 267$ ) between 18 and 40 years of age, who smoked at least one cigarette in the past 30 days completed a cross-sectional, online survey about switching from cigarettes to e-cigarettes during pregnancy. Full details about sampling have been published elsewhere (Dobbs et al., 2021). Data were collected between November and December 2019, and the Institutional Review Board at a Southwestern University approved all procedures.

### Measures

**Participant demographics.** Questions about demographic characteristics included self-reported age, race/ethnicity, educational attainment, annual household income, and marital status (Table 1). Given the nearly even divide of educational attainment between those who had sought more than a high school education (54%) and those who had not (46%), and prior research that bifurcated education by those less than or equal to 12 years of education compared to those with more than 12 years of education (Tong et al., 2013), we decided to

dichotomize educational attainment by those who had some college experience and those

who had completed a high school diploma or less.

Table 1

*Participant Characteristics by Past 30-day Use of E-Cigarettes (n = 267)*

	Past 30-day use			p-value	Effect Size
	Total N = 267 n (%)	Yes N = 122 n (%)	No N = 145 n (%)		
Age in years (M, SD)	29.3 (5.5)	30.1 (5.3)	28.6 (5.7)	.024	-.279
Race/Ethnicity *					
Non-Hispanic white	142 (53.2)	79 (55.6)	63 (44.4)	.224	.162
Non-Hispanic black or AA	48 (18.0)	24 (50.0)	24 (50.0)		
Hispanic	29 (10.9)	16 (55.2)	13 (44.8)		
Non-Hispanic Asian	12 (4.5)	3 (25.0)	9 (75.0)		
Non-Hispanic AI/AN	9 (2.4)	5 (55.6)	4 (44.4)		
More than one race/ethnicity	26 (9.7)	18 (69.2)	8 (30.8)		
Education					
< HS or GED	16 (6.0)	12 (75.0)	4 (25.0)	.006	.232
HS or GED	107 (40.0)	66 (61.7)	41 (38.3)		
Associates degree or some college	52 (19.5)	31 (59.6)	21 (40.4)		
Bachelor's degree	48 (18.0)	18 (37.5)	30 (62.5)		
Graduate/Professional degree	44 (16.5)	18 (40.9)	26 (59.1)		
Annual household income					
Less than \$20,000	53 (19.9)	39 (73.6)	14 (26.4)	.008	.233
Between \$20,000 to \$39,999	69 (25.8)	40 (58.0)	29 (42.0)		
Between \$40,000 to \$59,999	52 (19.5)	26 (50.0)	26 (50.0)		
Between \$60,000 to \$99,999	52 (19.5)	31 (59.6)	21 (40.4)		
More than \$100,000	41 (15.4)	19 (46.3)	22 (53.7)		
Marital status					
Single, divorced, or separated	106 (34.8)	52 (49.1)	54(50.9)	.371	.117
Married or in a domestic partnership	161 (60.3)	91 (56.5)	70 (43.5)		
Past 30 days, cigarettes smoked per day					
1 cigarette	30 (11.3)	7 (23.3)	23 (76.7)	.121	.165
2-5 cigarettes	81 (30.3)	41 (50.6)	40 (49.4)		
6-10 cigarettes	74 (27.7)	34 (45.9)	40 (54.1)		
11-20 cigarettes	59 (22.1)	28 (47.5)	31 (52.5)		
20+ cigarettes	23 (8.6)	12 (52.2)	11 (47.8)		
How soon after you wake do you have your first cigarette?					
Within 5 minutes	99 (37.1)	48 (48.5)	51 (51.5)	.643	.079
6-30 minutes	109 (40.8)	49 (45.0)	60 (55.0)		
31-60 minutes	42 (15.7)	16 (38.1)	26 (61.9)		
After 60 minutes	17 (6.4)	9 (52.9)	8 (47.1)		

*Note.* Age limited to 18 to 40 years; Effect size measured via Cohen's d for age (measured with a t-test) and Cramér's V for all chi-squared analyses (all other variables). \*indicates 1 missing response; AA = African American, AI/AN = American Indian or Alaskan Native; HS = High School; GED = General Education Diploma

**Cigarette and e-cigarette use.** Use of cigarettes and e-cigarettes was measured using ever, past-year, and past 30-day use of cigarettes and e-cigarettes. Participants were asked, “In the past 30 days, on the days that you smoked cigarettes, about how many cigarettes do you smoke per day?” Response options included: “*Less than one cigarette per day on the days I smoke, 1 cigarette per day, 2-5 cigarettes per day, 6-10 cigarettes per day, 11-20 cigarettes per day, and more than 20 cigarettes per day.*” Nicotine dependence was measured via the time-to-first cigarette upon waking (within 5 minutes, 6-30 minutes, 31-60 minutes, after 60 minutes) (Baker et al., 2007; Fagerström, 2003; Muscat et al., 2009). Intention to resume smoking after pregnancy was measured by the statements, “*I will not use after my pregnancy*”; *three/six/twelve months after my pregnancy, I see myself smoking cigarettes.*”

**Reasoned action approach (RAA).** The RAA items were adapted from other RAA measures (Dobbs et al., 2020; Dobbs et al., 2019; Geshnizjani et al., 2013; Hinsz & Nickell, 2015; Sable et al., 2006; Sheats et al., 2013). A full list of items is cited elsewhere (Dobbs, 2022).

