National Institute on Drug Abuse

TAMB

Applying Social Network Theory to Vaping in High School: Implications for School-Based Prevention Programs

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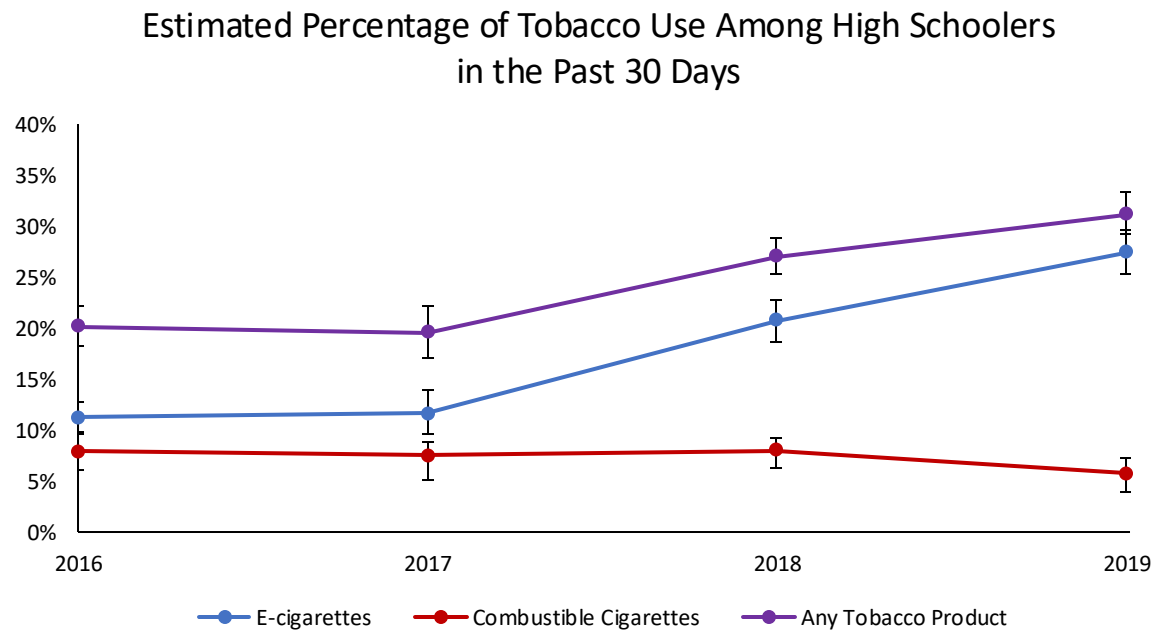
Intro: E-cigarette Epidemic Among Youth

From 2016-2019, high schoolers using:

- Combustible cigarettes dropped from 8% to 5.8%
- E-cigarettes increased from 11.3% to 27.5%



Cullen, K. A., Gentzke, A. S., Sawdey, M. D., Chang, J. T., Anic, G. M., Wang, T. W., … King, B. A. (2019). e-Cigarette Use among Youth in the United States, 2019. *JAMA - Journal of the American Medical Association*. https://doi.org/10.1001/jama.2019.18387

Adolescent Vulnerability to the E-cigarette Switch

Intrapersonal

- Age/Grade-Level, Gender, School Performance, Economic Status

Interpersonal

- Family Conflict, Peer Influence

Contextual

- Region-dependent minimum age to purchase tobacco products

Perceptions

- Healthier and easier to use discreetly than combustible cigarettes

Marketing geared towards adolescents

- Celebrities, cartoons, sexual appeal, social status

Perikleous EP, Steiropoulos P, Paraskakis E, Constantinidis TC, Nena E. (2018). E-Cigarette Use Among Adolescents: An Overview of the Literature and Future Perspectives. *Front Public Health*, 6(86). doi:10.3389/fpubh.2018.00086

Social Network Analysis

- Explanation of behaviors in the context of social ties
- Computationally model positions and tie strengths
- Maladaptive behaviors can spread through a network
  - Applicable to health: obesity and smoking

Why the Social Influence Model?

1) Peer influence on risky behavior is especially potent in adolescence[1]
2) A similar model has proved effective for adult smoking networks[2]

Apply well-established methodology to the age-group most prone to social influence

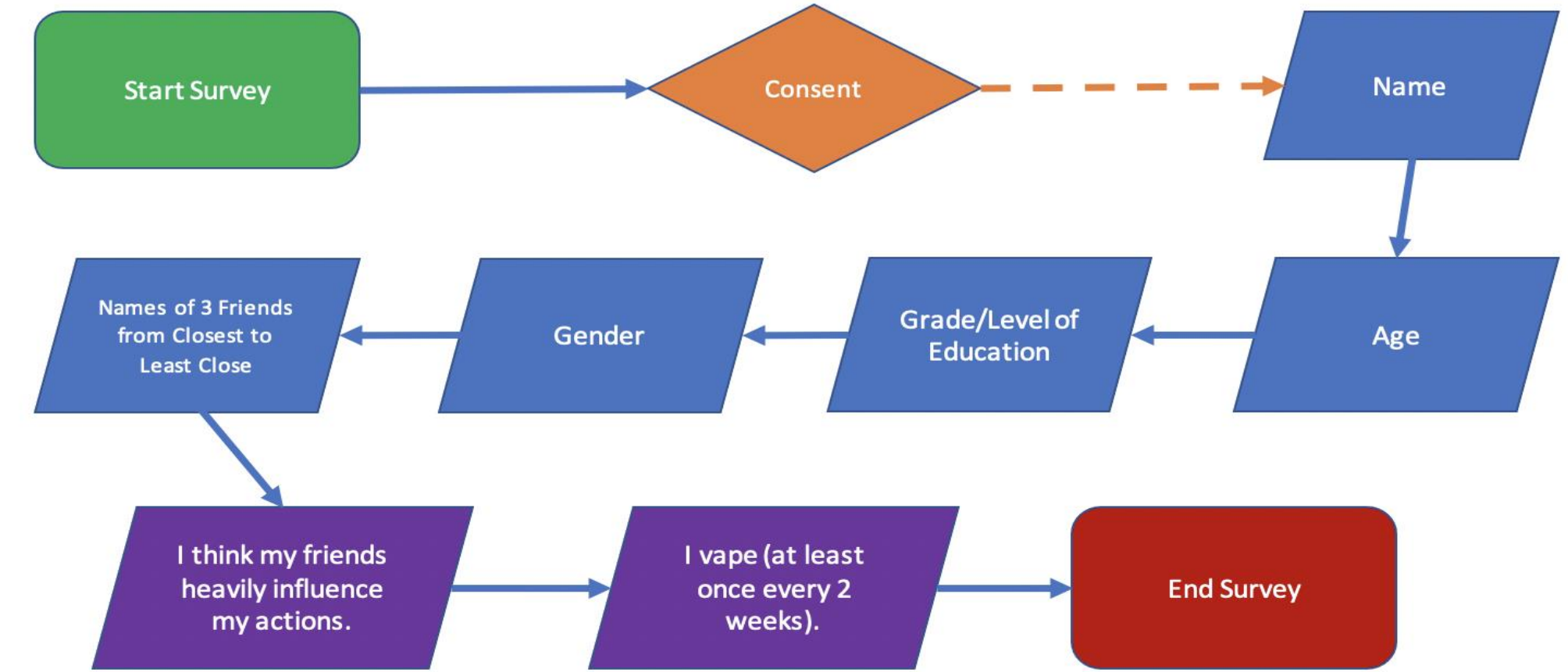
1. Gardner, M., & Steinberg, L. (2005). Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: An experimental study. *Developmental Psychology*. https://doi.org/10.1037/0012-1649.41.4.625

