Published in final edited form as:

Addict Behav. 2018 June ; 81: 78–83. doi:10.1016/j.addbeh.2018.02.008.

E-Cigarette Advertising Exposure in E-cigarette Naïve Adolescents and Subsequent E-Cigarette Use: A Longitudinal Cohort Study

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Abstract

Objective—Electronic (E-) cigarettes are one of the most popular tobacco products used by adolescents today. This study examined whether exposure to advertisements in (1) social networking sites (Facebook, Twitter, YouTube, Pinterest/Google Plus), (2) traditional media (television/radio, magazines, billboards), or (3) retail stores (convenience stores, mall kiosks, tobacco shops) was associated with subsequent e-cigarette use in a longitudinal cohort of adolescents.

Methods—Data were drawn from longitudinal surveys conducted in fall 2013 (wave 1) and spring 2014 (wave 2) of a school-based cohort attending 3 high schools and 2 middle schools in Connecticut. Adolescents were asked about tobacco use behaviors and where they had recently seen e-cigarette advertising at wave 1. We used logistic regression to determine whether advertising exposure at wave 1 increased the odds of e-cigarette use by wave 2, controlling for demographics and cigarette smoking status at wave 1.

Results—Among those who have never used e-cigarettes in wave 1 (n=1,742), 9.6% reported e-cigarette use at wave 2. Multivariate logistic regression demonstrated that exposure to e-cigarette advertising on Facebook (OR 2.12 =p<0.02) at wave 1, but not other venues, significantly increased the odds of subsequent e-cigarette use wave 2. Age, white race, and cigarette smoking at wave 1 also was associated with e-cigarette use at wave 2.

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Conflict of Interest

The authors report no disclosures.

Contributors

Kevin M. Gutierrez wrote the first draft of the manuscript with Deepa Camenga. Deepa Camenga revised subsequent drafts. Suchitra Krishnan-Sarin designed the study, obtained grant funding, and wrote the protocol. Grace Kong, Dana Cavallo, Patricia Simon, and Suchitra Krishnan-Sarin critically reviewed the manuscript.

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Conclusion—This study provides one of the first longitudinal examinations demonstrating that exposure to e-cigarette advertising on social networking sites among youth who had never used e-cigarettes increases the likelihood of subsequent e-cigarette use.

Keywords

electronic cigarette; advertisement; youth

Introduction

The prevalence of lifetime electronic (e-) cigarette use among adolescents in the United States increased nearly 10-fold between 2011 and 2016 (Jamal, et al., 2017). To date, use of e-cigarettes has surpassed use of traditional cigarettes among adolescents. In 2016 11.3 % of high school and 4.3% of middle school students reporting past 30-day use of e-cigarettes, whereas rates of past 3-day traditional cigarette use were 8% and 2.2% respectively (Jamal, et al., 2017). In addition, several studies demonstrate that adolescent report that e-cigarettes are the first tobacco product they ever tried (S. Krishnan-Sarin, Morean, Camenga, Cavallo, & Kong, 2015; Sutfin, et al., 2015). Although this popularity may be due, in part, to the product's novelty and unique features, such as flavors, (Kong, Morean, Cavallo, Camenga, & Krishnan-Sarin, 2015). it is also likely due to effective marketing of the product (Singh, Arrazola, et al., 2016).

E-cigarette advertising expenditures in traditional venues, such as television, print, and radio, increased from 6.4 million dollars in 2011 to 115 million in 2014 (Duke, et al., 2014). As a result of these marketing expenditures, U.S. adolescents have high levels of e-cigarette advertisement exposure, with 7 out of 10 middle and high school students reporting exposure in 2014 (Singh, Agaku, et al., 2016). Cross-sectional studies have shown that adolescents commonly see e-cigarette advertisements in retail stores and on the Internet (Yunji Liang, et al., 2015; Mantey, Cooper, Clendennen, Pasch, & Perry, 2016; Singh, Agaku, et al., 2016).

Although the science on the effects of e-cigarettes is still in its infancy, emerging research suggests that exposure to e-cigarette advertisements may be associated with e-cigarette use. For example, a cross-sectional analysis of the 2014 National Youth Tobacco Survey found that exposure to e-cigarette advertisements on the internet, in retail stores, print media, and TV/movies was associated with an increased odds of ever and current e-cigarette use (Mantey, et al., 2016; Singh, Agaku, et al., 2016). However, to build the empiric evidence base in this area, longitudinal studies are needed to examine whether the advertising exposure precedes subsequent e-cigarette use.

