Social Network Structure and Cigarette Smoking Among Adolescents and Young Adults:

A Step Towards Understanding Tobacco-related Disparity and Youth Tobacco Control Preventive Measure Effectiveness

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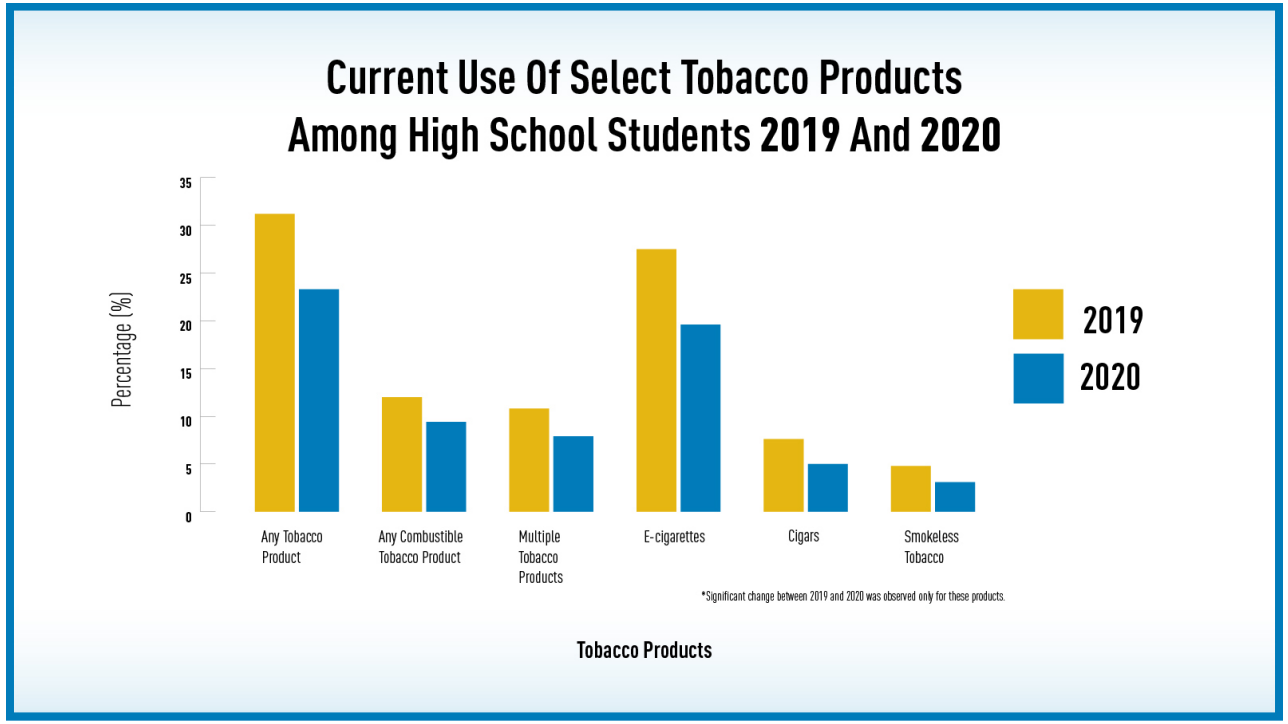
Background



- Youth tobacco users near all-time highs
- Rates of combustible tobacco use remains high
- The proportion of smokers that initiated cigarette smoking in early adulthood nearly doubled from 2002 to 2018.

National Youth Tobacco Survey Infographics, 2020
Barrington-Trimis, et al. 2020 JAMA

