Secondary Prevention of Heart Disease: A Focus on Socioeconomic Status & Smoking

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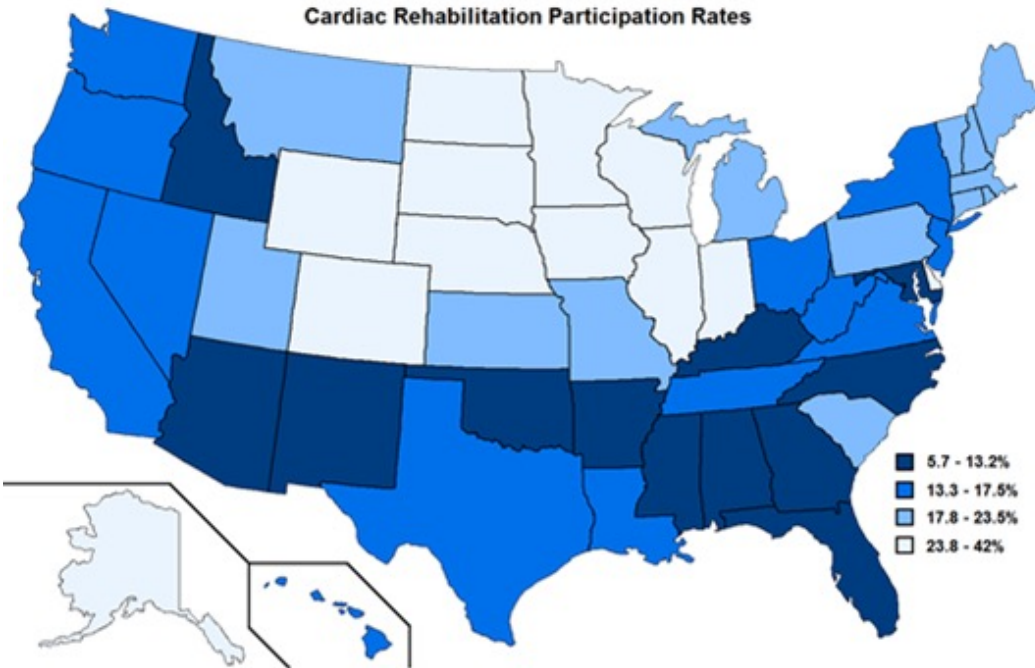The University of Vermont

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- No other conflicts to disclose

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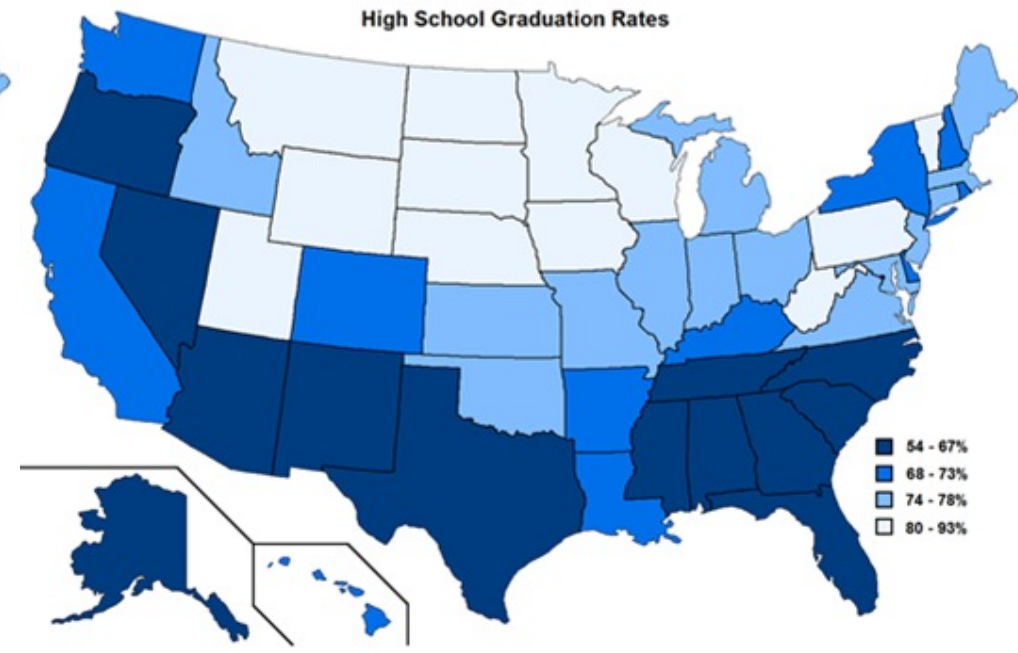
Terms to be Familiar With

- Socioeconomic status
  - Educational attainment
  - Income
  - Insurance status/type
  - Occupation
- Smoking
  - Combusted tobacco use, generally cigarettes
- Secondary prevention
  - Improve health-related behaviors
  - Cardiac rehabilitation

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Where I Started:
Cardiac Rehabilitation Participation and High School Graduation Rates

Cardiac Rehabilitation Participation Rates

- 5.7 - 13.2%
- 13.3 - 17.5%
- 17.8 - 23.5%
- 23.8 - 42%

High School Graduation Rates

- 54 - 67%
- 68 - 73%
- 74 - 78%
- 80 - 93%

Gaalema et al., 2014

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Socioeconomic Disparities in Cardiac Disease

- Disparities in development of disease[1-3]
  - Higher risk cardiac profiles
  - Smoking, diabetes, physical inactivity

- Disparities in outcomes[3-7]
  - Worse prognosis following a cardiac event
  - 1-year mortality rate more than double that of more affluent patients

- Disparities in secondary prevention

1. Chan et al., 2008. 2. Mackenbach et al. 2015. 3. Salomaa et al. 2000. 4. Alter et al. 2006. 5. Gerber et al. 2008. 6. Canto et al. 2002. 7. Alter et al., 2004.