**Behavioral intention.** Behavioral intention included four items to assess how much participants agreed with the statements, “*I (want/intend/plan/expect) to switch from using cigarettes to e-cigarettes...*” Responses were rated using a 7-point Likert scale (Strongly Disagree = -3; Strongly Agree = 3), where higher scores indicated greater behavioral intention to switch.

**Instrumental and experiential attitudes.** The 10-item attitude construct measured instrumental and experiential attitudes. Five items measured instrumental attitudes with each item using a 7-point semantic differential scale (e.g., “*Me switching from using cigarettes to e-cigarettes...would be e.g., Bad = -3; Good =*

*3),*” and five items were used to measure experiential attitudes (e.g., *Unenjoyable = -3; Enjoyable = 3*).

**Injunctive and descriptive norms.** Eight items measured the social norm construct with injunctive (four items) and descriptive norms (four items) both evaluated. A 7-point semantic differential scale was used for each scale: injunctive norms (e.g., “*Those who are important to me [Disapprove of me switching = -3; Approve of me switching = 3] from using cigarettes to e-cigarettes...*”) and descriptive norms (e.g., “*Most pregnant women who smoke cigarettes (Do not want = -3; Want = 3) to switch from using cigarettes to e-cigarettes...*”).

**Perceived autonomy and capacity.** Eight items measured the PBC construct including both autonomy and capacity. Autonomy was measured using four items (e.g., “*It is up to me if I switch from using cigarettes to e-cigarettes...*”), and capacity was measured using three items (e.g., “*If I really wanted to, I could switch from using cigarettes to e-cigarettes...*”). Both scales used a 7-point Likert scale (e.g., *Strongly Disagree = -3; Strongly Agree = 3*).

## Data Analysis

Frequencies were examined using IBM SPSS Statistics 24 (IBM SPSS Statistics for Windows, 2019) and missing data for two participants on four separate items was replaced with the overall sample mean of each individual item. Although more advanced and rigorous imputation methods exist, the overall sample mean was selected given the small number of items that were imputed, and the marginal bias introduced by this method (Donders et al., 2006). Next, t-test (i.e., for age) and chi-square analyses (using Cramér’s V to determine the effect sizes) were performed to examine any potential differences between the demographic data of those who had and had

not used an e-cigarette in the past 30 days. Differences between past 30-day e-cigarette users and those who had not used an e-cigarette in the past 30 days based on these downstream social factors were used to inform the overall research question. To explore whether the RAA constructs interacted differently with pregnant persons' intention to switch from cigarettes to e-cigarettes when controlling for educational attainment (i.e., those who had college experience vs. those who had not attended college), we used a higher-order regression model. To perform this analysis, structural equation modeling (SEM) was used to test RAA's application to pregnant smokers' intention to switch from cigarettes to e-cigarettes for the remainder of their pregnancy for both groups (those who had college experience and those who had not attended college) (Muthén & Muthén, 2017). SEM is ideal for testing theoretical applications, due to its ability to account for multi-level associations between both continuous and categorical variables and lowering type 1 error (Bentler, 1983; Buhi et al., 2007). Further, SEM can help to explore theoretical constructs' application by measuring the variability of latent variables (i.e., instrumental attitudes, experiential attitudes, injunctive norms, descriptive norms, autonomy, capacity) and their interaction with one another via regression. The current study considered multiple factors (i.e., attitudes, social norms, perceived behavioral control) that may influence intention to switch during pregnancy and the relationship between these latent variables (e.g., RAA constructs).

Because the RAA constructs were measured using continuous variables, model goodness-of-fit was measured using chi-square of model fit ( $\chi^2$ ), which can be sensitive to larger sample sizes (Hoyle, 1995); thus, we also used Root Mean Squared Error of Approximation (RMSEA),

Standardized Root Mean Square Residual (SRMR), Tucker Lewis Index (TLI), and Comparative Fit Index (CFI) (Bentler & Bonett, 1980; West et al., 2012) to test the model fit. Acceptable model fit for RMSEA and SRMR are determined when scores are  $< .08$ , and "close" fit is when scores are  $< .06$  (Hoyle, 1995). CFI and TLI cutoff values were set at 0.90, with values closer to 1 indicating stronger model fit (Hu & Bentler, 1999; Kline, 2015).

## Results

A total of 267 participants completed the survey with an average age of 29.3 years ( $SD = 5.5$ ). The largest demographic group of the sample was non-Hispanic whites (142, 53.2%), followed by non-Hispanic black or African American ( $n = 48$ , 18.0%) and Hispanic ( $n = 29$ , 10.9%). Over half of the sample had some college experience ( $n = 144$ , 53.9%; associate degree or some college, bachelor's degree, or graduate or professional degree), and most were married or in a domestic partnership (60.3%,  $n = 161$ ). Further, 25.8% ( $n = 69$ ) of the sample earned between \$20,000 and \$39,999 a year. When asked about smoking behaviors, the most common response to cigarettes smoked per day was 2-5 cigarettes ( $n = 81$ ; 30.3%), and 40.9% ( $n = 109$ ) of the participants smoked their first cigarette of the day between 6 and 30 minutes after waking.