2. Christakis, N. A., & Fowler, J. H. (2008). The collective dynamics of smoking in a large social network. *The New England Journal of Medicine, 358*(21), 2249–2258. https://doi.org/10.1056/NEJMsa0706154

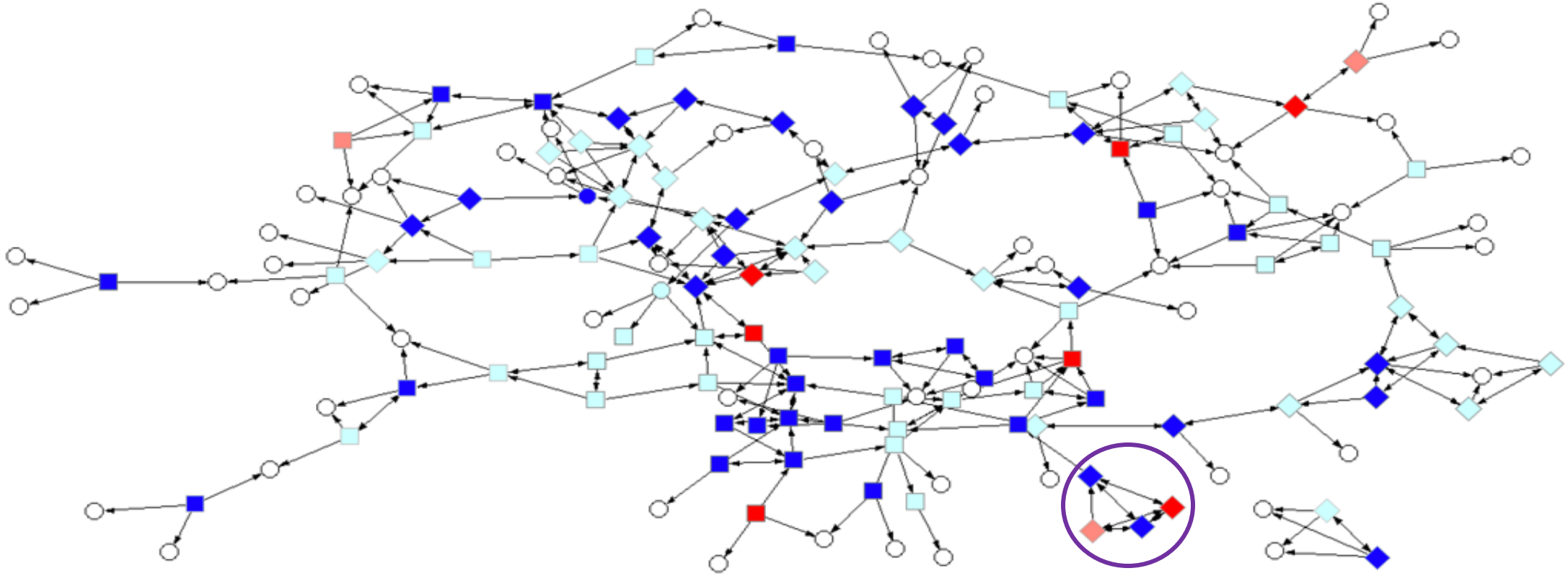
Hypothesis

High schoolers who vape will be tied to friends who also vape and exhibit low centrality in their social networks.

Survey Question Flowchart



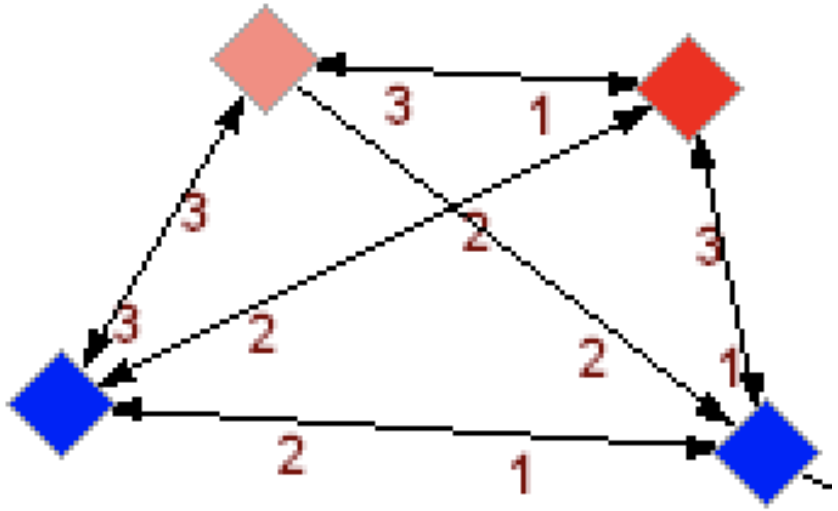
Prevalence of Vaping in a High School Network



Diamond: female Square: male White circle: student who did not respond but was listed as a friend by a respondent

Dark Blue: do not vape and believe they are influenced by peers Cyan: do not vape and believe they are not influenced

Bright Red: vape and believe they are influenced Light Mango: vape and believe that they are not influenced