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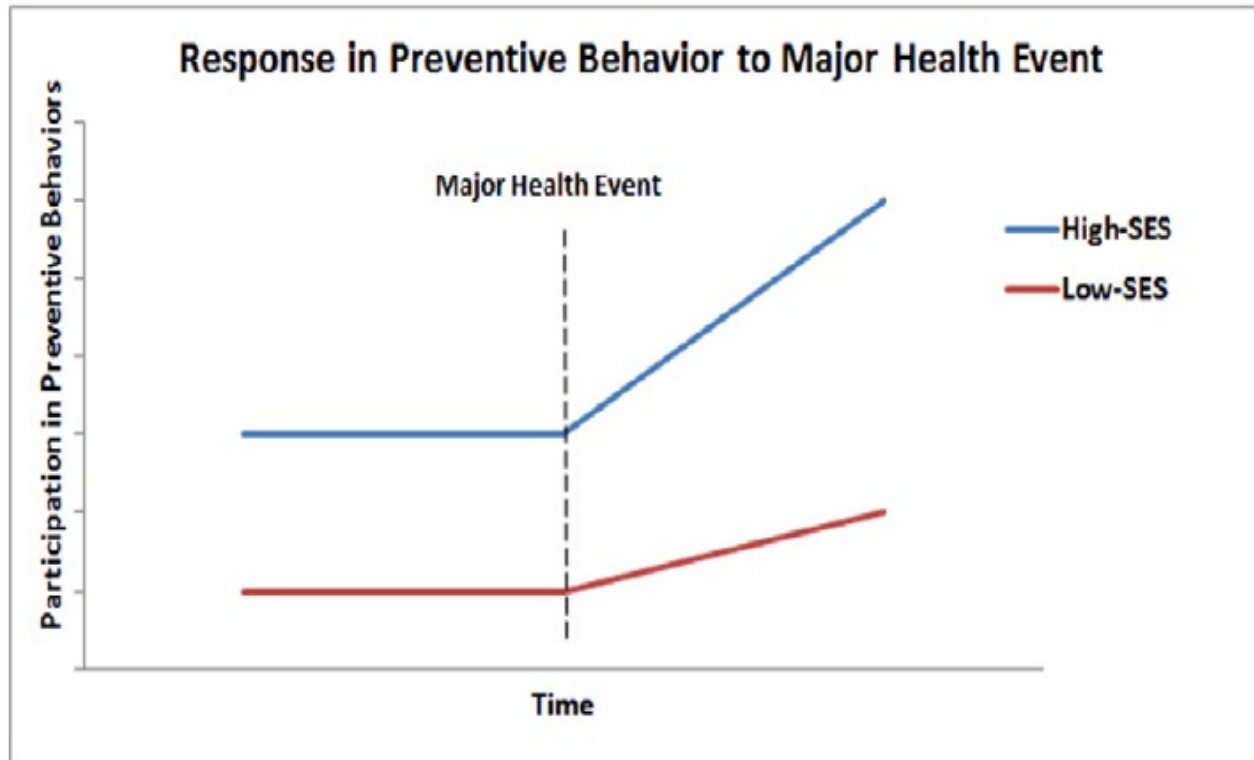The University of Vermont

Increasing Disparities?

Fig 1 – Hypothetical trajectories of participation in preventive health behaviors over time in which reduced response to a major health event in lower-SES populations would predict an increasing divergence in health disparities.

Cardiac Rehabilitation

- Cardiac rehabilitation (CR) is a medically supervised, structured program
  - Used to improve health following a cardiac event
    - Recent MI, CABG, PCI, or heart valve replacement or repair, chronic systolic heart failure

- Outpatient rehabilitation program
  - 1-3 visits per week over about 4-6 months
  - Most insurance covers 36 sessions

- Supervised progressive exercise
  - Symptom monitoring
  - Classes on medications, diet, physical activity, stress

Cardiac Rehabilitation

- CR is highly effective at reducing morbidity and mortality rates[1,2]
  - 26% decrease in cardiac mortality over 3 years
  - 31% reduction in cardiac re-hospitalizations over a 12-month period

- CR attendance rates are not ideal
  - Less than half of eligible candidates in the U.S. and Canada participate[3-5]
  - Dropout also a problem and benefits dose dependent[6-7]

1. Taylor, et al., 2004. 2. Heran, et al., 2011. 3. Suaya et al., 2007. 4. Cortés and Arthur, 2006. 5. CDC, 2008. 6. Suaya, et al., 2009. 7. Hammill et al., 2010.

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CR Participation in Disadvantaged Populations

- Attendance issues even more pronounced in those with lower-SES
- Medicare patients
  - Only 18% attended CR
  - Only 3-5% of those with dual Medicare/Medicaid status did so[1,2]
- Washington State Medicaid patients discharged following an MI in 2004
  - Of 322 only two (< 1%) attended CR within the year following their MI[3]
- Nationally, those with lower levels of educational attainment
  - At least a third less likely to attend CR[4]
- Problem locally as well[5]

	Total Eligible	Number in CR	Percent Participation	Percent Completing
Medicaid/ State agencies	114	28	24%	8%
Commercial/ Medicare	518	236	46%	35%