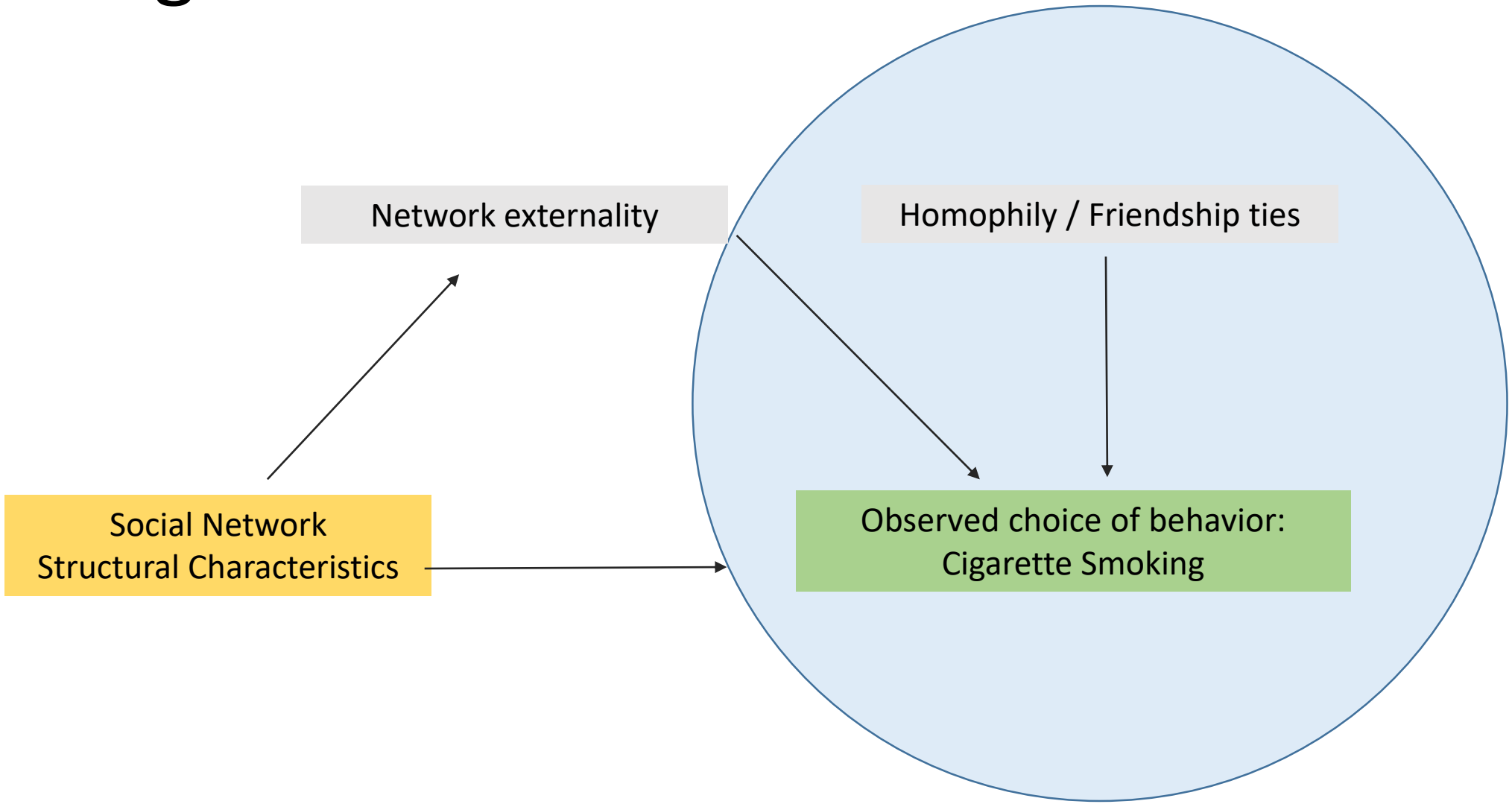
Background

- Distributions of cigarette smoking vary by population socio-demographic background, especially among the young.

- Social network plays an important role in shaping the population-level distribution patterns of these behaviors.