Closed Network of Female High Schoolers

- Closed network: isolated group in which members rarely connect to others outside of the group
- Less affected by alternative influences from weakly connected friends outside of the in-group[1]

1 Ellwardt, L., Wittek, R. P. M., Hawkley, L. C., & Cacioppo, J. T. (2019). Social Network Characteristics and Their Associations With Stress in Older Adults: Closure and Balance in a Population-Based Sample. *The Journals of Gerontology: Series B*. https://doi.org/10.1093/geronb/gbz035

Average Number and Strength of Ties

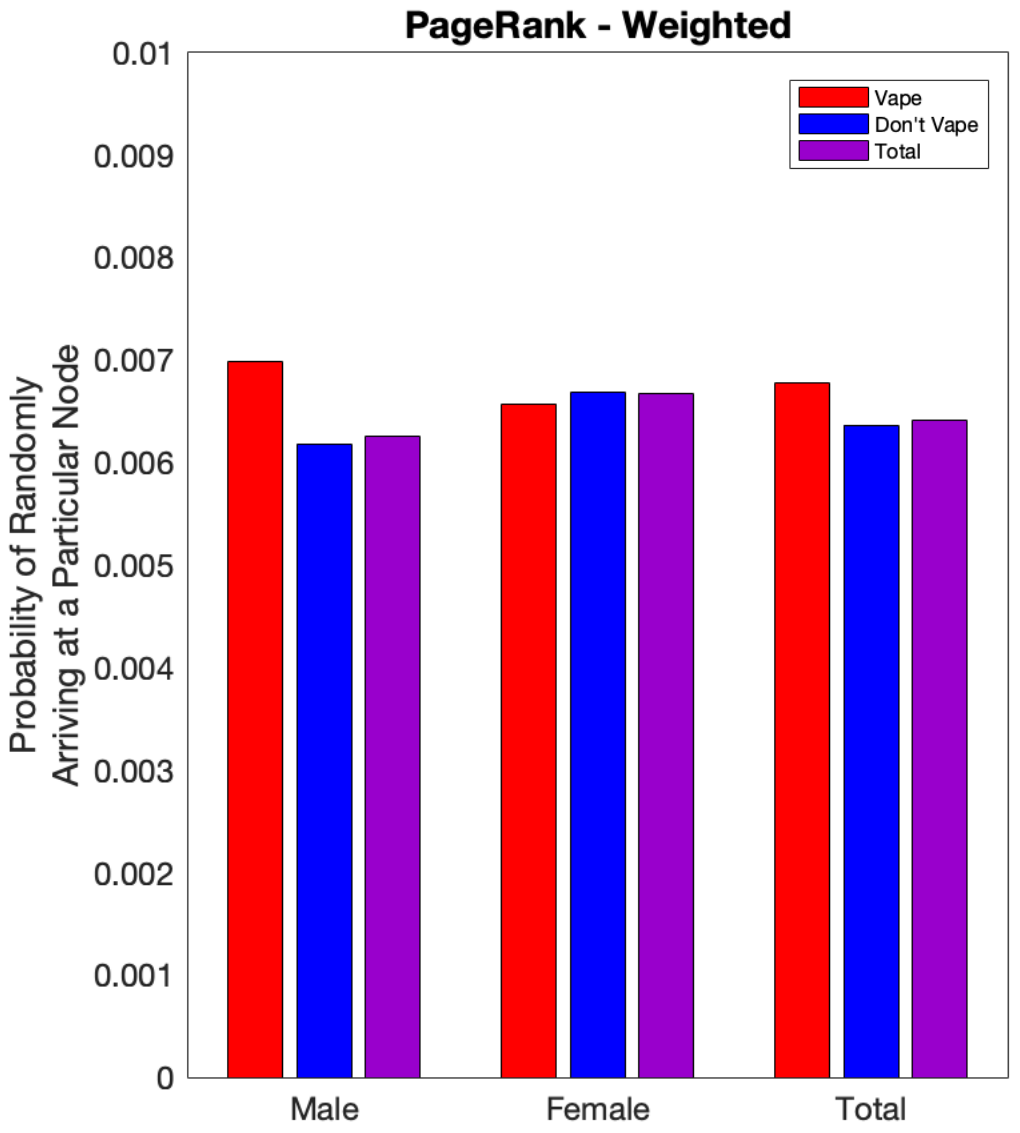
- Quantifies local centrality
- Female high schoolers who vape exhibit above average number and strength of ties.
- Gender-based differences may be more significant than anticipated.