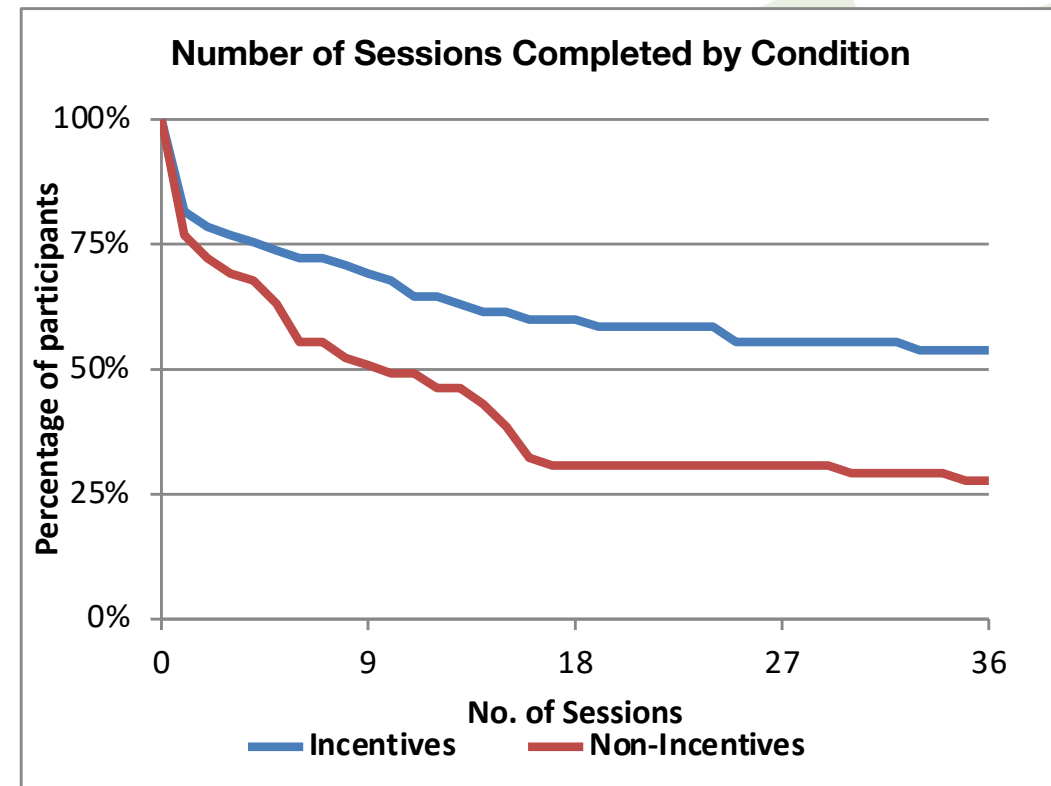Vermont Center on Behavior & Health
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1. Suaya, et al., 2007; 2. 2009; 3. Oberg et al., 2009. 4. Sun et al., 2017. 5. Gaalema et al., 2016

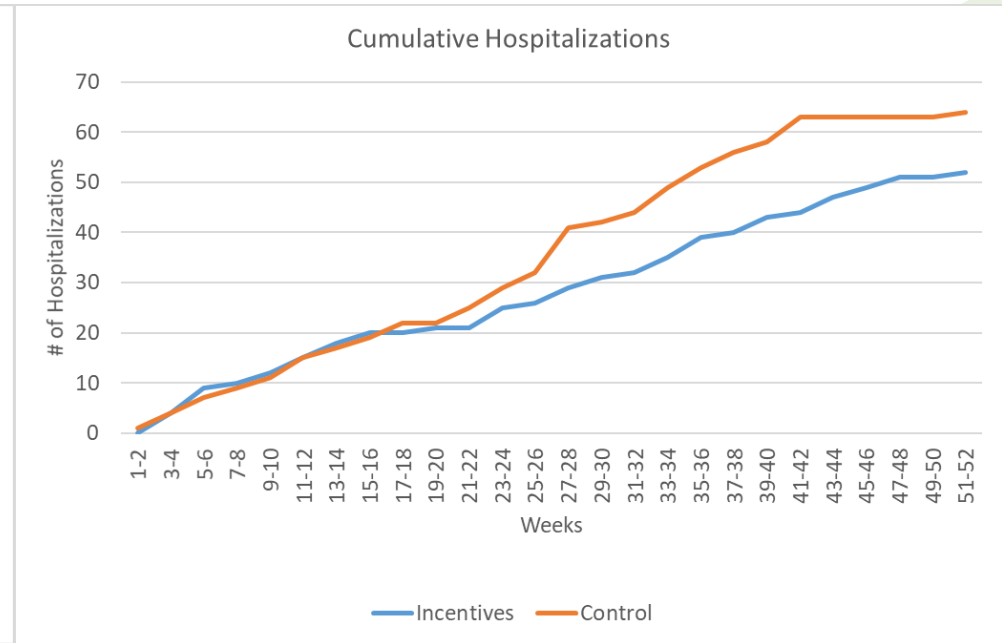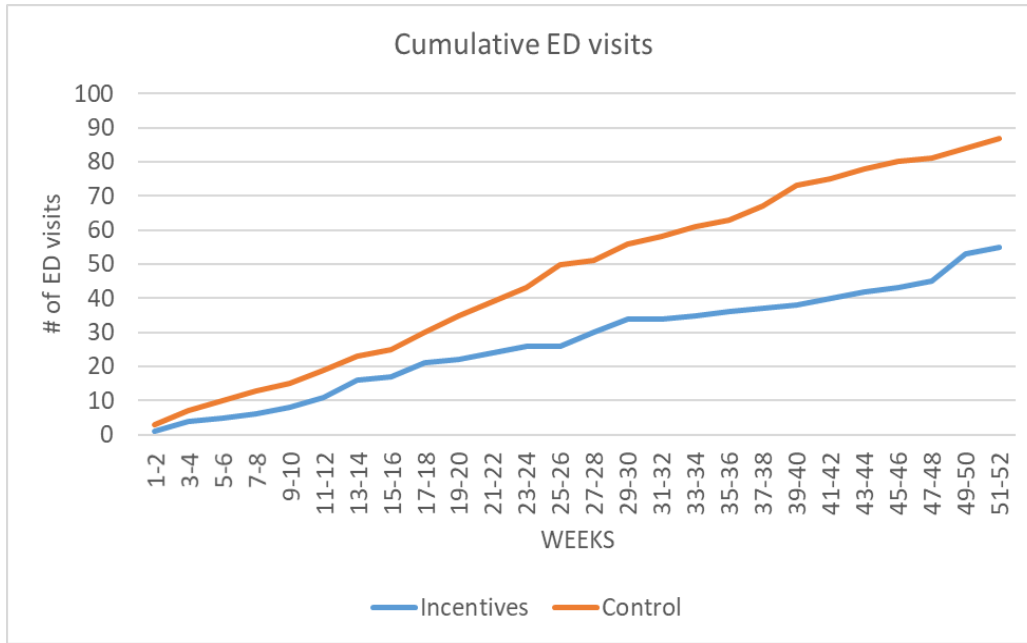# Contingency Management/Financial Incentives

