Short communication

Chronic disease as a risk factor for cigarette and e-cigarette use from young adulthood to adulthood

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ABSTRACT

Chronic disease prevalence in young adults is increasing with 15–20 % reporting 1 or more chronic diseases. This study examined cross-sectional and prospective relationships between chronic disease and e-cigarette/cigarette use from young adulthood to adulthood utilizing the U.S.- based National Longitudinal Study of Adolescent to Adult Health (Add Health). Add Health Study wave 3 (2001–2002; ages 18–26), wave 4 (2008; ages 24–34), and wave 5 (2016–2018; ages 33–44) were used. Past 30-day cigarette use at waves 3–5 and past 30-day e-cigarette use at wave 5 were assessed. Two measures of chronic disease were used: asthma (yes/no) and non-asthmatic chronic disease (yes/no) composed of 7 additional chronic diseases (diabetes, migraine, heart problem, hepatitis B/C, high blood pressure, epilepsy, and cancer). Weighted multilevel logistic regression (controlling for age, race/ethnicity, gender, and education) was used to assess cross-sectional associations at wave 3, and then prospective associations of wave 3 chronic disease (asthma and non-asthmatic) with waves 4 and 5 cigarette and wave 5 e-cigarette use. Logistic regressions showed no significant cross-sectional or prospective relationships between asthma and cigarette and e-cigarette use. However, wave 3 non-asthmatic chronic disease was significantly associated with wave 4 cigarette use (aOR 1.38, p <.001, 95 % CI: 1.15, 1.65) and with wave 5 cigarette use (aOR 1.49, p <.001, 95 % CI: 1.21, 1.84) but not e-cigarette use. The association between chronic disease in young adulthood and tobacco use in adulthood differed by type of chronic disease and tobacco product, indicating the need for targeted interventions.

1. Introduction

Chronic disease is defined as "any disease that is long-lasting or permanent" (Last, 2007) Asthma is the most common chronic disease in young adulthood but rates of other chronic diseases such as diabetes and hypertension are increasing in young adults. It is estimated that 15–20 % of youth and the majority of adults report at least one chronic health condition (Jin et al., 2017; Schmitz et al., 2007).

Previous research investigating the relationship between chronic disease and cigarette use in adolescents has primarily focused on asthma. Most studies have been cross-sectional and have shown a significant association between asthma and cigarette use (Fedele, 2016).

Among adults, asthma has been significantly associated with smoking and nicotine dependence (McLeish et al., 2011; McLeish and Zvolensky, 2010). In a cross-sectional study of adults with a chronic condition, 22.9 % reported being current smokers, but current smoking

was less likely in adults with high blood pressure, heart disease, and diabetes compared to those without chronic health conditions (McLeish et al., 2011). This may be because they developed these chronic conditions past the time when smoking initiation is more common or they were able to successfully quit smoking after a chronic disease diagnosis (Schmitz et al., 2007). However, in another study, half of adults with asthma began smoking *after* they were diagnosed with asthma (McLeish et al., 2011). Current cigarette smoking is also higher in adults with epilepsy (24.9 %) than adults with no history of epilepsy (16.6 %) across multiple ethnicities, educational levels, and income levels (Sapkota, 2020).

The limited literature on chronic disease and e-cigarette use indicates some differences in the patterns of association compared to cigarettes. One cross-sectional study of young adults showed significantly higher rates of cigarette use but not e-cigarette use in those with asthma than those without asthma (Hawkins, 2020). Similarly, adults

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with pre-diabetes were more likely than those without to report current e-cigarette use (Atuegwu, 2019). Cross-sectional studies of never (Atuegwu, 2019) and current (Kruse et al., 2017) adult smokers also show current use of e-cigarettes was significantly higher for those with a chronic condition than those without. Recently, a study of waves 1–4 of the U.S.-based PATH study showed that adults with chronic pain at wave 1 were at higher risk of cigarette use, e-cigarette use, and dual use in subsequent waves (Powers, 2022).