- Most studies to-date examining the association between social network and health behaviors have been anchored upon the Contagion Theory (LeBon, Park& Blumer) and the Homophily Theory (McPherson)

Background

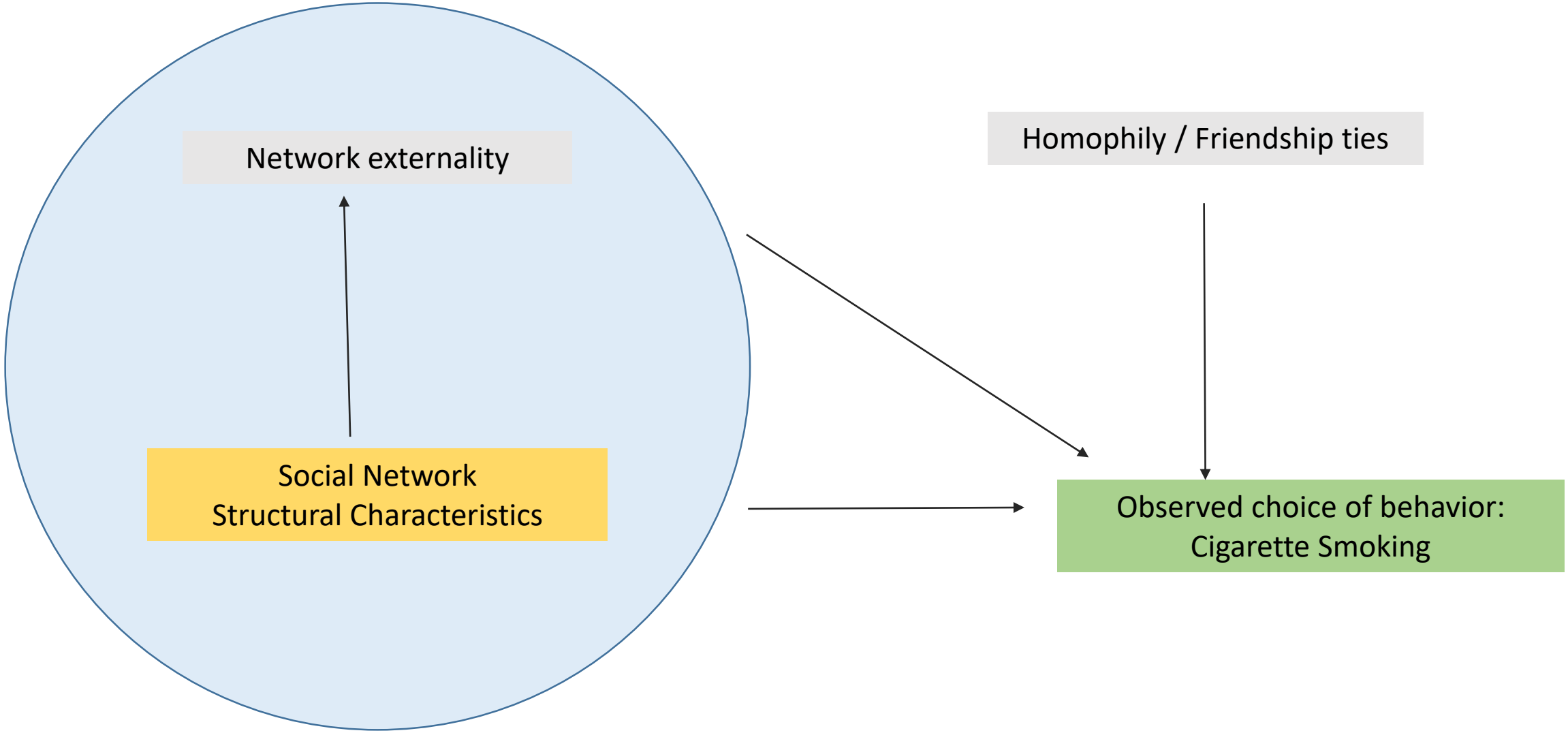

Network externality
Homophily / Friendship ties
Social Network
Structural Characteristics
Observed choice of behavior:
Cigarette Smoking