AVERAGE NUMBER OF TIES	MALE	FEMALE	TOTAL
VAPE	1.6	2.2	1.9
DON'T VAPE	1.71	2.1	1.88
TOTAL	1.7	2.11	1.88

AVERAGE TIE STRENGTH	MALE	FEMALE	TOTAL
VAPE	1.2	1.8	1.5
DON'T VAPE	1.33	1.5	1.4
TOTAL	1.32	1.53	1.41

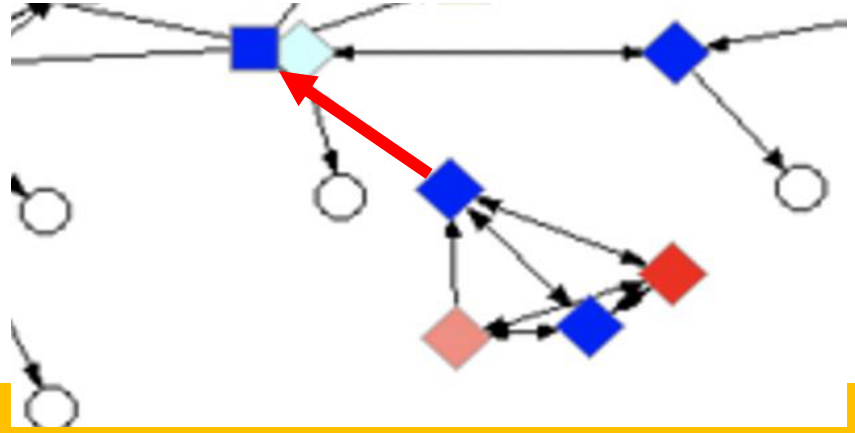
PageRank

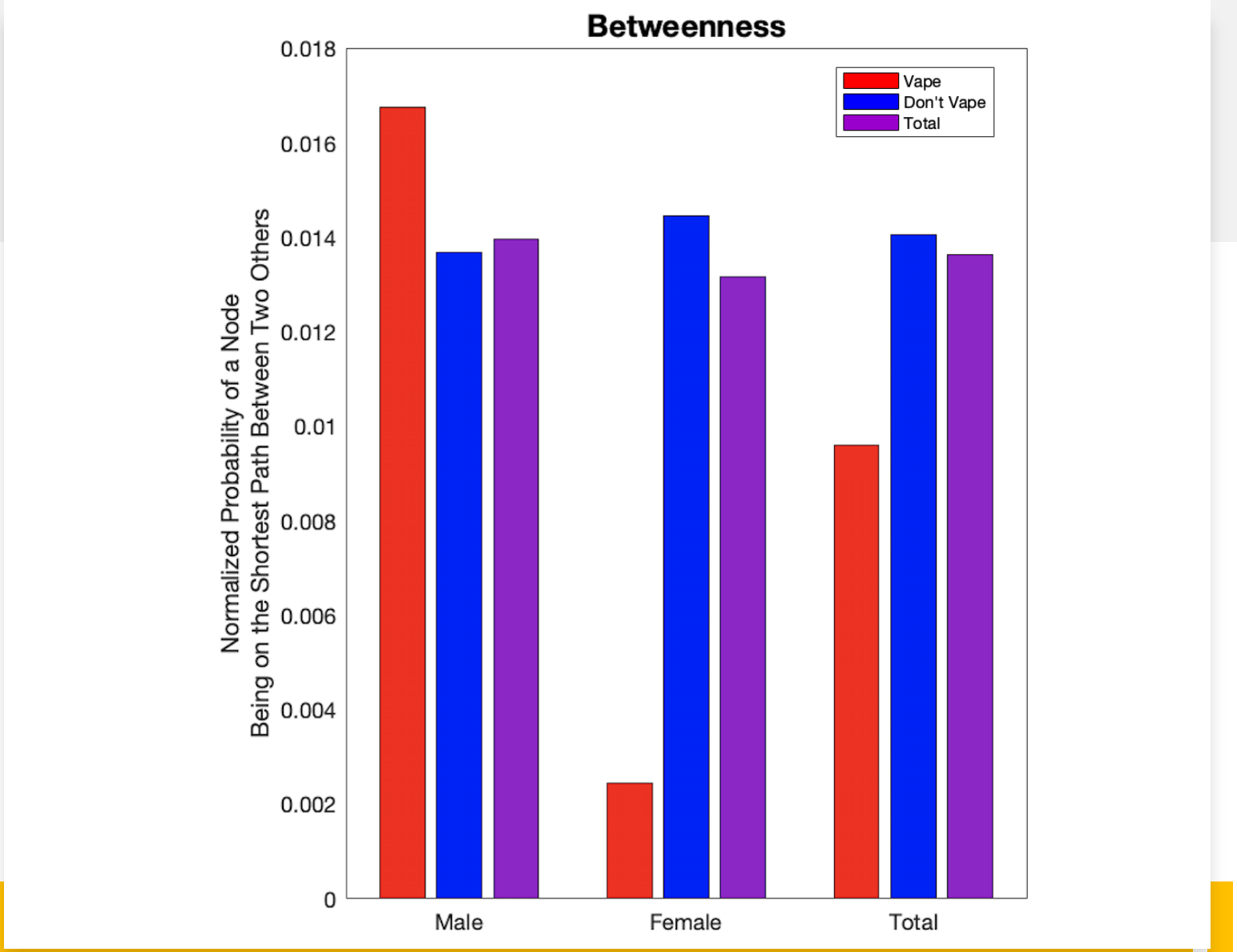
- Describes wide-reaching influence and importance in the network on a macro-scale
- Likelihood that a person randomly clicking on links will arrive at a particular page



Betweenness

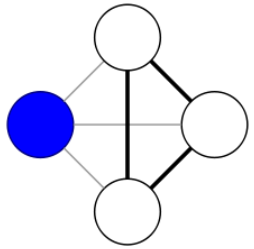
- Importance as an intermediary
- Probability that a node lies on shortest path between others





Clustering Coefficient

- How tightly knit, characterized by a relatively high density of ties
- Fraction of pairs of node's ties that are tied to each other



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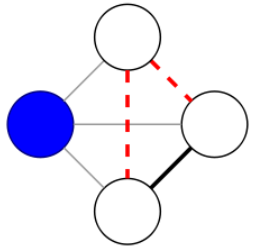
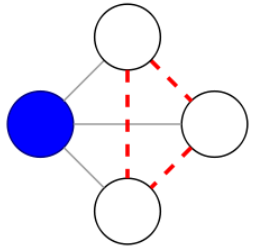
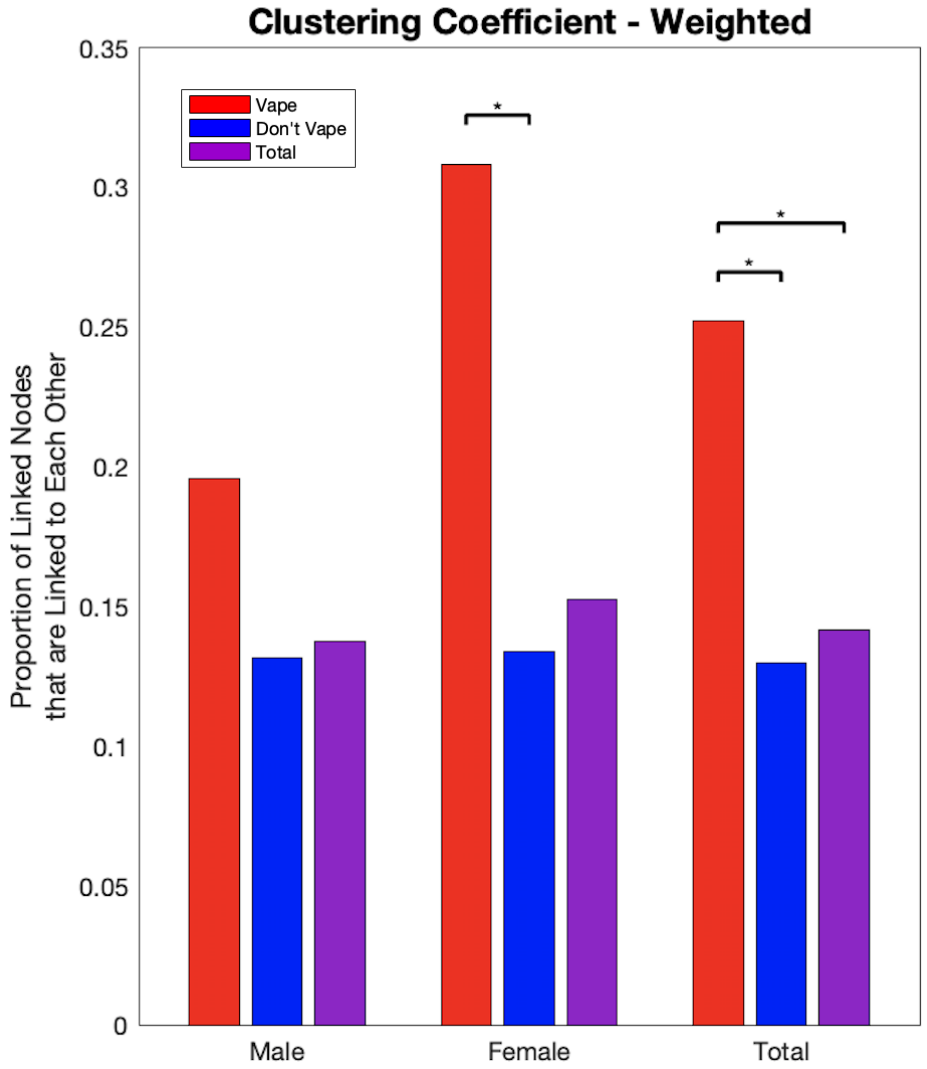