Furthermore, given the popularity of *social networking sites* among youth, and its current lack of regulation in comparison to print, retail or TV advertising, it is also necessary to better understand the role of social networking site advertising on e-cigarette use. E-cigarette advertisements and promotions are present on social networking sites such as Twitter, (Zhan, Liu, Li, Leischow, & Zeng, 2017). YouTube, (Hua, Yip, & Talbot, 2013; Huang, Kornfield, & Emery, 2016; Suchitra Krishnan-Sarin, Morean, Camenga, Cavallo, & Kong, 2014; Paek, Kim, Hove, & Huh, 2013; Romito, Hurwich, & Eckert, 2015) and even Facebook, despite

company-imposed tobacco advertising bans (Emery, Vera, Huang, & Szczypka, 2014). Social networking site advertising is a specific type of online advertising that targets advertising based on user characteristics such as demographics and search histories (Kaplan & Haenlein, 2010; Mangold & Faulds, 2009). A unique aspect of social networking site advertising is that it can generate advertisements that users share with their social network (i.e., peers) to help increase product exposure and customer reach. The tobacco industry and e-cigarette companies use social networking sites to promote their products (Chu, Sidhu, & Valente, 2015; Y. Liang, Zheng, Zeng, & Zhou, 2016; Richardson, Ganz, & Vallone, 2015).

The potential link between advertising exposure and e-cigarette use is not surprising given the well-established association between traditional cigarette advertising exposure and smoking initiation among adolescents (Lovato, Watts, & Stead, 2011). A multitude of longitudinal studies have demonstrated that exposure to television, magazine and point-of-sale advertising (e.g., convenience stores, liquor stores, grocery stores) is associated with cigarette smoking initiation in adolescents (Lovato, et al., 2011). Overall, there is strong empirical evidence that tobacco companies' advertising practices affect cigarette smoking initiation by promoting awareness of smoking, awareness of particular brands, the recognition and recall of cigarette advertising, positive attitudes about smoking, and intentions to smoke (U.S. Department of Health and Human Services, 2012).

Thus, the primary aim of this study was to use longitudinal data collected from middle and high schools in CT to examine whether baseline (wave 1) exposure to e-cigarette advertisements (on social networking sites, traditional media, and in retail stores) was associated with subsequent e-cigarette use at wave 2 among adolescents without a history of using e-cigarettes. We measured specified advertisements within each advertising category including social networking sites: (1) Facebook, (2) Twitter, (3) YouTube, (4) Pinterest, (5) Google Plus; traditional media locations: (1) television/radio, (2) billboards, (3) magazines; and retail stores (point-of-sale locations): (1) convenience stores, (2) mall kiosks, (3) tobacco shops. Given the existing longitudinal studies of cigarette use, and studies linking e-cigarette advertising exposure to positive e-cigarette attitudes, (Reinhold, Fischbein, Bhamidipalli, Bryant, & Kenne, 2017) we hypothesized that exposure to e-cigarette advertisements at wave 1 would increase the likelihood of e-cigarette use at wave 2 among never e-cigarette users. Given the popularity of social networking sites among youth, we also hypothesized that social networking site advertisements types (e.g., Facebook) would be associated with subsequent e-cigarette use.

Methods

Study procedures

All study procedures were approved by the Yale Institutional Review Board and the participating schools. Survey responses were confidential and anonymous. All students were informed that their participation was voluntary. Information sheets were mailed to parents in advance of the study, and parents were instructed to contact the research staff if they did not want their child to participate. No parents from wave 1, and 12 parents from wave 2 declined participation for their child. Survey administration followed the same procedures outlined elsewhere (Bold, Kong, Cavallo, Camenga, & Krishnan-Sarin, 2016a, 2016b).