Rationale and Gaps Addressed

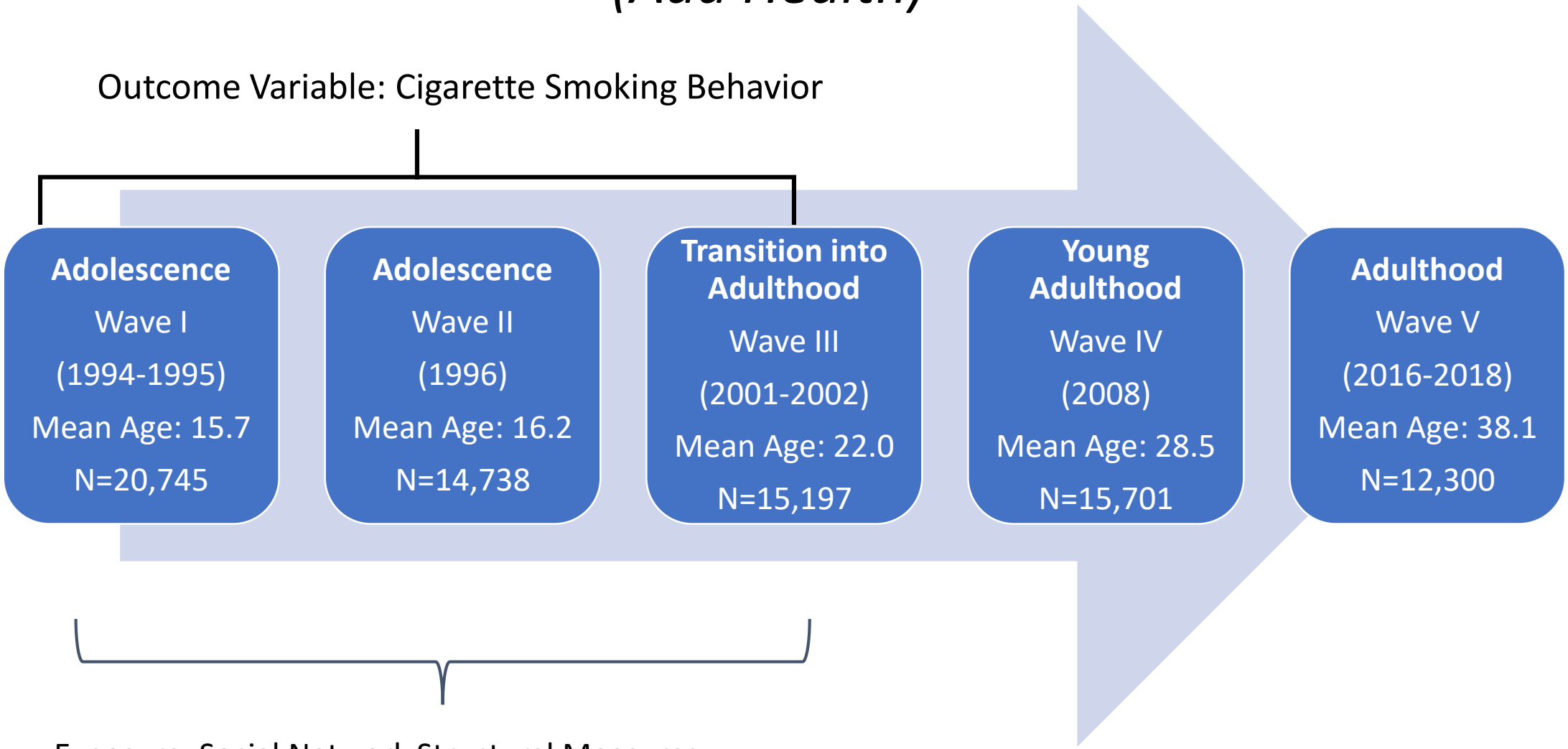
- Limited number of studies to-date explored the social network structural features and their association with tobacco product use behavior.

- Network structural properties are key to network dynamics including signaling, diffusion, and evolutionary game dynamics, which are crucial to understanding of tobacco use behavior and designs of effective tobacco control measures.