- Promote behavior change by immediately reinforcing objectively verified behaviors
  - Gift cards
  - Incentives can be used to further treatment goals
- Incentive-based treatments effective in disadvantaged populations
  - For pregnant smokers incentives significantly more effective (RR 0.76) than other behavioral or pharmacological treatments[1]
- Incentives can increase completion and adherence rates
  - Doubled treatment completion rates[2]
- Randomized 130 CR-eligible Medicaid-insured participants[3]
  - Earn incentives on escalting scale for completion of 36 CR sessions
  - Non-incentive control

1. Lumley et al., 2009; 2. Higgins et al., 2008. 3. Gaalema et al., 2019.

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Primary Outcomes

- ## Participants in the incentive condition

  - Earned ~$716

  - Completed significantly more CR sessions

    - 22.4 vs. 14.7 (p = 0.013)

  - Were almost twice as likely to complete CR

    - 55.4% vs. 29.2% (p = 0.002)

Number of Sessions Completed by Condition

Percentage of participants

No. of Sessions

— Incentives — Non-Incentives

Gaalema et al., 2019

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Hospital Outcomes
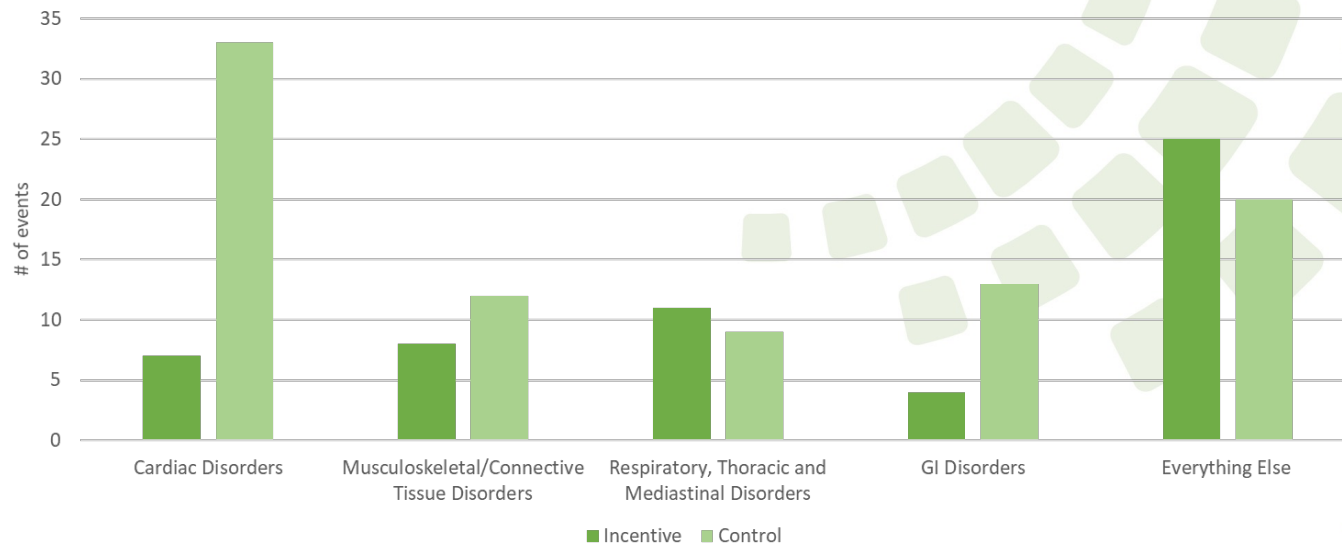
Next Study

- Recruiting 200 lower-SES patients eligible for CR (114 so far)
- Inclusion criteria
  - CR qualifying diagnosis (MI, CABG, PCI, valve surgery, CHF)
  - Insured through Medicaid/ Less than HS education
- Randomized into one of four conditions
  - Usual Care
  - Incentives only
  - Case Management only
  - Incentives + Case Management
- Why case management?
  - Initial needs assessment
    - Medical
    - Social
    - Psychological
    - Practical
  - Available as needed to answer acute needs
  - Weekly encouragement to reach goals

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Fleg et al., 2020

But Attending CR is Not the Only Secondary Preventive Behavior

Post-MI Behavior Change by SES

- Systemized review
- 44 studies
  - Behavior change following MI
  - Measure of SES
- 5 behaviors
  - CR attendance
  - Medication adherence
  - Change in diet
  - Change in physical activity
  - Smoking cessation