Overall, 45.7% ( $n = 122$ ) of the sample had used an e-cigarette in the past 30 days. When examining the relationship between the demographic variables and behavioral data of those who had and had not used an e-cigarette in the past 30 days, we found age ( $p < .05$ ), educational attainment ( $p < .01$ ), and annual household income ( $p < .01$ ) to be significantly related to past-30-day e-cigarette use. Given the relationship between educational attainment and annual household income, we explored the relationship

between the RAA constructs and pregnant persons' intention to switch from cigarettes to e-cigarettes among those who had some college experience versus those who had not attended college.

### Full Model by Educational Attainment

We ran two separate models. One model included only participants who had received a high school diploma or less, and the other model included only those who had attended college (e.g., received an associate degree or had completed some college, completed a bachelor's degree, or received a graduate or professional degree). For the model that included only those whose highest level of educational attainment was a high school diploma or less, most model fit indices were acceptable,  $\chi^2(354) = 710.4, p < .001$ , SRMR = .06, RMSEA = .09 (90% CI: .08 to .10), CFI = .90, TLI = .89. Within this model, the following RAA constructs significantly predicted intention to switch from using cigarettes to e-cigarette during the remainder of their pregnancy: instrumental attitudes ( $p < .05$ ), experiential attitudes ( $p < .05$ ),

descriptive norms ( $p < .001$ ), and autonomy ( $p < .05$ ), see Figure 1A for the full structural model. The adjusted  $R^2$  indicated this model explained 71.6% of the variability of the intention of pregnant smokers who had not completed at least some college to switch from using cigarettes to e-cigarettes during the remainder of their pregnancy (See Table 2).

For the model that included only those who had completed some college, most model fit indices were acceptable,  $\chi^2(354) = 680.38, p < .001$ , SRMR = .07, RMSEA = .08 (90% CI: .07 to .09), CFI = .90, TLI = .89. Within this model, the following RAA constructs significantly predicted intention to switch from using cigarettes to e-cigarette during the remainder of their pregnancy: instrumental attitudes ( $p < .001$ ), experiential attitudes ( $p < .01$ ), and descriptive norms ( $p < .001$ ). See Figure 1B for the full structural model. The adjusted  $R^2$  indicated the model with only those who had completed at least some college explained 62.9% of the variability of the intention to switch from using cigarettes to e-cigarettes during the remainder of their pregnancy.

Table 2

### *Pregnant Smokers' Intention to Switch from Cigarettes to E-cigarettes During Pregnancy Expanded Constructs*

Variable	Completed Associate, Bachelor's, or Higher Degree ( $n = 144$ )			High School Diploma or Less ( $n = 123$ )		
	$\beta$	SE	$p$	$\beta$	SE	$p$
Instrumental attitude	0.67	.19	.001	0.33	.15	.025
Experiential attitude	-0.36	.14	.007	0.26	.11	.022
Injunctive norm	-0.21	.16	.197	-0.11	.14	.412
Descriptive norm	0.59	.18	.001	0.42	.12	.001
Autonomy	0.05	.16	.743	0.29	.13	.029
Capacity	0.03	.17	.201	-0.22	.13	.086
			$R^2 = 0.63$			$R^2 = 0.72$