c = 1/3



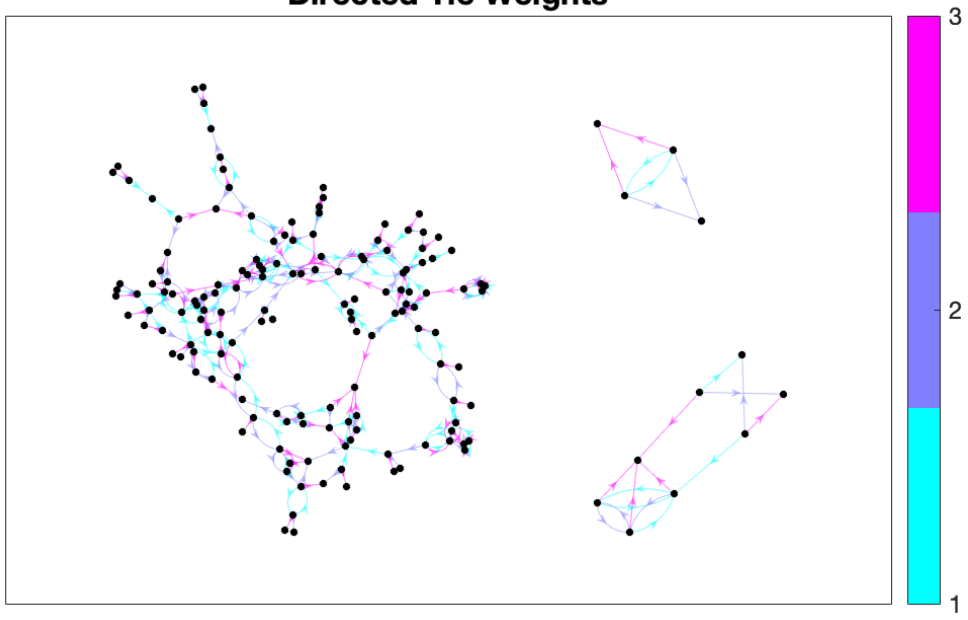
c = 0

https://en.wikipedia.org/wiki/Clustering_coefficient

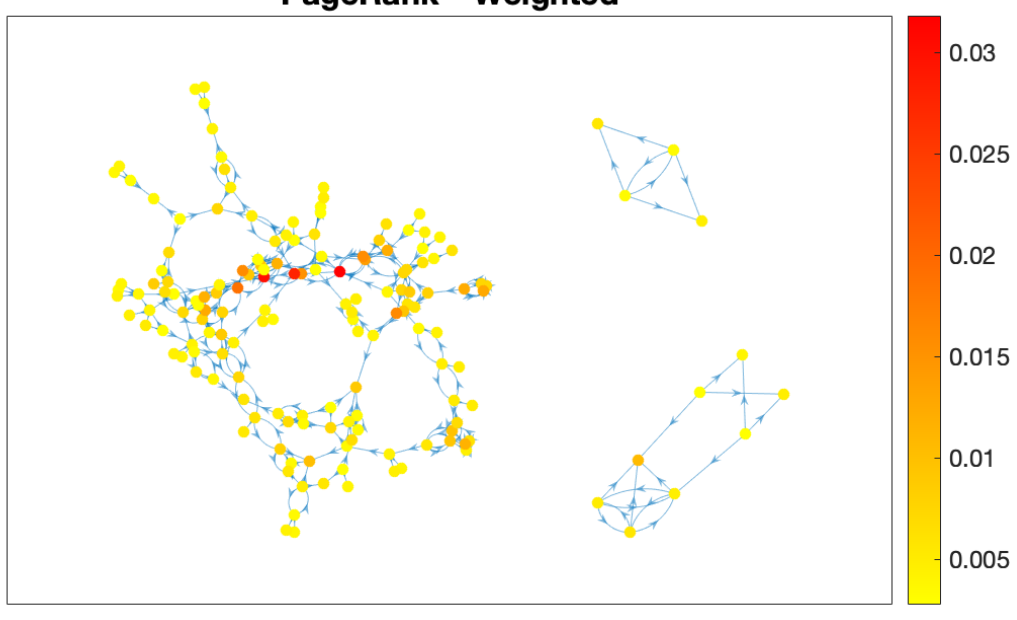


* $p < 0.05$

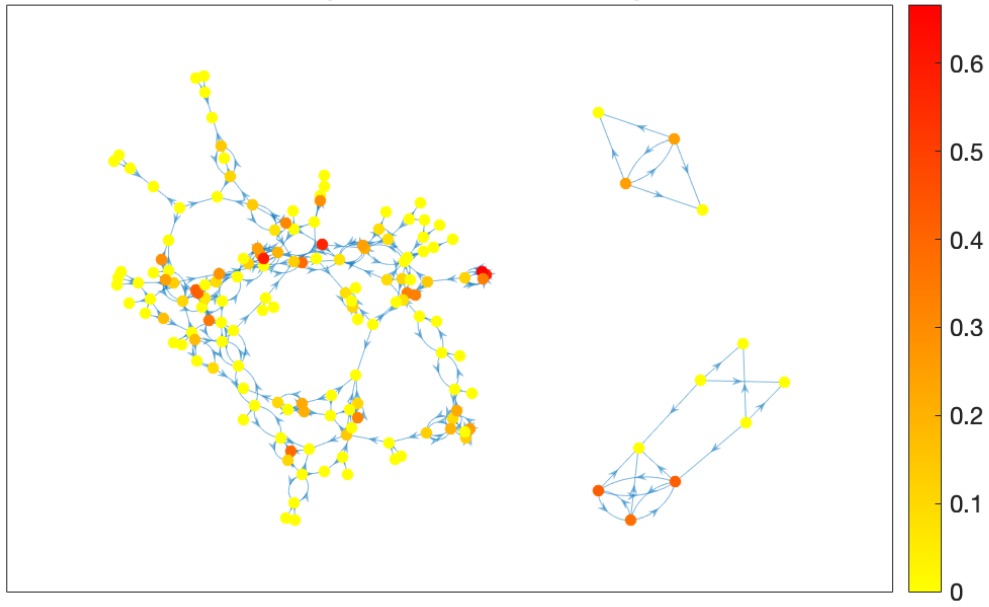
Directed Tie Weights



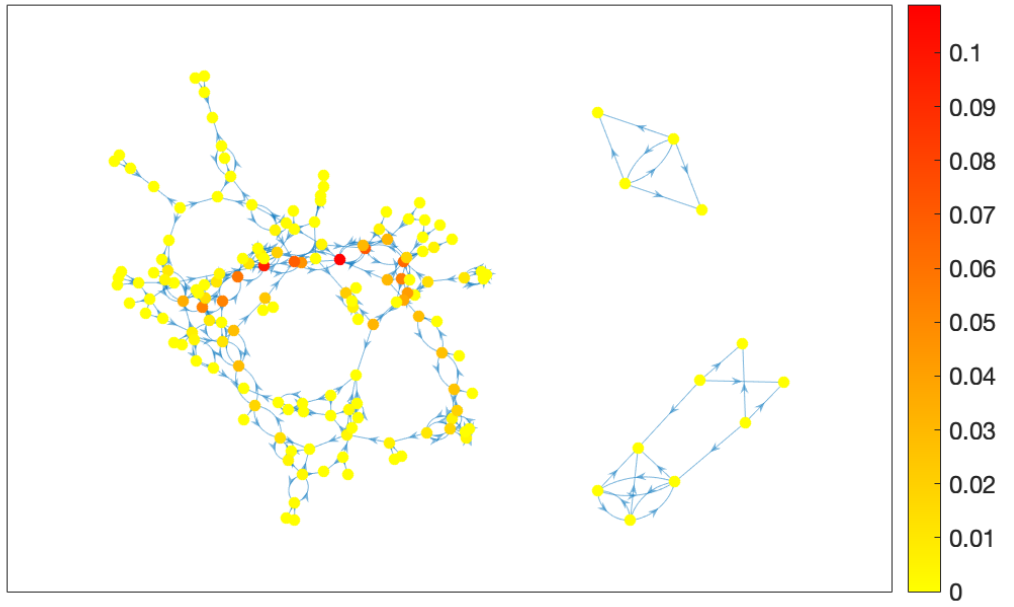
PageRank – Weighted



Clustering Coefficients – Weighted



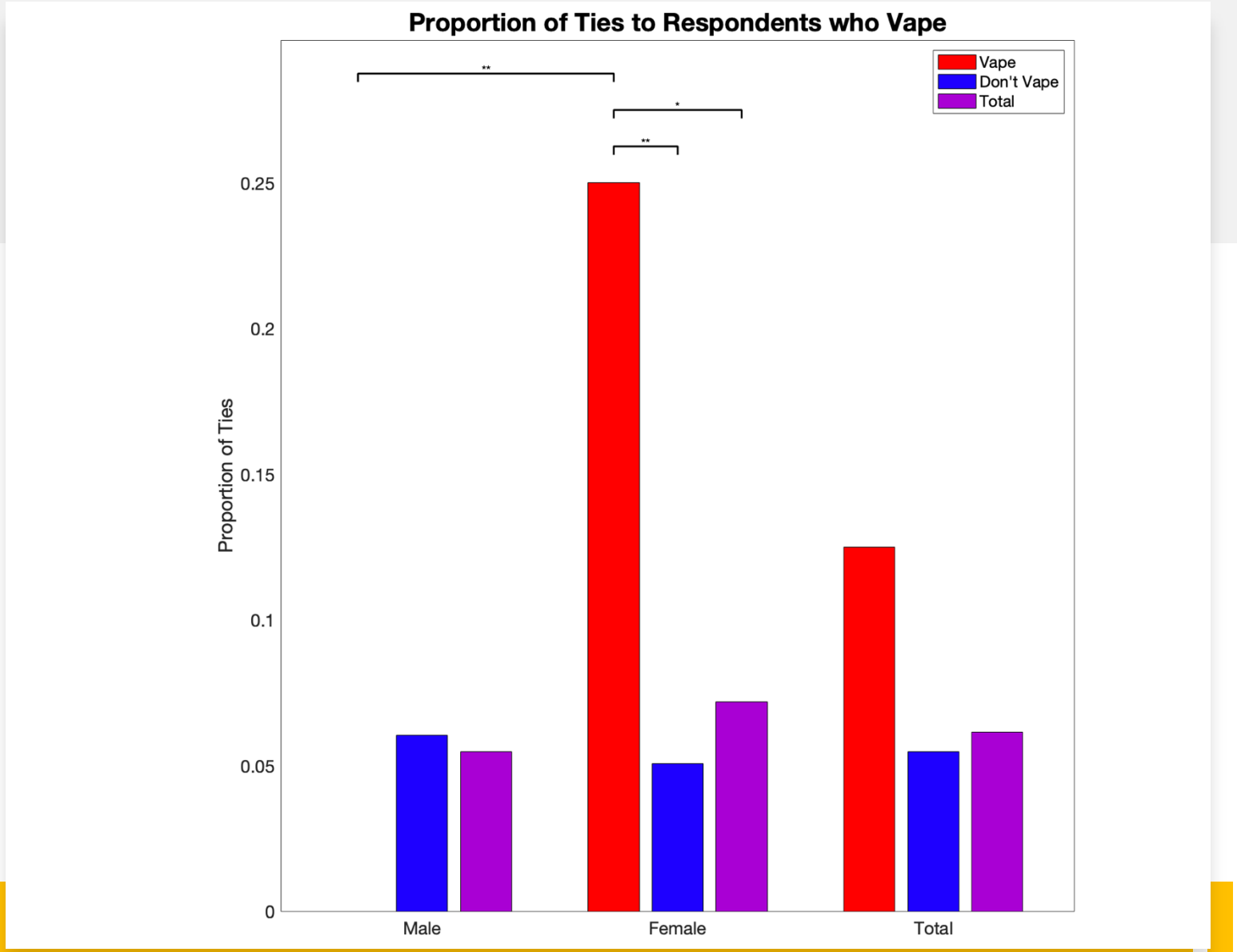
Betweenness Centrality Scores



Homophily Among Female Students who Vape

- “Birds of a feather flock together.”
- The proportion of ties to students who vape is highest among females.

* p < 0.05, ** p < 0.01



Takeaways

- Confirms high response rates for school-based surveys
- High schoolers who vape may not be entirely peripheral at first glance but may nevertheless be loosely tied to the rest of the network.
- Females who vape are more often than females who don’t vape to be tied to other students who vape.
- Targeting egos and their ties in close-knit female networks may produce a more profound effect than in male networks.
  - Group-oriented vs individual-oriented solutions

JOHNS HOPKINS UNIVERSITY RESEARCH PARTICIPANT INFORMED CONSENT FORM

Study Title: Peer Influence on Vaping in High Schools

Application No.: HIRB00012211

Funded By: Johns Hopkins University Provost Undergraduate Research Award

Principal Investigator: Dr. Andrew Cherlin
Johns Hopkins University Department of Sociology
cherlin@jhu.edu, 410-516-2370
3400 N. Charles St. Baltimore, MD 21218. Mergenthaler Hall 556

You are being asked to join a research study. Participation in this study is voluntary. Even if you decide to join now, you can change your mind later.

1. Research Summary (Key Information)
The information in this section is intended to be an introduction to the study only. Complete details of the study are listed in the sections below. If you are considering participation in the study, the entire document should be discussed with you before you make your final decision. You can ask questions about the study now and at any time in the future.