Rationale and Gaps Addressed



The National Longitudinal Study of Adolescent to Adult Health (Add Health)



Methods

Network Structural Features	
Density	Sum of degrees of all the nodes divided by total number of ties
Betweenness Centrality	The number of times a node acts as a bridge along the shortest path between two other nodes
Local Clustering Coefficient	Fraction of a pair of nodes' friends that are also friends with each other
Diameter	The shortest distance between the two most distant nodes in the network
Centrality Measure	
Indegree Centrality	Percentage of ties that belong to one particular group out of entire network ties

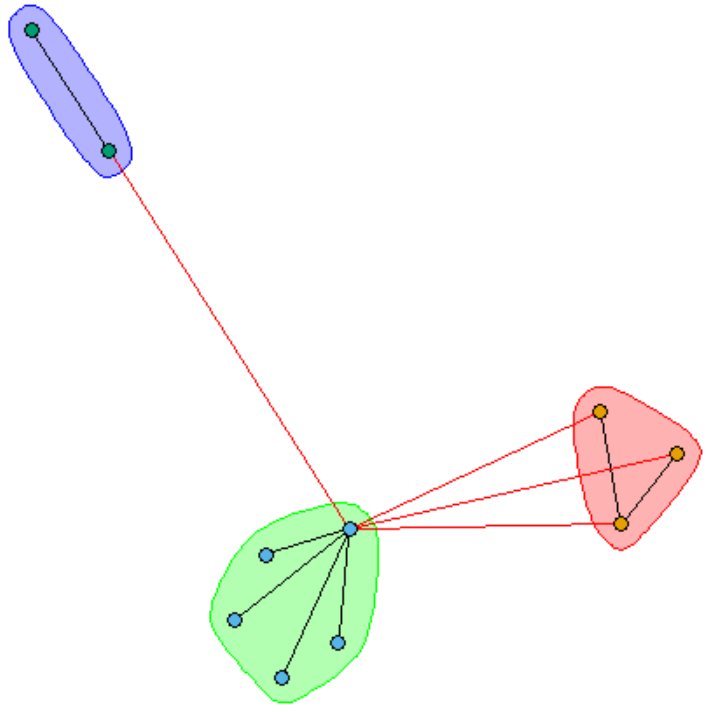
Methods

- Cigarette smoking behavior was obtained using the Add Health Study In-home Questionnaire during Wave I and III respectively.
- Participants were categorized as never smoker, former smoker and current smoker.
- Social network structural characteristics of current smoker, former smoker and never smoker at both Wave I and III were explored.
- Association between network structural characteristics and cigarette smoking was assessed using logistic regressions.

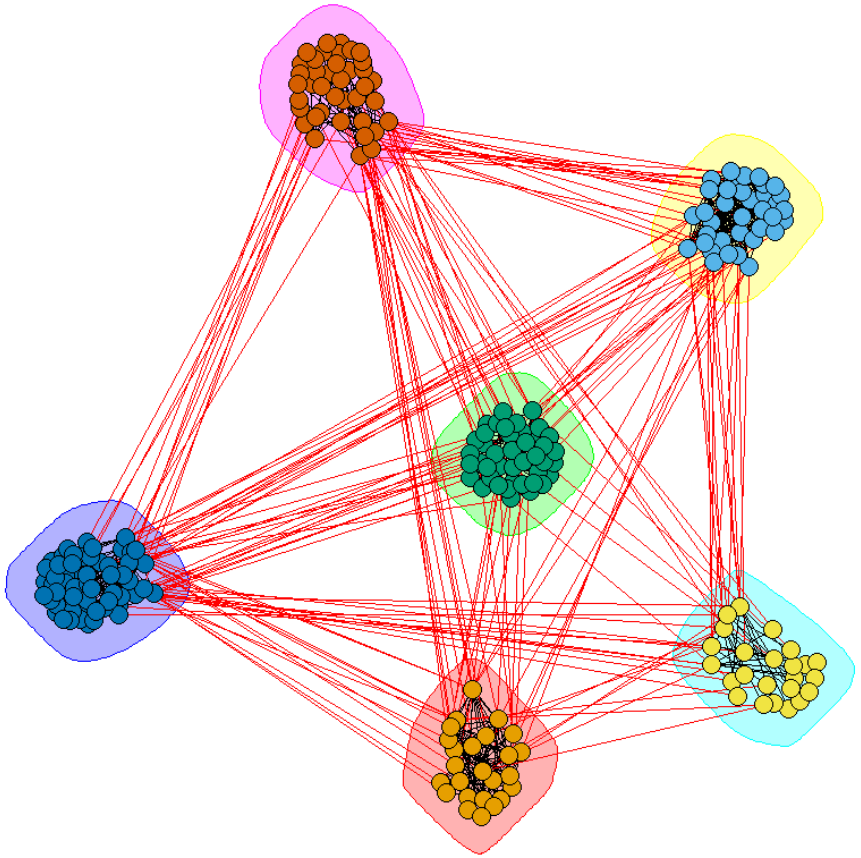
Characteristics of Add Health Study Participants that Participated the Wave I and III In-Home Friendship Nomination Survey