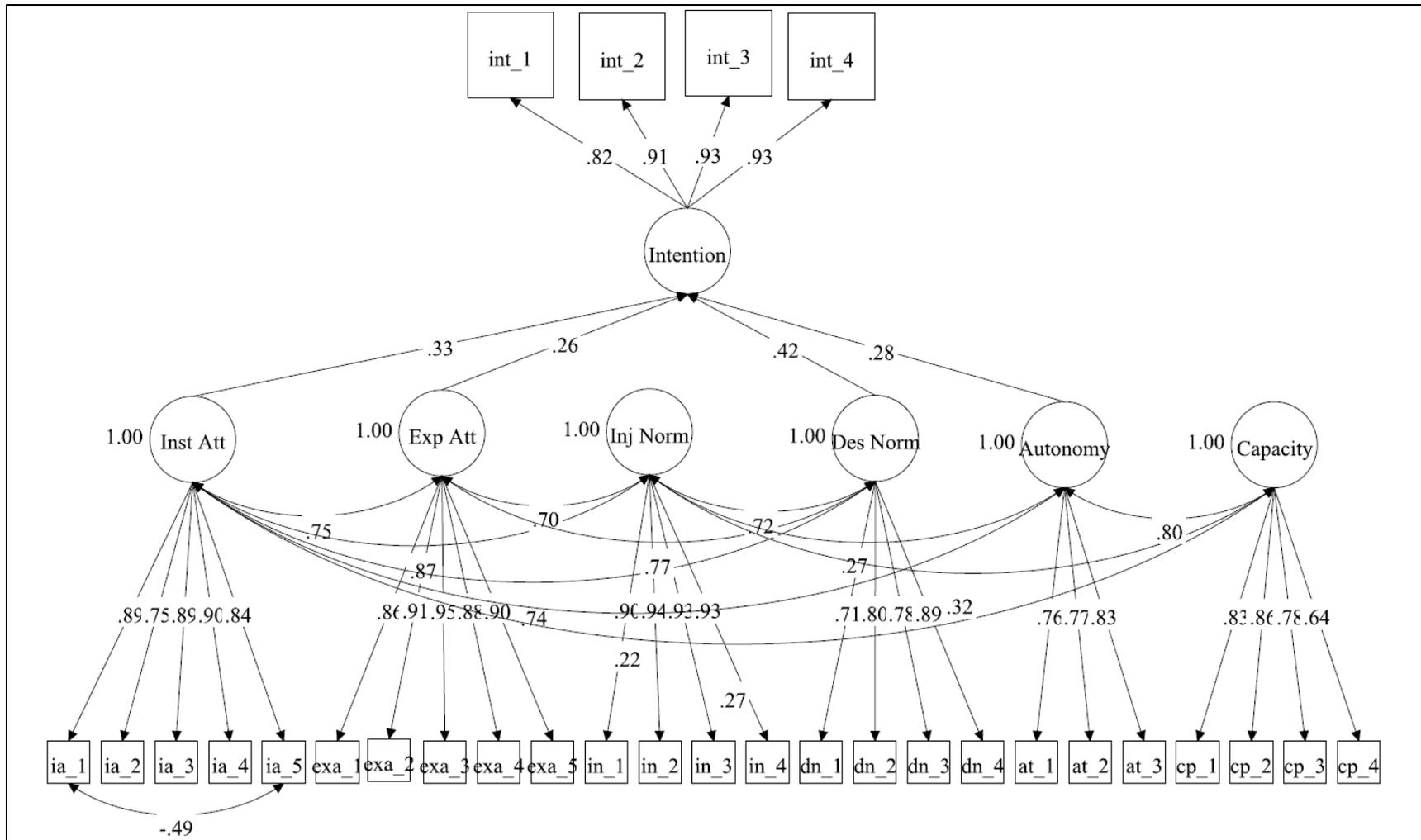


Figure 1(A). Pregnant smokers' intention to switch from cigarettes to e-cigarettes among those who had not completed a college degree. Int = Intention; Inst Att & ia = Instrumental Attitude; Exp Att & exa = Experiential Attitude; Inj Norm & in = Injective Norm; Des Norm & dn = Descriptive Norm; at = Autonomy; cp = capacity

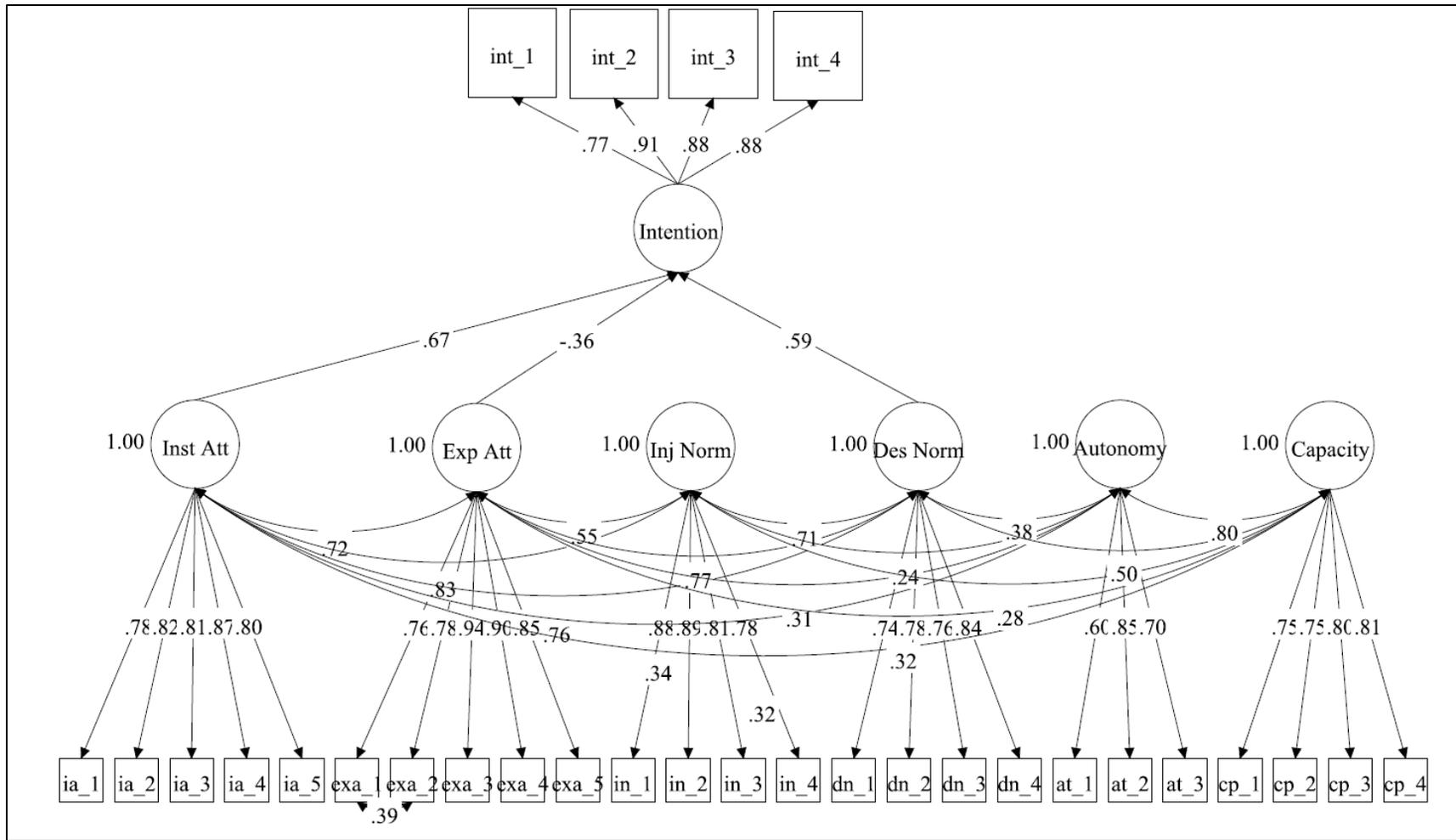


Figure 1(B). Pregnant smokers' intention to switch from cigarettes to e-cigarettes among those who had completed a college degree. Int = Intention; Inst Att & ia = Instrumental Attitude; Exp Att & exa = Experiential Attitude; Inj Norm & in = Injective Norm; Des Norm & dn = Descriptive Norm; at = Autonomy; cp = capacity