Gaalema et al., 2017

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Behavior Following Myocardial Infarction
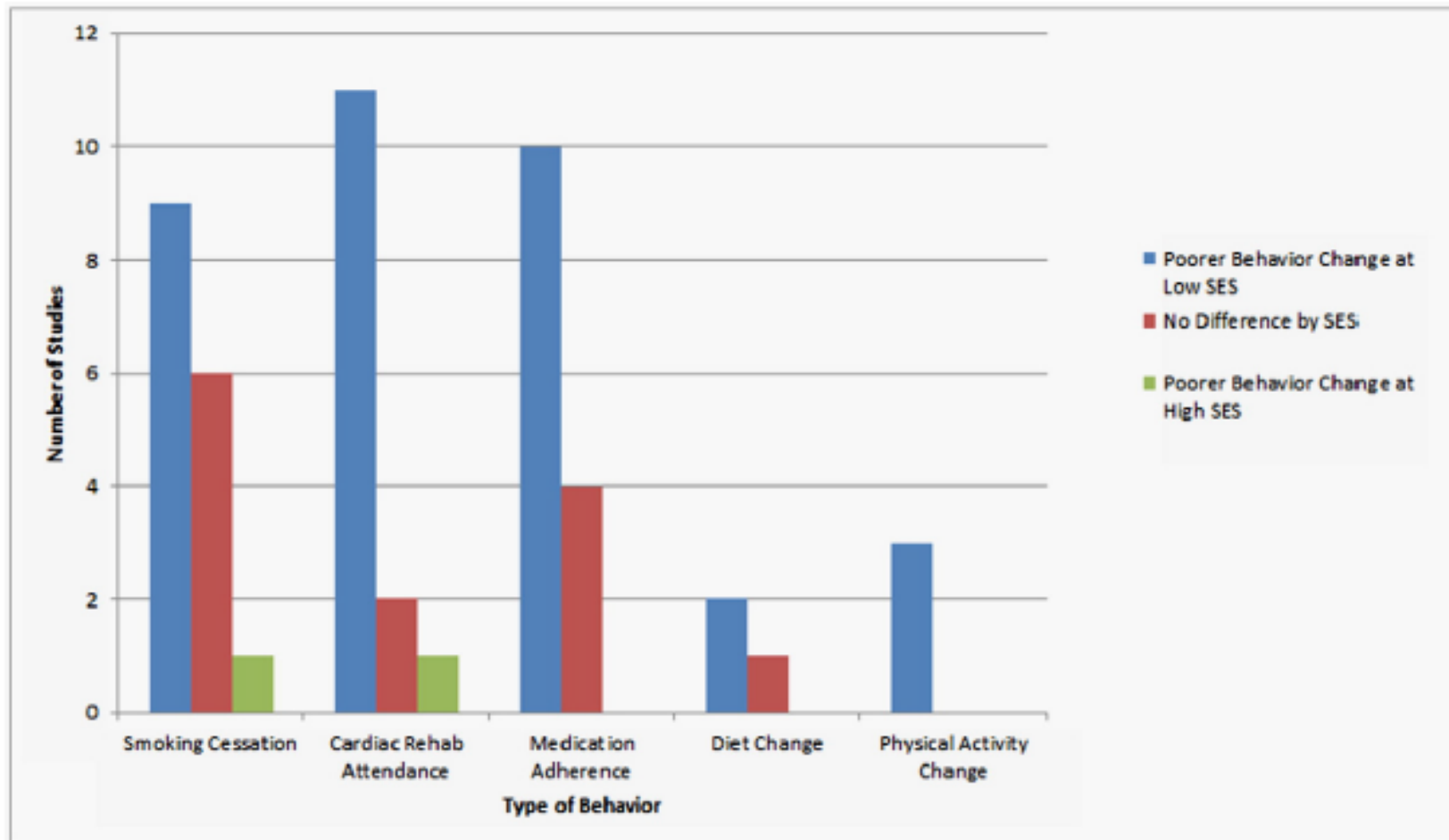
Gaalema et al., 2017

Behavior Following Myocardial Infarction
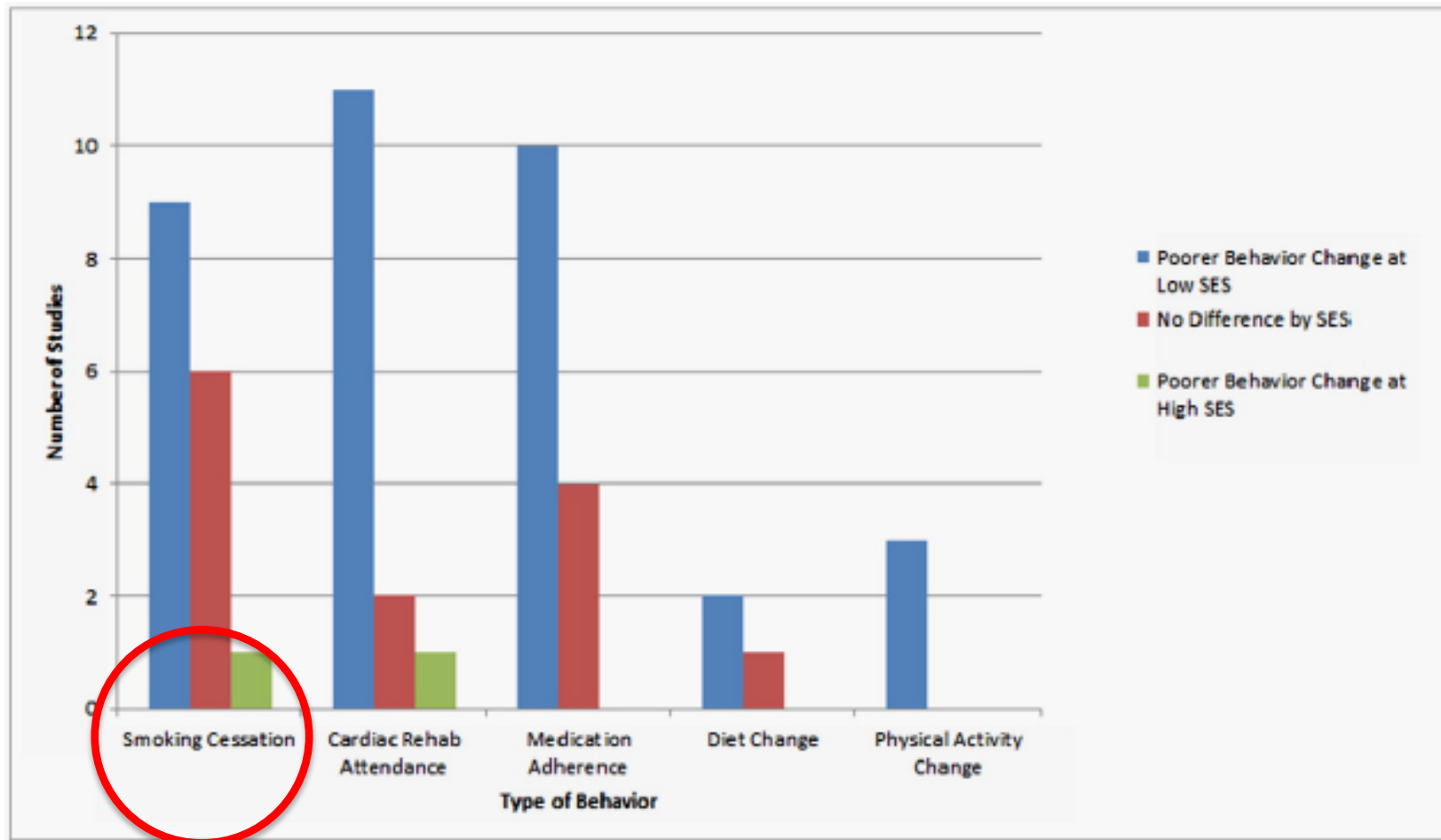
Gaalema et al., 2017