This research project collects data by surveying high school seniors who are 18 years old or older. You are asked for your name, the names of up to seven of your closest friends who are also 18+ year old seniors in your high school, whether you vape or not, and basic demographic information, such as gender. Despite asking for names, your response remains anonymous even to the researchers by immediately converting names into identifiers. The survey includes 18 questions and should take about 3 minutes to complete. You will be assigned an anonymous identifier and passcode for entering a random drawing for a gift card. There are no costs associated with participation. However, there is a risk associated with providing information about vaping, an activity that is illegal in certain states, such as Virginia, for individuals younger than 21 years old. Your data is used to create a graph connecting seniors in your high school to study social networks and peer influence on vaping. A key element of the study is the use of software that allows the data to be collected without any identification of the participant. Names are converted to a string of letters and numbers and cannot be feasibly reversed to the original names even by the researchers since the researchers did not write the algorithm but rather use a standard program developed by the U.S. National Security Agency (NSA).

By clicking below and proceeding to the survey, you are indicating that you understand the information given to you in this form, you accept the provisions in the form, and you agree to join the study. You will not give up any legal rights by agreeing to the terms of this consent form.

I consent

Vape Survey

By completing this survey, you are consenting to be in this research study. Your participation is voluntary, and you can stop at any time.

Question: 4 | Name

The website will automatically assign an identifier to each name, keeping answers anonymous even to the researchers. Please type your FIRST and LAST name:

Question: 5 | Gender

Please select your gender:

Question: 6 | Closest 1