## Discussion

The current research explored whether factors that influence pregnant persons' intention to switch from cigarettes to e-cigarettes differed between women who had completed some college and those who had not (completed a high school degree or equivalent or less). Using the constructs of the RAA, we found most RAA constructs were similarly related to intention to switch from cigarettes to e-cigarettes, but a key difference between groups was that autonomy was significantly associated with intention to switch among those who had not completed any college. This is an important difference due to the link between smoking while pregnant and severe complications during and after pregnancy including low birth weight, premature birth, or sudden infant death syndrome (SIDS) (England et al., 2015; U.S. Department of Health and Human Services, 2014). Although complete abstinence from all nicotine-containing products while pregnant is recommended (U.S. Department of Health and Human Services, 2014), switching from combustible cigarettes to some form of e-cigarette may provide an alternative for women who smoke and are unable to quit entirely.

Similar to prior research, placing importance on a behavior (instrumental attitudes) and having close companions or role models who also perform the behavior (descriptive norms) was found to be associated with pregnant persons' intention to switch from cigarettes to e-cigarettes (Dobbs et al., 2021); however, we also found experiential attitudes were associated with intention among both participants who had and those who had not completed some college. Instrumental and experiential attitudes may be influenced by descriptive norms a person observes happening in their own environment. While these norms may fall outside of society on a larger scale, the

microcosms in which people live and work are often with others who have a complimentary educational attainment (Aliprantis et al., 2019). Thus, important referents (descriptive norms) to pregnant persons who smoke may have a similar set of values and beliefs, including what they believe is instrumentally important and experiences they expect to have when they engage in a particular behavior (e.g., e-cigarette use).

Uniquely, we also found that autonomy was significantly associated with intention to switch from cigarettes to e-cigarettes among pregnant persons who smoked and had not completed a college degree. Research has found recent increases in the rates of smoking during pregnancy among women with lower educational attainment (Azagba et al., 2020), and women with lower educational attainment have also been found to be less likely to spontaneously quit smoking during pregnancy (White et al., 2014). These women with lower educational attainment have also been found to exhibit higher stress levels and higher rates of prior depression than their counterparts (White et al., 2014). Although stressors were not assessed in our study, feelings of being unable to control an addiction could potentially cause stress or be a result of the stressful experience. As one of the most significant predictors of smoking during pregnancy, educational attainment may also be related to a myriad of socio-demographic and quality of life variables that may differentiate pregnant people (Härkönen et al., 2018). The perception of control over one's own actions, especially intertwined with addiction, may be diluted by the downstream effects of attaining less education. Further, those with less education may have less personal agency as a result of coupled social determinants of health such as lower wages and less access to healthcare (e.g., smoking cessation).

In order to understand the health implications of pregnant smokers' intention to switch from cigarettes to e-cigarettes, it is important to understand who is more likely to switch and what factors influence their behavioral decision-making. Our findings suggest intention to switch from cigarettes to e-cigarettes during pregnancy was influenced by perceptions of internal or external barriers (i.e., perceived autonomy) to controlling one's own behavior for those who had completed less education, but not for those who had completed at least some college classes. Thus, among women with lower educational attainment, those who believed they were in control of their ability to switch from cigarettes to e-cigarettes were more likely to intend to perform this behavior, implying that those not in control would not be able to switch. This may help to explain why pregnant smokers with lower educational attainment are less likely to spontaneously stop smoking, given that they may not believe they are in control of their addiction to cigarettes, and thus they intend to continue smoking throughout their gestational period (White et al., 2014).

### **Limitations**

The current study is subject to limitations. Inherent in the use of a cross-sectional design is the inability to infer causal influence. Our survey was restricted to self-report responses, thus leaving room for reporting bias, such as underreporting use of cigarettes, as well as the inability to verify information, such as pregnancy status. In the design of our survey, we chose not to include questions related to prenatal care, including conversations with healthcare providers, which may have an influence on intention for behavior change. Additionally, data were not gathered regarding previous experience with smoking cessation, or use of e-cigarettes, which could affect confidence or intention with current

behavior. Questions regarding specific state of residence and rural or urban characterizations were not asked, leaving the inability to determine geographical representation or influence. Finally, respondents were limited to English speaking and those who had Internet access, which limited sample size. Due to the small sample size and sampling methods employed, findings are not generalizable to all pregnant people.