On to Smoking

Risks of Smoking in Those with Coronary Heart Disease[1]

- Dangers of combusted tobacco use
  - Endothelial dysfunction
  - Blood vessel constriction
  - Platelet activation
  - Chronic inflammatory state
  - Dyslipidemia
- Outcomes
  - Accelerate atherosclerosis
  - Destabilize coronary artery plaques
  - Precipitate acute coronary events

1. Barura et al., 2018

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Tobacco and Heart Disease

- 50 years of smoking has led to 7,787,000 premature deaths due to cardiovascular and metabolic diseases[1]

- Multivariate-adjusted RR for CHD mortality
  - Men 2.50 (95% CI, 2.34–2.66)
  - Women, 2.86 (95% CI, 2.65–3.08)

1. USDHHS, 2014

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Secondary Prevention - Smoking

- Continued smoking number one predictor of a subsequent event[1]

- Those with cardiac disease well aware of the dangers of continued smoking[2]

- Most recognized modifiable risk factor[3]
  - General public
  - Patients

1. Beatty et al., 2015; 2. Fernandez et al., 2008; 3. McDonnel et al., 2014

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Smoking Cessation

- Quitting smoking provides immediate cardiovascular health benefits[1]
  - Reduce recurrence of coronary events to that of a non-smoker within 3 years[2]
  - Reducing mortality following a MI by half over 3 to 5 years[3]
- Yet successful cessation difficult
  - Relapse rates 75-85% after 6-12 months, even with treatment[4,5]

1. USDHHS 2014; 2. Critchley et al., 2003; 3. Gerber et al., 2009; 4. Rigotti et al., 2014; 5. Rigotti et al., 2010

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Epidemiological - PATH

- Longitudinal, national level data set
  - Focus on tobacco/nicotine use
- Initial data: 23,282 who could be characterized by health status
  - No major health event
  - Life time MI
- Tobacco use
- Attitudes towards products

Gaalema et al., 2018

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Use and Attitudes about Tobacco

- Initial data

- Those who reported lifetime MI

  – More likely to have been a current or former combusted tobacco user (OR 3.2, 95%CI 2.0, 5.0; OR 2.4, 95%CI 1.6, 3.8)

  – More likely to believe that smoking/using tobacco is causing/worsening a health problem (OR 2.6, 95%CI: 2.0, 3.3)

Gaalema et al., 2018

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Effects of a New MI

- Follow-up data
  - Longitudinal design unique opportunity
  - Those who report having a MI during last 12 months
- No change in condition (n = 13,028)
- New MI (n = 240)
  - Changes in tobacco use

Gaalema et al., 2018

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Effects of a New MI

- ## Individuals with new MI
  - Higher odds (2.1, 95% CI 1.4–3.2) of attempting to quit/reduce combusted

- ## However, recent MI not a significant predictor of:
  - Cessation
  - Change in CPD

Gaalema et al., 2018

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Current Smoking and Other Health-related Behaviors

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Back to the Epidemiological Data

- Health-related behaviors predict health related behaviors
  - What about current smoking?
- National level survey - Behavioral Risk Factor Surveillance Survey
- Characterizing 26,000 participants who reported lifetime MI

Current vs. Former Smokers			
Not taking cholesterol med	16,043	1.37	(1.22, 1.55)
Not taking blood pressure med	18,389	1.39	(1.21, 1.60)
Problematic drinking	24,232	1.77	(1.50, 2.09)
Zero minutes physical activity	23,002	1.23	(1.14, 1.33)
Not eating at least one veg daily	22,788	1.25	(1.14, 1.37)
Not attending outpatient CR	2118	1.55	(1.20, 2.00)

Gaalema et al., 2020

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Gaalema et al., 2020

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Clustering of Risk Factors

	Problematic Drinking	No Physical Activity	Less than One Vegetable/Day	Cluster Frequency	Additional Risk Factors
Never-Smokers (*n*=7,749)				49.2%	0
		X		29.7%	1
		X	X	10.4%	2
			X	8.8%	1
	X			1.1%	1
	X	X		0.4%	2
Former Smokers (*n*=9,493)				47.4%	0
		X		31.3%	1
		X	X	8.9%	2
			X	8.7%	1
	X			1.9%	1
	X	X		1.2%	2
Current Smokers (*n*=4,269)				37.5%	0
		X		34.3%	1
		X	X	12.4%	2
			X	8.7%	1
	X			3.0%	1
	X	X		2.8%	2

Gaalema et al., 2020

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Can't Forget about SES!