Data were obtained from anonymous school-wide surveys that were repeated in two middle schools and three high schools in fall 2013 and spring 2014. Surveys were matched across time points using a self-generated identification code (McGloin, Holcomb, & Main, 1996; Yurek, Vasey, & Sullivan Havens, 2008) comprised of six unique indicators: first letter of middle name, second letter of last name, day value from date of birth, school, homeroom, and sex. This method has been used in other longitudinal studies where preserving anonymity is important, such as collecting data on youth substance use (McGloin, et al., 1996; Yurek, et al., 2008). Full details of the matching procedure are outlined in our previous work (Bold, et al., 2016a, 2016b).

The match rate of our sample was 72.0%, representing $n=2100$ students out of $n=2915$ who provided data at both wave 1 and wave 2 surveys. This match rate is comparable to other anonymous longitudinal surveys (Yurek, et al., 2008). Sample characteristics at wave 1 were compared between the matched and un-matched sample. Match rates were slightly higher among female (77.7%) vs. Male students (71.0%; $p<.001$). The matched sample was also slightly younger ($M=14.4$, $SD=1.9$), than the unmatched sample ($M=14.6$, $SD=2.0$; $p=.007$). Although these values are significantly different, the actual differences are quite small and were not considered to be meaningful. The full matched sample ($n=2100$) was 53.0% female, 66.4% were high school students, and the average age was 14.4 ($SD=1.9$). Schools' socioeconomic status (SES) was characterized by their District Reference Group, which are school groupings rated A through I based on indicators of socioeconomic status, parental education and financial need (CT Voices for Children, 2006). Overall, 49.2% of the matched sample was from a higher SES (DRG B) school and 50.8% from a lower SES school (DRG D and E).

Participants

A subset of participants from the matched sample, those without a history of using e-cigarettes at wave 1, were selected from the dataset for subsequent analyses ($n=1,742$). This sample subset was 53.9% female and the mean age was 14.06 ($SD=1.90$). This sample was 88.1% white, 5.8% Asian, 4.9% Hispanic, 3.1% black, 1.4% American Indian, 0.8% Middle Eastern, 0.4% Pacific Islander, and 0.2% "other" ethnicity.

Measures

Ever E-cigarette use—At wave 1 and 2, lifetime e-cigarette use was determined by (yes/no) response to the question, *"Have you ever tried e-cigarettes?"*

E-cigarette use was assessed longitudinally by examining the proportion of those who had never tried e-cigarettes (i.e., never e-cigarette users) at wave 1 but reported trying an e-cigarette at wave 2. Specifically, subsequent e-cigarette use at wave 2 was defined as reporting "no" to the question *"Have you ever tried e-cigarettes?"* at wave 1 and answering "yes" at wave 2.

Ever Cigarette use—Cigarette use was assessed at wave 1 with the following item: *"How old were you when you first tried a cigarette?"* Never smokers were defined as respondents

who indicated, “*I never smoked even just 1 or 2 puffs*”, whereas lifetime cigarette smokers were defined as respondents who provided an age to the open-ended response option.

E-cigarette advertisement exposure—Exposure to advertisements was assessed at wave 1 using the following item: “*Where have you recently seen advertisements?*” For e-cigarettes, response options included locations on social networking sites: (1) Facebook, (2) Twitter, (3) YouTube, (4) Pinterest, (5) Google Plus; traditional media locations: (1) television/radio, (2) billboards, (3) magazines; and point-of-sale locations: (1) convenience stores, (2) mall kiosks, (3) tobacco shops. Respondents could also choose (1) I did not see any and (2) other. Responses to Google Plus or Pinterest were collapsed into one category to improve cell sizes.

Data analysis

Analyses were restricted to those who did not report lifetime e-cigarette use at wave 1 (n=1,742). Chi-square and Fisher’s exact tests were used to assess bivariate associations. Logistic regression analyses were conducted to examine the association between each type of e-cigarette advertisement exposure at wave 1 on subsequent e-cigarette use at wave 2. To control for known predictors of e-cigarette use, covariates included age, race (white vs. other race) gender, and cigarette smoking status at wave 1 (Chaffee, Couch, & Gansky, 2017). Proc survey logistic procedures were conducted with SAS v.9.3 (Cary, NC) to account for clustering by school and $p < 0.05$ was considered statistically significant.