	Baseline Participants (N= 20747)		Wave III Participants (N= 10057)
Mean (SD)		**Mean (SD)**	
Age	15.7 (1.7)	**Age**	22.0 (1.8)
N (%)		**N (%)**	
Current Smoker	64 (0.3)	**Current Smoker**	1785 (17.8)
Former Smoker	597 (2.9)	**Former Smoker**	327 (3.3)
Never Smoker	16456 (79)	**Never Smoker**	3061 (30.4)
Female	5929 (29)	**Female**	2001 (19.9)
Race		**Race**	
White	5852 (28.2)	**White**	2115 (21.0)
Black	2689 (13.0)	**Black**	1020 (10.1)
Hispanic	2033 (9.8)	**Hispanic**	464 (4.6)
Asian	813 (3.9)	**Asian**	227 (2.3)
Other	344 (1.7)	**Other**	136 (1.4)
Nominated Never Smoker	3831 (12.0)	**Nominated Never Smoker**	525 (5.2)
Nominated Former Smoker	134 (0.4)	**Nominated Former Smoker**	80 (0.8)
Nominated Current Smoker	25 (0.1)	**Nominated Current Smoker**	932 (9.3)

Wave I and III Overall Friendship Network Communities

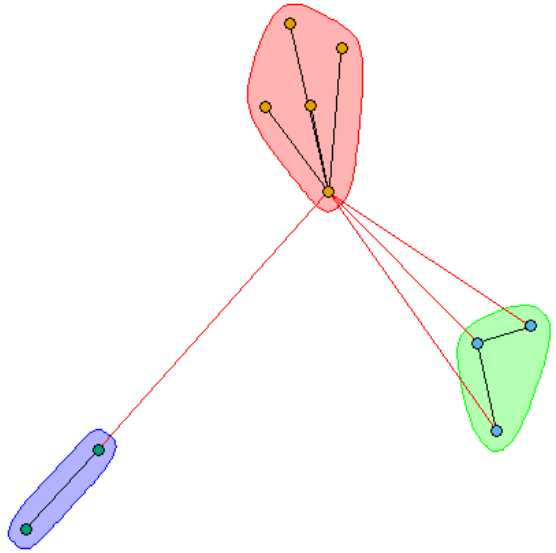


Wave 1 Overall Friendship Network
N of Edges = 35720
Maximum Number of Communities Detected = 3



Wave 3 Overall Friendship Network
N of Edges = 6907
Maximum Number of Communities Detected = 6

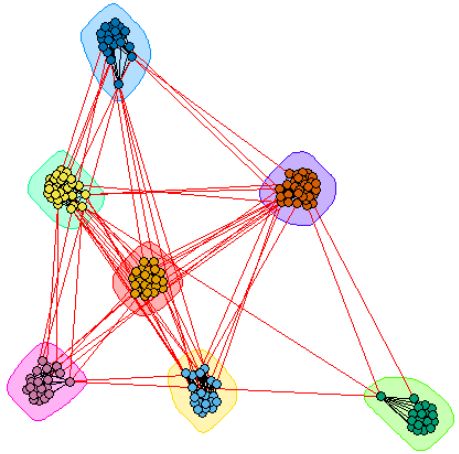
Wave I Friendship Network Communities, by Cigarette Smoking Status