Similar to cigarette use, studies of e-cigarette use in adolescents with chronic conditions focus on asthma. Adolescents with asthma had a higher rate of ever and past 30 day e-cigarette use than those without asthma, (Fedele, 2016; Choi and Bernat, 2016; Schweitzer, 2017) and is independent of their cigarette use (Schweitzer, 2017; Wills et al., 2020). Past 30 day e-cigarette use in adolescents was also associated with increased susceptibility to smoking cigarettes and with having an asthma attack in the past year (Choi and Bernat, 2016).

While studies on chronic disease have documented largely cross-sectional associations with cigarette and e-cigarette use in adolescents and adults, relatively little attention has been given to young adults. Young adulthood is a unique developmental stage and a growing proportion of smokers begin smoking in young adulthood rather than adolescence (U.S. Department of Health and Human Services, 2014). Studies focusing on young adults with a chronic health condition also show a higher risk of tobacco use for those with a chronic disease. A recent study among college students showed that those with asthma were more likely to smoke than those without asthma, but those with asthma *and* obesity had the highest rate of smoking (Hawkins, 2020).

While chronic disease is a well-established outcome of health risk behaviors such as smoking (Last, 2007; Kruse et al., 2017), we propose that chronic disease in young adulthood can also put young adults at increased risk of smoking. Chronic disease in young adulthood can lead to anxiety and depression, lifestyle adjustments, and limitations on educational, social, and occupational opportunities as a result of their chronic disease (Choi and Bernat, 2016; Schweitzer, 2017; Wills et al., 2020). Young adults could adopt smoking as a coping mechanism for this increased anxiety/depression. As a first step in investigating this association, this study examined cross-sectional and prospective relationships between chronic disease, cigarette use, and e-cigarette use from young adulthood to adulthood using waves 3–5 of the National Longitudinal Study of Adolescent to Adult Health. We hypothesized that young adults with a chronic illness at wave 3 would be more likely to report cigarette and/or e-cigarette use in later waves than young adults without a chronic health condition.

2. Materials and methods

2.1. Add Health study

The National Longitudinal Study of Adolescent to Adult Health (Add Health) is a nationally representative longitudinal study that explores influences on health and health risk behaviors from adolescence to adulthood in the United States (https://addhealth.cpc.unc.edu/home/). The survey oversampled racial/ethnic groups and contains diverse socio-economic status (SES) and geographic representation. This ongoing longitudinal study has gathered 5 waves of data extending from 1994 to 2018. The 25-year retention rate is 60 %, and the 8-year retention rate between waves 4 and 5 is 72 %. The University of Oklahoma IRB deemed this secondary data analysis exempt from human subjects review.

2.2. Participants

Add Health participants at wave 3 (2001–2002, ages 18–26 years old), wave 4 (2008, ages 24–34 years old), and wave 5 (2016–2018, ages 33–44 years old) who answered the chronic disease, cigarette, and e-cigarette use questions at waves 3–5 were included in the study.

2.3. Tobacco use

Cigarette use was assessed at wave 3, wave 4, and wave 5 using "During the past 30 days, on how many days did you smoke cigarettes?" Responses were dichotomized by "0 days" and "1 or more day" in the past 30 days. Electronic cigarette use was only asked at wave 5 using the question "E-cigarettes look like regular cigarettes, but are battery-powered and produce vapor instead of smoke. During the past 30 days, on how many days did you use an e-cigarette?" Responses were dichotomized to "0 days" and "1 or more days" in the past 30 days.

2.4. Chronic disease

Presence of asthma diagnosed by a health care professional (yes/no) was assessed at wave 3. A second non-asthmatic chronic disease composite variable was created using 7 additional chronic diseases assessed by Add Health (diabetes, migraine, heart problem, hepatitis B/C, high blood pressure, epilepsy, and cancer). Diagnoses (yes/no) of diabetes, high blood pressure, epilepsy, and cancer by a health care professional were assessed at wave 3. Participants retrospectively reported heart problems, hepatitis B/C, migraine diagnosis status (i.e., ever been diagnosed) and age of diagnosis at waves 4 and 5. The reported diagnosis age of each disease was matched with participant age at wave 3 to identify the presence of each chronic disease at wave 3. Participants reporting the presence of at least one of the 7 chronic diseases were considered as having non-asthmatic chronic disease.