### **Implications for Health Behavior Theory**

This study utilized the RAA to determine whether the RAA constructs demonstrated differences in their relationship with the behavioral intention of pregnant persons to switch from cigarettes to e-cigarettes throughout the remainder of their pregnancy when grouped by educational attainment. Our findings demonstrate the need to tailor messages about switching from cigarettes to e-cigarettes during pregnancy to one's audience based on upstream social factors, such as educational attainment. Moreover, among women who had not completed a college education, autonomy was found to be significantly related to their intention to switch from cigarettes to e-cigarettes, a finding not identified among women who had completed a college education. Therefore, providers can use patient intake forms and instruments to measure patient demographic information to tailor patient education and conversations to encourage behavior change. While some may find that some RAA constructs are predictive of behavioral intention or behavior, it is important to consider that not all RAA constructs may be predictive of intention for all subgroups within a sample. These differences in the theoretical model highlight the importance of defining the population when developing the research question. Further, population subgroups should be disaggregated and examined to tailor behavior change

interventions and messaging to at-risk audiences.

### Discussion Questions

1. How might different constructs of the RAA be associated with intention differently based on the population included in the study?
2. What other background variables would be important to study when explaining pregnant persons' intentions to switch from smoking cigarettes to using e-cigarettes?

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### References

- Agrawal, A., Rogers, C. E., Lessov-Schlaggar, C. N., Carter, E. B., Lenze, S. N., & Grucza, R. A. (2019). Alcohol, cigarette, and cannabis use between 2002 and 2016 in pregnant women from a nationally representative sample. *JAMA Pediatrics*, *173*(1), 95–96. <https://doi.org/10.1001/JAMAPEDIATRICS.2018.3096>
- Aliprantis, D., Carroll, D., & Young, E. R. (2019). What explains neighborhood sorting by income and race? Federal Reserve Bank of Cleveland, Working Paper no. 18-08R. <https://doi.org/10.2139/SSRN.3195529>
- Azagba, S., Manzione, L., Shan, L., & King, J. (2020). Trends in smoking during pregnancy by socioeconomic characteristics in the United States, 2010-2017. *BMC Pregnancy and Childbirth*, *20*(1), Article 52. <https://doi.org/10.1186/s12884-020-2748-y>
- Baker, T. B., Piper, M. E., McCarthy, D. E., Bolt, D. M., Smith, S. S., Kim, S. -Y., Colby, S., Conti, D., Giovino, G. A., Hatsukami, D., Hyland, A., Krishnan-Sarin, S., Niaura, R., Perkins, K. A., & Toll, B. A. (2007). Time to first cigarette in the morning as an index of ability to quit smoking: Implications for nicotine dependence. *Nicotine & Tobacco Research*, *9*(Suppl 4), S555–S570. <https://doi.org/10.1080/14622200701673480>
- Bentler, P. M. (1983). Some contributions to efficient statistics in structural models: Specification and estimation of moment structures. *Psychometrika* *48*(4), 493–517. <https://doi.org/10.1007/BF02293875>
- Bentler, P. M., & Bonett, D. G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin*, *88*(3), 588–606. <https://doi.org/10.1037/0033-2909.88.3.588>
- Bowker, K., Orton, S., Cooper, S., Naughton, F., Whitmore, R., Lewis, S., Bauld, L., Sinclair, L., Coleman, T., Dickinson, A., & Ussher, M. (2018). Views on and experiences of electronic cigarettes: A qualitative study of women who are pregnant or have recently given birth. *BMC Pregnancy and Childbirth*, *18*(1), Article 233. <https://doi.org/10.1186/s12884-018-1856-4>

- Buhi, E. R., Goodson, P., & Neilands, T. B. (2007). Structural equation modeling: A primer for health behavior researchers. *American Journal of Health Behavior*, 31(1), 74–85.
- Cohn, A. M., Elmasry, H., Wild, R. C., Johnson, A. L., Abudayyeh, H., Kurti, A., & Coleman-Cowger, V. H. (2022). Birth outcomes associated with e-cigarette and non-e-cigarette tobacco product use during pregnancy: An examination of PATH data waves 1–5. *Nicotine & Tobacco Research*, nta111. <https://doi.org/10.1093/NTR/NTAC111>
- Cornelius, M. E., Wang, T. W., Jamal, A., Loretan, C. G., & Neff, L. J. (2020). Tobacco product use among adults — United States, 2019. *Morbidity and Mortality Weekly Report (MMWR)*, 69(46), 1736–1742. <https://doi.org/10.15585/MMWR.MM6946A4>
- Do, E. K., Green, T. L., Prom-Wormley, E. C., & Fuemmeler, B. F. (2018). Social determinants of smoke exposure during pregnancy: Findings from waves 1 & 2 of the Population Assessment of Tobacco and Health (PATH) Study. *Preventive Medicine Reports*, 12, 312–320. <https://doi.org/10.1016/j.pmedr.2018.10.020>
- Dobbs, P. D., Branscum, P., Cohn, A. M., Tackett, A. P., & Comiford, A. L. (2021). Pregnant smokers' intention to switch from cigarettes to e-cigarettes: A reasoned action approach. *Women's Health Issues*, 31(6), 540–549. <https://doi.org/10.1016/J.WHI.2021.07.005>
- Dobbs, P. D., Branscum, P., & Wilkerson, A. H. (2020). Intention to use e-cigarettes to quit smoking: A reasoned action approach. *American Journal of Health Education*, 51(6), 360-370. <https://doi.org/10.1080/19325037.2020.1822238>
- Dobbs, P. D., Jozkowski, K. N., Hammig, B., Blunt-Vinti, H., Henry, J. L., Lo, W. -J., Gorman, D., & Luzius, A. (2019). College student e-cigarette use: A reasoned action approach measure development. *American Journal of Health Behavior*, 43(4), 753–766. <https://doi.org/10.5993/AJHB.43.4.9>
- Donders, A. R. T., van der Heijden, G. J. M. G., Stijnen, T., & Moons, K. G. M. (2006). Review: A gentle introduction to imputation of missing values. *Journal of Clinical Epidemiology*, 59(10), 1087–1091. <https://doi.org/10.1016/J.JCLINEPI.2006.01.014>
- Drake, P., Driscoll, A. K., & Mathews T, J. (2018). Cigarette smoking during pregnancy: United States, 2016. NCHS Data Brief, no. 305. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics.
- England, L. J., Bunnell, R. E., Pechacek, T. F., Tong, V. T., & McAfee, T. A. (2015). Nicotine and the developing human: A neglected element in the electronic cigarette debate. *American Journal of Preventive Medicine*, 49(2), 286–293. <https://doi.org/10.1016/j.amepre.2015.01.015>