Results

Among this cohort of 1,742 never e-cigarette users, exposure to e-cigarette advertisements varied considerably (see Table 1). Adolescents most frequently reported seeing e-cigarette advertisements at convenience stores (33.4%), on TV/radio (29.2%) and in magazines (19.4%). Overall, 9.6% of the sample of e-cigarette never-users at wave 1 reported subsequent e-cigarette use by wave 2. Those who have reported ever e-cigarette use at Wave 2 were more likely to be in high school relative to middle school, and older (mean age 14.9 vs. 14.0; $p < 0.001$). No gender or ethnic differences (white vs. other race) were found with respect to e-cigarette use at wave 2. A larger proportion of adolescents who tried e-cigarettes by wave 2 (vs. those who did not report e-cigarette use) reported seeing e-cigarette advertisements on social networking sites, convenience stores, and tobacco shops at wave 1 ($p < 0.001$). These groups did not differ in their exposure rates for TV/radio, magazines or billboards.

The logistic regression model (Table 2), which examined the individual effect of e-cigarette advertisement exposure on subsequent e-cigarette use, revealed that exposure to e-cigarette advertising on Facebook (OR= 2.20, $p < .01$) at wave 1 significantly increased the odds of e-cigarette use at wave 2. The covariates of age, race, and cigarette smoking status at wave 1 were also associated with e-cigarette use at wave 2.

Discussion

This longitudinal cohort study examined the association between exposure to e-cigarette advertisements and subsequent e-cigarette use. Notably, among never e-cigarette users at wave 1, 9.6% of adolescents reported e-cigarette use at wave 2. Exposure to e-cigarette advertisements on Facebook increased the likelihood of subsequent use, controlling for age, gender, race, and cigarette smoking status at wave 1. However, given that only 7.6% of the sample reported exposure to Facebook advertising at wave 1, our findings do not allow us to make firm conclusions as to whether there are unique aspects of Facebook, rather than social networking sites in general, that influence subsequent e-cigarette use. However, this longitudinal study is one of the first to establish that exposure to advertisements among e-cigarette naïve adolescents both precedes and increases the likelihood of subsequent e-cigarette use.

Overall, adolescents' exposure to e-cigarette advertisements is very common. Our findings demonstrate that, like past research, the principle source of e-cigarette advertisement exposure is at retail stores. For example, the 2014 National Youth Tobacco Survey (NYTS) revealed that 53.6% of e-cigarette non-users had seen e-cigarette advertisements at retail stores (Singh, Agaku, et al., 2016). When combining rates of e-cigarette advertising at various physical locations observed in the present study (convenience stores, mall kiosks, tobacco shops), 37.8% had seen advertisements in these locations. The 2014 NYTS study also reported that 36.9% of e-cigarette non-users had seen e-cigarette advertising on the internet in general (Singh, Agaku, et al., 2016). We specifically queried about social networking site advertising, a specific type of online advertising that uses social networking websites. A unique aspect of social networking sites advertising is that it can generate ads that users share with their social network (i.e., friends) to help increase product exposure and customer reach. Overall, 15.4% of our sample had seen e-cigarette advertisements on social networking sites. The estimates from this study are most likely lower than those noted in the NYTS because we queried about specific types of stores and internet sites (social networking sites), and students completing the NYTS may have seen advertising in store and online locations that were not measured in our survey.

Social networking sites advertisement exposure could influence subsequent e-cigarette use through various psychosocial factors. For example, factors such as boredom, sensation-seeking, or impulsivity could be the driving force predisposing individuals to spend more time on social networking sites (which may increase exposure to e-cigarette advertisements and/or increase e-cigarette use). Alternatively, adolescents who have friends who use e-cigarettes may be more likely to see e-cigarette advertisements via social networking sites via peer endorsement from "shares" or "likes", which may be a marker of peer influence (Barrington-Trimis, et al., 2015). Similarly, social networking sites advertising may depict e-cigarettes in a positive light and create the perception that use of e-cigarettes is normative and, hence, may predispose individuals to experiment with e-cigarettes. Lastly, exposure to e-cigarette advertisements may be a function of interest in or curiosity about e-cigarettes as social networking site advertisements may be linked to users' search histories.