2.5. Demographics

Age, sex (male/female), race/ethnicity (Hispanic, non-Hispanic white, non-Hispanic African-American, Asian, other), and educational attainment (no college, some college or higher) were included as control variables.

2.6. Analysis

Data analyses were carried out in Mplus 8.7 (Muthen and Muthen, 2017) Since the Add Health data were based on a cluster sample where clusters (i.e., schools) were sampled with unequal probability, sampling weights were applied in analyses. First, variable means, standard deviation, frequencies, and weighted percentages were examined. Next, a series of weighted multilevel logistic regression analyses were conducted to examine associations between chronic disease, cigarette, and e-cigarette use, accounting for school-level intraclass correlations. Two separate weighted multilevel logistic regression analyses were performed, one for asthma, one for non-asthmatic chronic disease, to assess their cross-sectional associations with wave 3 cigarette use, controlling for age, gender, race/ethnicity, and educational attainment. Prospective associations of the two types of chronic disease at wave 3 with wave 4 and wave 5 cigarette use were also tested in separate regression models, controlling for the aforementioned demographic characteristics and wave 3 cigarette use. Finally, prospective associations between the two types of chronic diseases at wave 3 and wave 5 e-cigarette use were examined controlling for demographic characteristics. The robust maximum likelihood estimation method was used. Missing data were treated with full information maximum likelihood (Graham, 2012).

3. Results

Participants were young adults at wave 3 of the study (n = 15,197; average age = 22.4 years, SD = 1.8) and were transitioning to adulthood by wave 5 data collection approximately 15–17 years later (n = 12,300; average age = 37.9 years, SD = 2.0). At wave 3, approximately half the sample was female (53.3 %), White (68.6 %), and most had some college education or higher (79.7 %) (see Supplementary Data table). Among the participants, 17.5 % reported being diagnosed with asthma and 15.9

% were diagnosed with at least one non-asthma chronic disease by wave 3. Cigarette use rates were 33.9 %, 36.3 %, and 27.8 % respectively at waves 3, 4, and 5 and e-cigarette use rate was 6.3 % at wave 5.

Weighted multilevel logistic regressions showed no significant cross-sectional relationships between wave 3 asthma and wave 3 cigarette use (aOR = 1.12, p =.08, 95 % CI: 0.99, 1.26), after controlling for age, gender, race, and education. Additionally, no significant prospective relationship was identified between wave 3 asthma and wave 4 cigarette (aOR = 1.06, p =.55, 95 % CI: 0.87, 1.29), wave 5 cigarette (aOR = 1.10, p =.39, 95 % CI: 0.88, 1.37), or wave 5 e-cigarette use (aOR = 1.13, p =.42, 95 % CI: 0.84, 1.50) (see Table 1). As shown in Table 2, wave 3 non-asthmatic chronic disease was significantly associated with wave 4 cigarette use (aOR = 1.38, p <.001, 95 % CI: 1.15, 1.65) and with wave 5 cigarette use (aOR = 1.49, p <.001, 95 % CI: 1.21, 1.84), after controlling for demographic characteristics and wave 3 cigarette use. No significant cross-sectional association was identified between wave 3 non-asthmatic chronic disease and wave 3 cigarette use (aOR = 1.07, p =.36, 95 % CI: 0.93, 1.24) nor prospective association between wave 3 non-asthmatic chronic disease and wave 5 e-cigarette use (aOR = 1.05, p =.74, 95 % CI: 0.80, 1.37).

4. Discussion

Smoking among young adults and adults with chronic disease puts them at increased risk for the development of co-morbidities, lower quality of life, and early death (U.S. Department of Health and Human Services, 2014). Young adults with a chronic disease may use cigarettes or e-cigarettes to cope with disease symptoms or the anxiety, depression, and financial, social, and occupational stress which often accompany chronic illness. Youth with a chronic health condition are at greater risk for long-term smoking if they have a less positive vision for their future, or if they report lower emotional well-being (Tercyak, 2006; Gubelmann, 2018).