- Fagerström, K. (2003). Time to first cigarette; the best single indicator of tobacco dependence? *Monaldi Archives for Chest Disease*, 59(1), 91–94.
- Fallin, A., Miller, A., Assef, S., & Ashford, K. (2016). Perceptions of electronic cigarettes among Medicaid-eligible pregnant and postpartum women. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 45(3), 320–325.  
<https://doi.org/10.1016/j.jogn.2016.02.009>
- Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behavior: The reasoned action approach*. Psychology Press (Taylor & Francis).
- Geshnizjani, A., Jozkowski, K. N., & Middlestadt, S. E. (2013). Factors influencing the intention of getting the HPV vaccine among college women: An application of the reasoned action approach. *Californian Journal of Health Promotion*, 11(2), 1-11.  
<https://doi.org/10.32398/cjhp.v11i2.1526>
- Hajek, P., Phillips-Waller, A., Przulj, D., Pesola, F., Myers Smith, K., Bisal, N., Li, J., Parrott, S., Sasieni, P., Dawkins, L., Ross, L., Goniewicz, M., Wu, Q., & McRobbie, H. J. (2019). A randomized trial of e-cigarettes versus nicotine-replacement therapy. *New England Journal of Medicine*, 380(7), 629–637.  
<https://doi.org/10.1056/NEJMoa1808779>
- Hansen, A. R., Akomolafe, T. O., McGalliard, Z., Belle-Isle, L., & Zhang, J. (2018). Striving to meet Healthy People 2020 objectives: Trend analysis of maternal smoking. *Public Health Reports*, 133(6), 644–649.  
<https://doi.org/10.1177/0033354918793120>
- Härkönen, J., Lindberg, M., Karlsson, L., Karlsson, H., & Scheinin, N. M. (2018). Education is the strongest socio-economic predictor of smoking in pregnancy. *Addiction*, 113(6), 1117–1126.  
<https://doi.org/10.1111/ADD.14158>
- Hinsz, V. B., & Nickell, G. S. (2015). The prediction of workers' food safety intentions and behavior with job attitudes and the reasoned action approach. *Revista de Psicologia Del Trabajo y de Las Organizaciones (Journal of Work and Organizational Psychology)*, 31(2), 91–100.  
<https://doi.org/10.1016/j.rpto.2015.03.001>
- Hoyle, R. H. (1995). *Structural equation modeling: Concepts, issues, and applications*. SAGE Publications Inc.
- Hu, L. -T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, 6(1), 1–55.  
<https://doi.org/10.1080/10705519909540118>
- IBM SPSS Statistics for Windows. (2019). *Version 26.0*. IBM Corp.
- Kline, R. B. (2015). *Principles and practice of structural equation modeling* (4<sup>th</sup> ed.). Guilford Publications.