Table 7. Sociodemographic characteristics among respondents who experienced a lifetime myocardial infarction by total number of behavioral risks. BRFSS, United States, 2017.

	Total No. Risks				
	0 (n = 9,723)	1 (n = 9,924)	2 (n = 4,842)	3+ (n = 1,515)	
	Weighted % (95% CI)	Weighted % (95% CI)	Weighted % (95% CI)	Weighted % (95% CI)	p
College graduate	22.9 (21.2, 24.5)	14.3 (13.0, 15.6)	8.5 (7.3, 9.8)	6.0 (4.4, 7.7)	

Gaalema et al., 2020

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Bringing this Back to Cardiac Rehabilitation

- Cardiac rehabilitation (CR) is a medically supervised, structured program
  - Used to improve health following a cardiac event
    - Recent MI, CABG, PCI, or heart valve replacement or repair, chronic systolic heart failure
  - Up to 36 exercise sessions over a 3 to 4 month period
  - Education sessions on medication, diet, stress management
- CR is highly effective at reducing morbidity and mortality rates
  - 26% decrease in cardiac mortality over 3 years
  - 31% reduction in cardiac re-hospitalizations over a 12-month period (Taylor, et al., 2004; Heran, et al., 2011)

- What happens with those who are current smokers?

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Smoking and CR
Referral/Attendance/Adherence

- ## Systematic review
  - Effects of smoking on referral/attendance/completion
  - 56 studies included

- ## Referral
  - Current smokers possibly more likely to be referred

- ## Attendance
  - Current smokers less likely to attend CR

- ## Completion
  - Current smokers much less likely to complete CR

Gaalema et al., 2015

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Smoking and CR Drop-out

Table 3
The effects of reported smoking status on likelihood of dropping out of a cardiac rehabilita

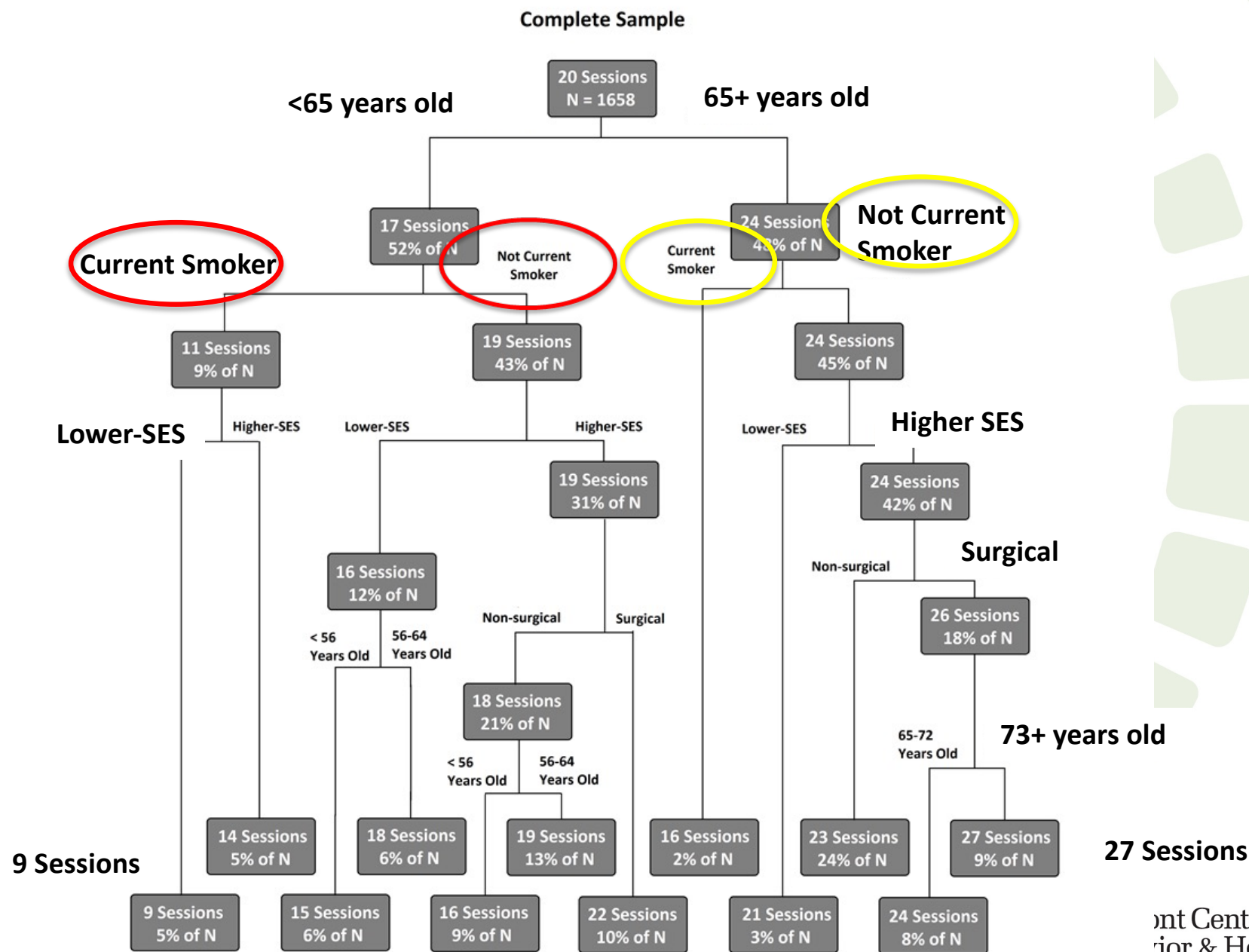| Author	Year	Location	n	sex	Effect direction
Oldridge & Streiner	1990	Canada	120	100% M	*+
Oldridge et al.	1983	Canada	733	100% M	*+
Dorn et al.	2001	6 states and DC, USA	931	100% M	*+
Beckie et al.	2010	Southeastern US	252	0% M	*+
Sarrafzadegan et al.	2007	Iran	1115	77% M	*+
Wittmer et al.	2011	Switzerland	2371	85% M	*+
Marzolini et al.	2008	Toronto, Canada	5922	82% M	*+
Sanderson et al.	2003	Alabama	526	65% M	*+
Digenio et al.	1992	South Africa	711	Unknown	*+
Beauchamp	2013	Melbourne, Australia	281	73% M	+
Kerins et al.	2011	Ireland	187	71% M	+
Oldridge et al.	1978	Hamilton, Canada	163	100% M	+
Waites et al.	1983	Atlanta, Georgia	22	86% M	+, criterion not specified
Eyherabide and Yates	1985	Wisconsin	236	81% M	*+/=
Worcestor et al.	2004	Melbourne, Australia	573	70% M	*+/=
Sanderson and Bittner	2005	Alabama	228	0% M	*=
Taylor et al.	1988	California	97	100% M	*=
Yohannes et al.	2007	Manchester, UK	189	74% M	*=
Oldridge et al.	1992	Wisconsin	492	68% M	*=
Soleimani et al.	2009	Iran	1986	73% M	=
Fontana et al.	1986	Connecticut	95	100% M	=