Preventing initiation of cigarette and e-cigarette use in young adults

Table 1
Multiple Regression of Asthma Predicting Cigarette and E-Cigarette Use for Wave 3 (2001–2002; ages 18–26), wave 4 (2008; ages 24–34), and wave 5 (2016–2018; ages 33–44) of the US National Longitudinal Study of Adolescent to Adult Health (Add Health).

	W3 Cigarette Use AOR (95 % CI)	W4 Cigarette Use AOR (95 % CI)	W5 Cigarette Use AOR (95 % CI)	W5 E-Cigarette Use AOR (95 % CI)
W3 Asthma	1.12 (0.99, 1.26)	1.06 (0.87, 1.29)	1.10 (0.88, 1.37)	1.13 (0.84, 1.50)
Age	0.99 (0.95, 1.03)	**0.92** (0.88, 0.97)	0.98 (0.94, 1.03)	0.99 (0.92, 1.06)
Gender (Female as ref.)	1.06 (0.94, 1.20)	**1.33** (1.12, 1.57)	**1.28** (1.08, 1.52)	**1.74*** (1.38, 2.19)
Race (non-Hispanic White as ref.)				
Hispanic	**0.47*** (0.37, 0.60)	0.81 (0.62, 1.05)	**0.69** (0.53, 0.90)	**0.58** (0.39, 0.87)
African American	**0.36*** (0.28, 0.46)	1.00 (0.80, 1.26)	**1.40** (1.13, 1.75)	**0.43*** (0.28, 0.66)
Asian	**0.41*** (0.26, 0.65)	**0.68* (0.48, 0.96)	0.72 (0.46, 1.14)	0.84 (0.47, 1.49)
Other	0.82 (0.63, 1.07)	1.18 (0.81, 1.73)	1.42 (0.99, 2.05)	1.23 (0.76, 2.01)
Education (below college as ref.)				
Some college or higher	**0.49*** (0.42, 0.56)	**0.44*** (0.37, 0.54)	**0.39*** (0.33, 0.47)	**0.68** (0.53, 0.87)
W3 Cigarette Use		**14.64*** (12.12, 17.70)	**9.30*** (7.79, 11.10)	

Note. W3 = Wave 3, W4 = Wave 4, W5 = Wave 5, Ref. = reference group. AOR = adjusted odds ratio, CI = confidence interval. *p <.05, **p <.01, ***p <.001.

Table 2
Multiple Regression of Non-Asthma Chronic Disease Predicting Cigarette and E-Cigarette Use for Wave 3 (2001–2002; ages 18–26), Wave 4 (2008; ages 24–34), and Wave 5 (2016–2018; ages 33–44) of the US National Longitudinal Study of Adolescent to Adult Health (Add Health).

	W3 Cigarette Use AOR (95 % CI)	W4 Cigarette Use AOR (95 % CI)	W5 Cigarette Use AOR (95 % CI)	W5 E-Cigarette Use AOR (95 % CI)
W3 Non-Asthmatic Chronic Disease	1.07 (0.93, 1.24)	**1.38*** (1.15, 1.65)	**1.49*** (1.21, 1.84)	1.05 (0.80, 1.37)
Age	0.99 (0.95, 1.03)	**0.92** (0.88, 0.97)	0.98 (0.93, 1.03)	0.98 (0.92, 1.05)
Gender (Female as ref.)	1.07 (0.94, 1.21)	**1.37*** (1.16, 1.62)	**1.33** (1.13, 1.57)	**1.72*** (1.41, 2.11)
Race (non-Hispanic White as ref.)				
Hispanic	**0.47*** (0.37, 0.60)	0.82 (0.63, 1.07)	**0.71* (0.54, 0.92)	**0.63* (0.43, 0.91)
African American	**0.36*** (0.28, 0.46)	1.00 (0.80, 1.26)	**1.41** (1.13, 1.75)	**0.45*** (0.31, 0.65)
Asian	**0.41*** (0.26, 0.65)	**0.70* (0.49, 0.99)	0.75 (0.47, 1.19)	0.77 (0.43, 1.36)
Other	0.82 (0.63, 1.07)	1.16 (0.79, 1.70)	1.40 (0.97, 2.02)	1.09 (0.69, 1.72)
Education (below college as ref.)				
Some college or higher	**0.49*** (0.42, 0.56)	**0.45*** (0.37, 0.55)	**0.40*** (0.33, 0.48)	**0.72** (0.58, 0.91)
W3 Cigarette Use		**14.75*** (12.26, 17.75)	**9.37*** (7.89, 11.14)	