The following three questions ask you to list your three closest friends in order of decreasing friendship strength (i.e., from closest to least close). Please only list your closest friends who are also 18+ year old seniors in your high school. Your friends will remain anonymous, assigned identifiers, and will not be told that you are responding with their names. In this field, please type the FIRST and LAST name of your 18+ year old closest/best friend in your grade:

Question: 7 | Closest 2

Please type the FIRST and LAST name of your 18+ year old SECOND closest friend in your grade:

Question: 8 | Closest 3

Please type the FIRST and LAST name of your 18+ year old THIRD closest friend in your grade:

Anonymous Incentive Method (AIM)

Pseudocode	Explanation
identifier = hashlib.sha512(name + salt1)	The respondent's name is passed into the encryption function along with a salt and returns a deterministic, irreversible identifier.
password = hashlib.sha512(identifier + salt2)	The identifier is passed with a different salt into the same function to return a second identifier that serves as a password.

Vape Survey Survey Visualizations About Winners

Vape Survey Winners

By completing this survey, you are consenting to be in this research study. Your participation is voluntary, and you can stop at any time.

Winning Identifiers

Winning Identifiers

Password

Enter the password you were given when you submitted the survey

Submit

Vape Survey Survey Visualizations About Winners

Congratulations!

Your Amazon giftcard code is [redacted]

Multi-Response Detection

- Maintain anonymity
- Automatically detect when scammers press the back button/copy and paste names into the survey

Single Identifier	Multiple Entries
538c6beb	41f39156
182f5f1e	41f39156
f2d28fc3	41f39156
f12c90e8	41f39156
277c4b2c	41f39156
815b102f	41f39156
cab5da31	41f39156
b4c1d510	41f39156
3123edd5	41f39156
ee415311	41f39156
47623d60	38cc332b
eb2cd702	38cc332b
cc75ad2f	38cc332b
44e74686	38cc332b
650ab161	49cd3f58
cc062fd0	49cd3f58

Pros

- Deterministic
  - Unambiguously detects multiple responses with same name
  - Reward only actual respondents
- Anonymous
- Easily supplemented
  - Score each name using name repository (e.g., “Daniwl” vs “Asdfghjkl”)
  - Extract additional data (IP address)
  - CAPTCHA