The absence of an association between television/radio advertisements and e-cigarette use is noteworthy. One potential explanation is that this type of advertising is ubiquitous and requires less willful engagement as compared to internet/store exposure; TV/radio advertising does not require an individual to have a certain online search history or to frequent certain stores. Alternatively, adolescents may be increasingly spending more time watching television shows and other traditional media on their laptops, tablets, and other electronic devices and spending less time watching television shows on their television sets. Commercials viewed while “streaming” television shows and programs often differ in content when compared to watching television shows and programs on television sets. Hence, there may be less e-cigarette advertising while streaming versus while viewing television commercials in a more traditional manner; although this is an empirical question that future research may wish to address. In addition, adolescents may be more inclined to listen to internet radio (e.g., SiriusXM, Pandora), as opposed to traditional radio, which also may differ in promotional e-cigarette content relative to traditional radio. Advertisements on internet radio may also contain less e-cigarette promotional content. Again, this is an empirical question that future research may wish to address.

Of note, cigarette smoking at wave 1 was strongly associated with e-cigarette use at wave 2. Studies of adult and adolescent smokers indicate that cigarette smoking is cross-sectionally associated with e-cigarette use (Wang, Wang, Cao, Wang, & Hu, 2016; Vardavas, Filippidis, & Agaku, 2015). Further, a recent meta-analysis of 9 longitudinal studies of 17,389 adolescents and young adults also indicated that e-cigarette use is associated with subsequent cigarette smoking (Soneji, et al., 2017). However, our current findings are independent of cigarette smoking since we observed that e-cigarette advertising exposure via social networking sites is independently associated with subsequent e-cigarette use, even after adjustment for cigarette smoking.

This study has several limitations. Survey data were drawn from middle school and high schools in CT which may not generalize to other adolescents in other areas of the United States or internationally. This study did not explore whether advertisement exposure was associated with frequency of e-cigarette use, and future research is needed to better understand how advertising impacts e-cigarette use trajectories. An additional limitation of concern is that adolescents who are curious about using e-cigarettes may be more likely to report seeing advertisements at various locations. As such, memory of advertisements may, in part, be a function of interest in e-cigarettes. Furthermore, individuals with family or friends who use e-cigarettes may be more likely to be exposed to advertisements, and future studies should examine how family and peer use of e-cigarettes influences subsequent use. Other limitations are related to the ever-changing landscape of social networking trends as different social networking sites may be more influential than others and advertising in other potentially-influencing venues (e.g., vape shops, festivals, expos) may also contribute to e-cigarette use. Thus, future research should investigate the impact of additional social networking sites on e-cigarette use, such as Instagram and Snapchat. Relatedly, these data do not allow us to ascertain why Facebook exposure, rather than other social networking sites, was associated with e-cigarette use at wave 2, and future research is needed to better understand why certain sites may be more influential than others.

Future research should expand on the present study by examining the “dosage” or frequency with which adolescents are exposed to e-cigarette social networking sites advertisements. Lastly, an in-depth examination of adolescents’ perceptions about the content of e-cigarette advertisements would shed much-needed light on what e-cigarette advertisements adolescents find convincing.

Conclusions

This study provides one of the first longitudinal examinations demonstrating that exposure to e-cigarette advertising on social networking sites among adolescent never users of e-cigarettes increases the likelihood of subsequent e-cigarette use. Future studies are needed to replicate these findings in larger samples and determine how social networking sites with e-cigarette advertising may cause e-cigarette use in youth. Our findings suggest that advertising exposure potentially influences e-cigarette use behaviors in youth, and that advertising regulations may be a target for primary prevention. This emerging body of research will help inform tobacco regulation policies that target e-cigarette advertising in an effort to protect public health.

Acknowledgments

Role of Funding Sources

Funding for this study was provided by grants to Dr. Krishnan-Sarin through the National Institutes of Health (NIH)/National Institute on Drug Abuse (NIDA) grants P50DA009241 and P50DA36151 (Yale TCORS). Dr. Simon’s efforts were supported by T32DA019426 and L40DA042454. Dr. Gutierrez’s effort was supported T32 DA19426. Drs. Camenga and Kong’s efforts were also supported by K12DA033012, CTSA grants UIR000142, and K12 TR000140 from the National Center for Advancing Translational Science (NCATS), Components of the NIH, and NIH Roadmap for Medical Research. Dr. Kong’s effort was also supported by National Center on Addiction and Substance Abuse at Columbia University (CASA Columbia). Grant agencies had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

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Highlights

- E-cigarette advertising is present in multiple venues.
- We examined data from a longitudinal cohort of adolescents.
- Exposure to advertisements on Facebook was associated with subsequent e-cigarette use.