Note. W3 = Wave 3, W4 = Wave 4, W5 = Wave 5, Ref. = reference group. AOR = adjusted odds ratio, CI = confidence interval. *p <.05, **p <.01, ***p <.001.

with chronic disease is important for long term chronic disease management. One study showed that 60 % of adult smokers diagnosed with heart disease and 81 % of those with lung disease did not quit smoking after their diagnoses (Newsom, 2012). Smokers with a chronic disease also smoke more cigarettes per day than those without a chronic illness and report more disability (Schmitz et al., 2007).

In this study we distinguished between asthma and non-asthmatic chronic disease. Our results differed from many previous studies in that the association between asthma and tobacco use was not significant (Fedele, 2016). This could be due to the longitudinal nature of this study compared to many of the other U.S.-based nationally-representative studies which were cross-sectional. This study also examined chronic disease in young adulthood rather than adolescence or later adulthood. Young adulthood poses unique developmental challenges that, paired with the challenges of living with a chronic disease, may influence their risk of tobacco use differently than those significantly older or younger than themselves. Finally, asthma may differ from other chronic diseases included in this study as those with mild asthma symptoms might experience smoking similarly to those without asthma while those with moderate/severe asthma who use a cigarette or e-cigarette get an immediate negative consequence by affecting their ability to breathe. Taking the severity of asthma into account may yield different results.

Use of other tobacco products should also be addressed in future studies with the growing popularity of e-cigarette products and the rising rate of young adults and adults who use more than one tobacco product. A prior study showed that among adult current cigarette smokers, those with a chronic disease were more likely to report e-cigarette use than those without a chronic disease (Kruse et al., 2017).

4.1. Limitations

The assessments between waves were approximately 7 years apart,

which could mean other factors influenced cigarette use not accounted for in this study. Secondly, the composite variable non-asthmatic chronic disease did not distinguish between likely different associations for each of these chronic diseases. Identifying which chronic conditions in young adulthood are associated with long term tobacco use is an important next step. This study was limited in having only one wave of data for e-cigarette use and we did not account for other forms of tobacco use such as smokeless tobacco and little cigars. Finally, the wave 5 assessment of e-cigarettes may underestimate current use as the question was limited to cigarette-like devices and was conducted before widespread use of later generation electronic nicotine delivery devices.

5. Conclusion

In sum, young adults with chronic disease are at greater risk of long-term cigarette use than those without chronic disease. While smoking rates have slowed or plateaued in recent years, examining chronic disease as a risk factor for smoking could also be useful in understanding smoking disparities as lower-educated adults and racial/ethnic minorities smoke at higher rates, have higher rates of chronic disease, and are less likely to make a successful quit attempt (U.S. Department of Health and Human Services, 2014). However, we have little information on cigarette/e-cigarette use and transitions in use across subgroups of adults with chronic disease. Identification of factors associated with long term cigarette or e-cigarette use can be used to target health promotion interventions to vulnerable points in high-risk young adult groups to slow the rate of cigarette use and the progression to long-term regular use.

Author contributions

Marshall Cheney participated in the conceptualization of the study, data analysis, interpretation of findings, and manuscript writing – original draft, review and editing. Yu Lu participated in the conceptualization of the study, data analysis, interpretation of findings, and manuscript review and editing. Hairong Song participated in the conceptualization of the study, data analysis, interpretation of findings, and manuscript review and editing. Shristi Bhochhibhoya participated in the data analysis and manuscript review and editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

Acknowledgments and disclosures

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2023.102473.

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