Cons

- Does not automatically detect entries with different identifiers
- More prone to exploitation if participant understands the basics of hashing or has a greater need for the reward

Takeaways

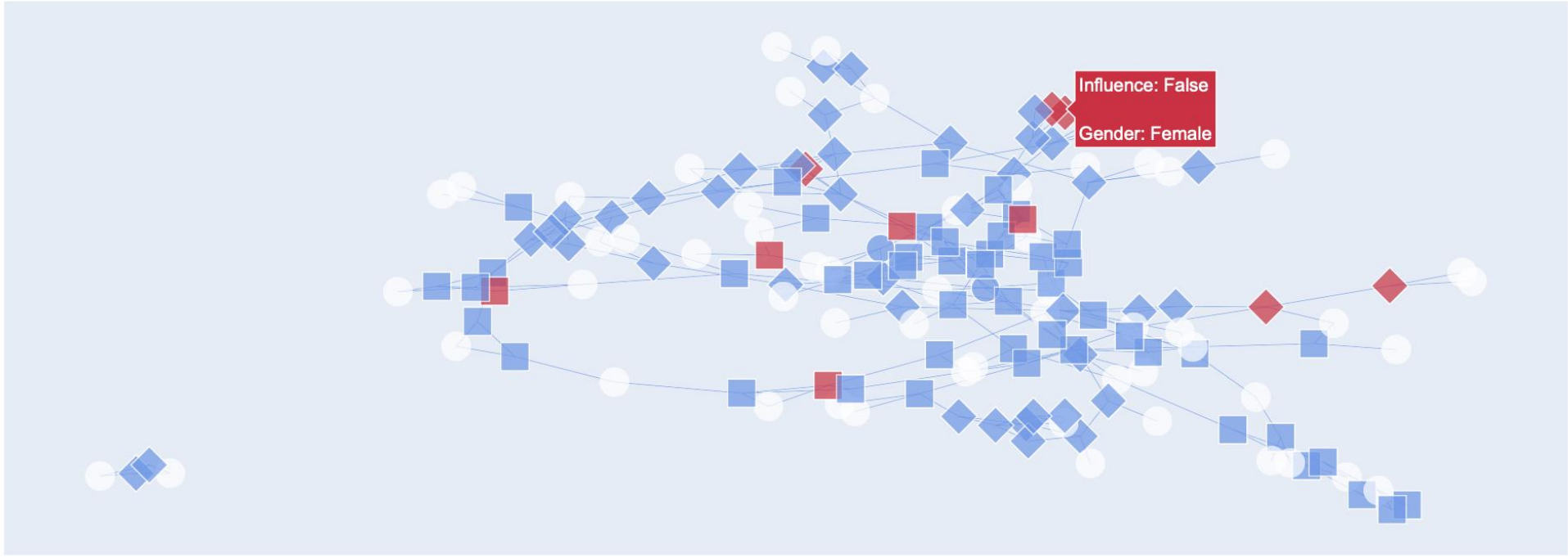
- Anonymous, irreversible, and deterministic
- Potential improvements over Qualtrics:
  - Can be adapted for the specific needs of the survey
  - Better handles multiple responses
- Faster IRB approval
- Safeguard but NOT end-all-be-all
- Easy to implement

Vape Survey Survey Visualizations About Winners

Viz Page

vapesurvey.org

School: 1



Thank You!
Questions?

Personal Information

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We acknowledge Dr. Andrew Cherlin for his guidance and suggestions on the survey methodology.

Key Reference

Habib, D. & Jha, N. (2021). Aim Against Survey Fraud. Jamia Open. https://doi.org/10.1093/jamiaopen/ooab099

References

Christakis, N. A., & Fowler, J. H. (2008). The collective dynamics of smoking in a large social network. *The New England Journal of Medicine*, *358*(21), 2249–2258. https://doi.org/10.1056/NEJMsa0706154

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De Nooy, W., Mrvar, A., & Batagelj, V. (2018). Exploratory Social Network Analysis with Pajek: Revised and Expanded Edition for Updated Software. In *Structural Analysis in the Social Sciences* (3rd ed.). https://doi.org/DOI: 10.1017/9781108565691

Ellwardt, L., Wittek, R. P. M., Hawkley, L. C., & Cacioppo, J. T. (2019). Social Network Characteristics and Their Associations With Stress in Older Adults: Closure and Balance in a Population-Based Sample. *The Journals of Gerontology: Series B*. https://doi.org/10.1093/geronb/gbz035

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Survey Response Rate By Grade Level

- 53% Response Rate
- Relative positions of 84% of the network

	9TH GRADE	10TH GRADE	11TH GRADE	12TH GRADE	TOTAL
RESPONDENTS	12	26	32	32	102
ALL STUDENTS	45	39	61	47	192
PERCENT OF TOTAL	26.7%	66.7%	52.5%	68.1%	53.1%

Survey Results

- Isolation does not necessarily increase the risk of vaping
- No gender differences on the surface
- Higher percentage of students who vape report heavy peer influence

	MALE	FEMALE	HEAVILY INFLUENCED	NOT HEAVILY INFLUENCED	ABOVE AVERAGE TIE STRENGTH	BELOW AVERAGE TIE STRENGTH	ABOVE AVERAGE NUMBER OF TIES	BELOW AVERAGE NUMBER OF TIES
VAPE	5	5	7	3	7	3	7	3
	4.9%	4.9%	6.9%	2.9%	6.9%	2.9%	6.9%	2.9%
DON'T VAPE	48	42	44	48	60	32	48	44
	47.1%	41.2%	43.1%	47.1%	58.8%	31.4%	47.1%	43.1%
TOTAL	53	47	51	51	67	35	55	47
	52.0%	46.1%	50.0%	50.0%	65.7%	34.3%	53.9%	46.1%

PageRank

- Describes wide-reaching influence and importance in the network on a macro-scale
- Likelihood that a person randomly clicking on links will arrive at a particular page
- Females who vape exhibit weak ties.

PageRank	Male	Female	Total
Vape	0.00693	0.00893	0.00793
Don't Vape	0.00642	0.00726	0.00677
Total	0.00647	0.00744	0.00688

Weighted	Male	Female	Total
Vape	0.00698	0.00657	0.00678
Don't Vape	0.00618	0.00668	0.00636
Total	0.00626	0.00667	0.00641

Long-Range Coupling

- Strengthens communication to non-bonded atoms/nodes