Table 1

Sample Characteristics by E-cigarette Use Status at Wave 2

Variable	Total	Subsequent E-cigarette Use at Wave 2				p
	n=1742	Yes n=168,	Yes 9.6%	No 1574,	No 90.4%	
Demographics						
Age at Wave 1, Mean (SD)	14.08	0.8%	[1.45]	13.99	[1.93]	<0.001
School Status, n (%)						<0.001
Middle School	682	39.2%	27	16.1%	655	41.6%
High School	1060	60.8%	141	83.9%	919	58.4%
Gender, n (%)						0.4
Female	943	54.1%	96	57.1%	847	53.8%
Male	799	45.9%	72	42.9%	727	46.2%
Race, n (%)						0.05
White	1533	88.0%	140	83.3%	1393	88.5%
Other Race	209	12.0%	28	16.7%	181	11.5%
Cigarette Smoking Status at Wave 1, n (%)						<0.0001
Ever- smoker	35	2.0%	15	8.9%	20	1.3%
Never Smoker	1707	98.0%	153	91.1%	1554	98.7%
Exposed to Advertisement at Wave 1, n (%)						
<i>Social Networking Sites</i>						
YouTube	151	8.7%	27	16.1%	124	7.9%
Facebook	133	7.6%	31	18.5%	102	6.5%
Twitter	118	6.8%	25	14.9%	93	5.9%
Pinterest/Google Plus	50	2.9%	18	10.7%	44	2.8%
<i>Any Social Networking Site</i>	268	15.4%	50	29.8%	218	13.9%
<i>Traditional Media</i>						
Television/Radio	509	29.2%	50	29.8%	459	29.2%
Magazines	338	19.4%	38	22.6%	300	19.1%
Billboards	183	10.5%	23	13.7%	160	10.2%

Variable	Total n=1742		Subsequent E-cigarette Use at Wave 2				p
			Yes		No		
			n=168,	9.6%	1574,	90.4%	
<i>Any Traditional Media Site</i>	674	38.7%	66	39.3%	608	38.6%	.8
<i>Retail Stores</i>							
Convenience stores	582	33.4%	78	46.4%	504	32.0%	0.0002
Mall kiosks	258	14.8%	31	18.5%	227	14.4%	0.2
Tobacco Shops	226	13.0%	32	19.0%	194	12.3%	0.01
Any retail store	659	37.8%	82	48.8%	577	36.7%	.002

Table 2

Associations between Advertisement Exposure at wave 1 and E-cigarette Use at Wave 2

Advertisement Exposure at wave 1	OR	95% CI		p-value
<i>Social Networking Sites</i>				
Facebook	2.20	(1.37	-- 3.52)	0.001
Twitter	1.23	(0.82	-- 1.84)	0.33
YouTube	1.28	(0.53	-- 3.09)	0.58
Pinterest/GooglePlus	1.30	(0.54	-- 3.13)	0.55
<i>Traditional Media</i>				
TV/radio	0.85	(0.43	-- 1.69)	0.64
Magazine	0.88	(0.59	-- 1.30)	0.51
Billboard	1.01	(0.45	-- 2.26)	0.98
<i>Retail Stores</i>				
Mall	1.73	(0.98	-- 3.06)	0.06
Convenience Stores	0.91	(0.38	-- 2.15)	0.82
Tobacco shops	0.80	(0.47	-- 1.36)	0.41
Covariates				
<i>Demographics</i>				
Age	1.28	(1.05	-- 1.57)	0.02
Male vs. Female	1.21	(1.00	-- 1.47)	0.05
White vs. Other Race	0.60	(0.44	-- 0.81)	0.001
<i>Cigarette Smoking Status at wave 1</i>				
Ever cigarette smoker (yes vs. no)	4.61	(2.97	-- 7.16)	<.0001

Overall fit of logistic regression model: c-statistic: 0.771. Likelihood Ratio Test χ^2 (15) 84.46, p<0.0001.