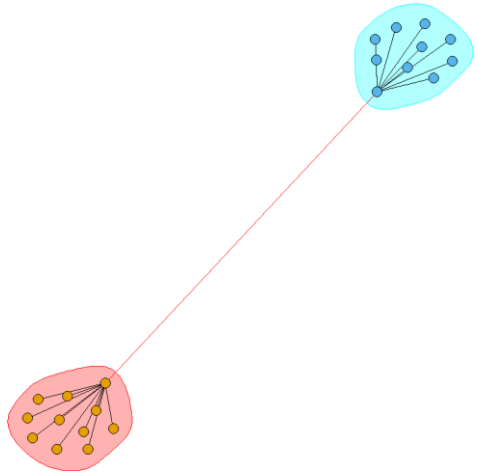
Community Detection for Wave I never smokers

At Wave 1, current smokers and former smokers exhibit no significant clustering as a community, whereas amongst the never smokers, there were three distinct sub-communities.

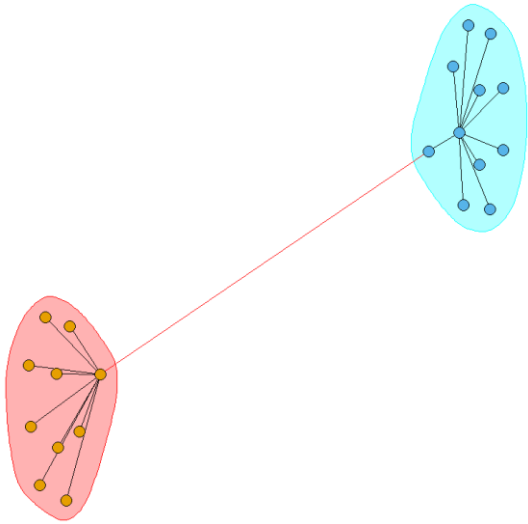
Wave III Friendship Network Communities, by Cigarette Smoking Status



Wave III Never Smokers



Wave III Current Smokers



Wave III Former Smokers

Risk of Smoking Associated with Social Network Structural Characteristics in Adolescents, using the National Longitudinal Study of Adolescent to Adult Health Study Wave I Dataset

	Odds Ratio (95% Confidence Interval)	
	Current Smoker VS Never Smoker	**Former Smoker VS Never Smoker**
Local Clustering Coefficient	0.38 (0.01, 9.64)	0.76 (0.24, 2.40)
Diameter	1.10 (0.26, 6.34)	1.12 (0.95, 1.49)
Indegree Centrality	0.97 (0.77, 1.22)	**0.86 (0.76, 0.96)**
Betweenness Centrality	0.93 (0.85, 1.25)	1.07 (0.82, 1.39)
All models are adjusted for age, sex, race/ethnicity, baseline familial socioeconomic index and nominated friend's smoking behavior.		

Risk of Smoking Associated with Social Network Structural Characteristics in Young Adults, using the National Longitudinal Study of Adolescent to Adult Health Study Wave III Dataset

	Odds Ratio (95% Confidence Interval)	
	Current Smoker VS Never Smoker	**Former Smoker VS Never Smoker**
Local Clustering Coefficient	**0.59 (0.35, 0.98)**	0.84 (0.31, 2.23)
Diameter	1.08 (0.94, 1.31)	1.02 (0.96, 1.07)
Indegree Centrality	0.99 (0.97, 1.00)	0.98 (0.95, 1.01)
Betweenness Centrality	**0.87 (0.82, 0.98)**	0.96 (0.89, 1.21)
All models are adjusted for age, sex, race/ethnicity, baseline familial socioeconomic index and nominated friend's smoking behavior.		

Conclusion and Limitation

- Macro-level network structural characteristics do differ by age and smoking status. In particular, clusters play an important role in differentiating networks among individuals of different smoking behaviors.

- Individual-level network structural characteristics including betweenness centrality and local clustering coefficient were observed to be associated with cigarette smoking behavior among young adult, not adolescents.

- Limited generalizability due to lack of update-to-date data source for population and bias due to missing covariate information as well as network nodes.

- Self-reported measures of tobacco use & network ties.

Future Research Direction

- Missing data imputation on a social network to evaluate the co-evolution between social network structural features and smoking behavior

- Incorporate key network structural features as parameters of simulation models evaluating dynamics of adolescent and young adults' smoking behavior as well as effectiveness of tobacco control measures on a social network