- Kurti, A. N., Bunn, J. Y., Tang, K., Nighbor, T., Gaalema, D. E., Coleman-Cowger, V., Coleman, S. R. M., & Higgins, S. T. (2020). Impact of electronic nicotine delivery systems and other respondent characteristics on tobacco use transitions among a U.S. national sample of women of reproductive age. *Drug and Alcohol Dependence*, 207, Article 107801. <https://doi.org/10.1016/j.drugalcdep.2019.107801>
- Kurti, A. N., Redner, R., Lopez, A. A., Keith, D. R., Villanti, A. C., Stanton, C. A., Gaalema, D. E., Bunn, J. Y., Doogan, N. J., Cepeda-Benito, A., Roberts, M. E., Phillips, J., & Higgins, S. T. (2017). Tobacco and nicotine delivery product use in a national sample of pregnant women. *Preventive Medicine*, 104, 50–56. <https://doi.org/10.1016/j.ypmed.2017.07.030>
- Marin, B. V., Marin, G., Perez-Stable, E. J., Otero-Sabogal, R., & Sabogal, F. (1990). Cultural differences in attitudes toward smoking: Developing messages using the theory of reasoned action. *Journal of Applied Social Psychology*, 20(6), 478–493. <https://doi.org/10.1111/J.1559-1816.1990.TB00423.X>
- McCubbin, A., Fallin-Bennett, A., Barnett, J., & Ashford, K. (2017). Perceptions and use of electronic cigarettes in pregnancy. *Health Education Research*, 32(1), 22–32. <https://doi.org/10.1093/her/cyw059>
- Middlestadt, S. E., Macy, J. T., Dowty, R., Arrieta, A., & Jay, S. J. (2020). Moderating effect of partner smoking on pregnant women's intention to stop smoking: Applying the reasoned action approach. *Addiction Research & Theory*, 28(6), 510–516. <https://doi.org/10.1080/16066359.2019.1708904>
- Muscat, J. E., Stellman, S. D., Caraballo, R. S., & Richie, J. P. (2009). Time to first cigarette after waking predicts cotinine levels. *Cancer Epidemiology Biomarkers and Prevention*, 18(12), 3415–3420. <https://doi.org/10.1158/1055-9965.EPI-09-0737>
- Muthén, L. K., & Muthén, B. O. (2017). *Mplus User's Guide* (8<sup>th</sup> ed.). Muthén & Muthén.
- Nighbor, T. D., Doogan, N. J., Roberts, M. E., Cepeda-Benito, A., Kurti, A. N., Priest, J. S., Johnson, H. K., Lopez, A. A., Stanton, C. A., Gaalema, D. E., Redner, R., Parker, M. A., Keith, D. R., Quisenberry, A. J., & Higgins, S. T. (2018). Smoking prevalence and trends among a U.S. national sample of women of reproductive age in rural versus urban settings. *PLOS ONE*, 13(11), Article e0207818. <https://doi.org/10.1371/JOURNAL.PONE.0207818>
- Obisesan, O. H., Osei, A. D., Iftekhar Uddin, S. M., Dzaye, O., Cainzos-Achirica, M., Mirbolouk, M., Orimoloye, O. A., Sharma, G., Al Rifai, M., Stokes, A., Bhatnagar, A., El Shahawy, O., Benjamin, E. J., DeFilippis, A. P., & Blaha, M. J. (2020). E-cigarette use patterns and high-risk behaviors in pregnancy: Behavioral Risk Factor Surveillance System, 2016–2018. *American Journal of Preventive Medicine*, 59(2), 187–195. <https://doi.org/10.1016/j.amepre.2020.02.015>

- Park, S. H., Duncan, D. T., El Shahawy, O., Lee, L., Shearston, J. A., Tamura, K., Sherman, S. E., & Weitzman, M. (2017). Characteristics of adults who switched from cigarette smoking to e-cigarettes. *American Journal of Preventive Medicine*, 53(5), 652–660. <https://doi.org/10.1016/J.AMEPRE.2017.06.033>
- Sable, M. R., Schwartz, L. R., Eleanor, P. J., & Lisbon, M. A. (2006). Using the theory of reasoned action to explain physician intention to prescribe emergency contraception. *Perspectives on Sexual and Reproductive Health*, 38(1), 20–27. <https://doi.org/10.1363/3802006>
- Schilling, L., Schneider, S., Karlheim, C., Maul, H., Tallarek, M., & Spallek, J. (2019). Perceived threats, benefits and barriers of e-cigarette use during pregnancy. A qualitative analysis of risk perception within existing threads in online discussion forums. *Midwifery*, 79, Article 102533. <https://doi.org/10.1016/j.midw.2019.102533>
- Sheats, J. L., Middlestadt, S. E., Ona, F. F., Juarez, P. D., & Kolbe, L. J. (2013). Understanding African American women's decisions to buy and eat dark green leafy vegetables: An application of the reasoned action approach. *Journal of Nutrition Education and Behavior*, 45(6), 676–682. <https://doi.org/10.1016/j.jneb.2013.07.013>
- Siu, A. L. (2015). Behavioral and pharmacotherapy interventions for tobacco smoking cessation in adults, including pregnant women: U.S. Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*, 163(8), 622–634. <https://doi.org/10.7326/M15-2023>
- Stroud, L. R., Papandonatos, G. D., Borba, K., Kehoe, T., & Scott-Sheldon, L. A. J. (2019). Flavored electronic cigarette use, preferences, and perceptions in pregnant mothers: A correspondence analysis approach. *Addictive Behaviors*, 91, 21–29. <https://doi.org/10.1016/j.addbeh.2018.10.043>
- Tong, V. T., Dietz, P. M., Morrow, B., D'Angelo, D. V., Farr, S. L., Rockhill, K. M., & England, L. J. (2013). Trends in smoking before, during, and after pregnancy — Pregnancy Risk Assessment Monitoring System, United States, 40 Sites, 2000–2010. *Morbidity and Mortality Weekly Report (MMWR)*, 62(SS06), 1–19. <https://www.cdc.gov/mmwr/preview/mmwrhtml/ss6206a1.htm>
- U.S. Department of Health and Human Services. (2014). *The health consequences of smoking—50 years of progress: a report of the Surgeon General*. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.
- Wagner, N. J., Camerota, M., & Propper, C. (2017). Prevalence and perceptions of electronic cigarette use during pregnancy. *Maternal and Child Health Journal*, 21(8), 1655–1661. <https://doi.org/10.1007/s10995-016-2257-9>
- West, S. G., Taylor, A. B., & Wu, W. (2012). Model fit and model selection in structural

equation modeling. In R. H. Hoyle (Ed.), *Handbook of Structural Equation Modeling* (pp. 209–231). The Guilford Press.

<https://psycnet.apa.org/record/2012-16551-013>

White, T. J., Redner, R., Skelly, J. M., & Higgins, S. T. (2014). Examining educational attainment, prepregnancy smoking rate, and delay discounting as predictors of spontaneous quitting among pregnant smokers. *Experimental and Clinical Psychopharmacology*, 22(5), 384-391.

<https://doi.org/10.1037/A0037492>