Gaalema et al., 2015

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Patient Characteristics and CR Sessions Completed

- Examination of CR program's prospectively collected database
  - Clinical and demographic characteristics
  - Number of sessions completed
  - CART analysis
    - Which factors explain the most variance
    - Effects of combinations of factors

Gaalema et al., 2017

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Predictors of CR Adherence

Gaalema et al., 2017

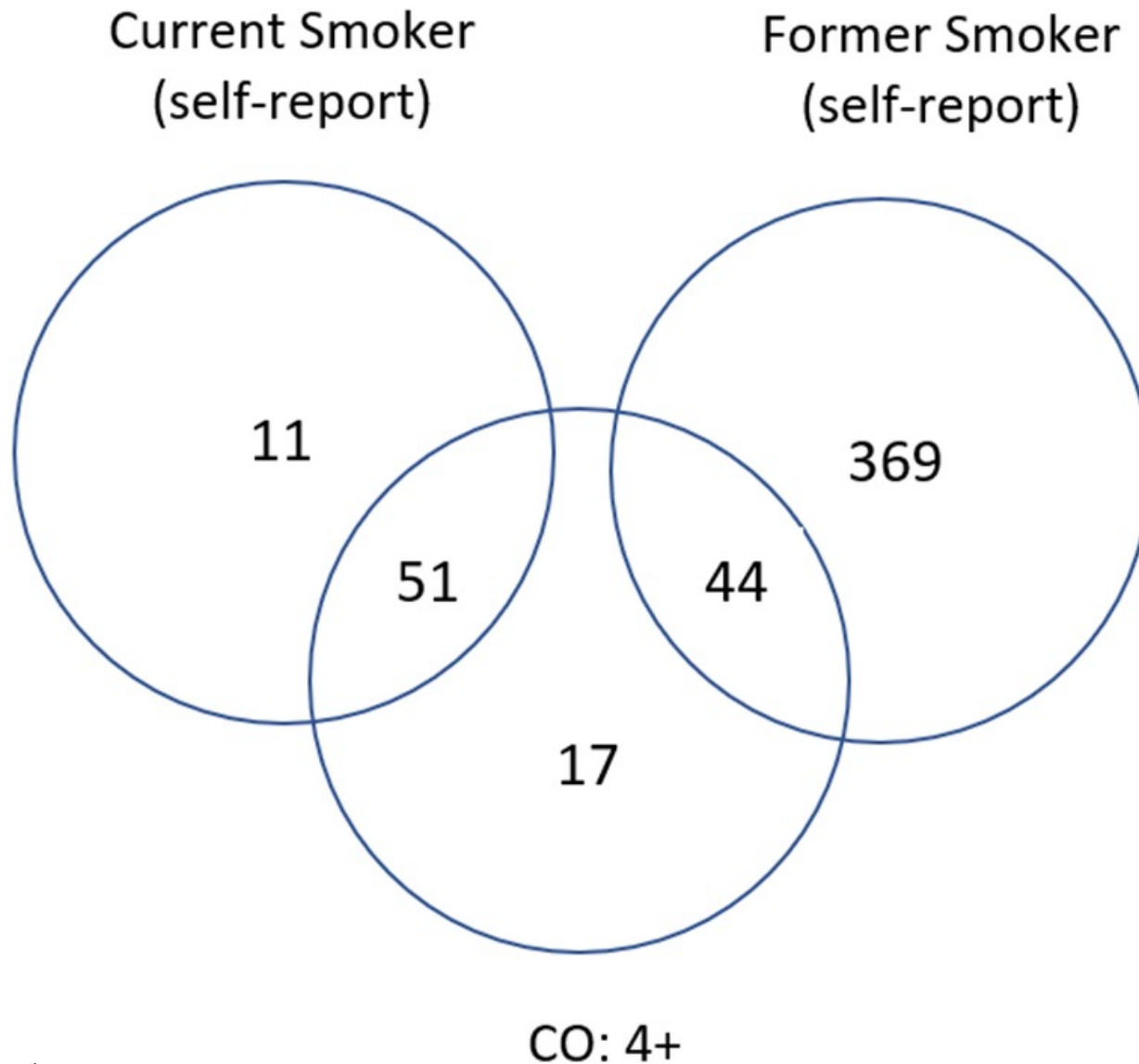# Smoking and Cardiac Rehabilitation

- Smoking is a large driver of cardiac events
- Current smoking risk factor for not attending/completing CR[1]
- Smoking a risk factor addressed in CR
  - But CR programs generally not terribly effective at promoting cessation[2]
- Where can we improve?
  - Currently relying on subjective report/hospital record
  - Objective measurement

1. Gaalema et al., 2015; 2. Taylor et al., 2004

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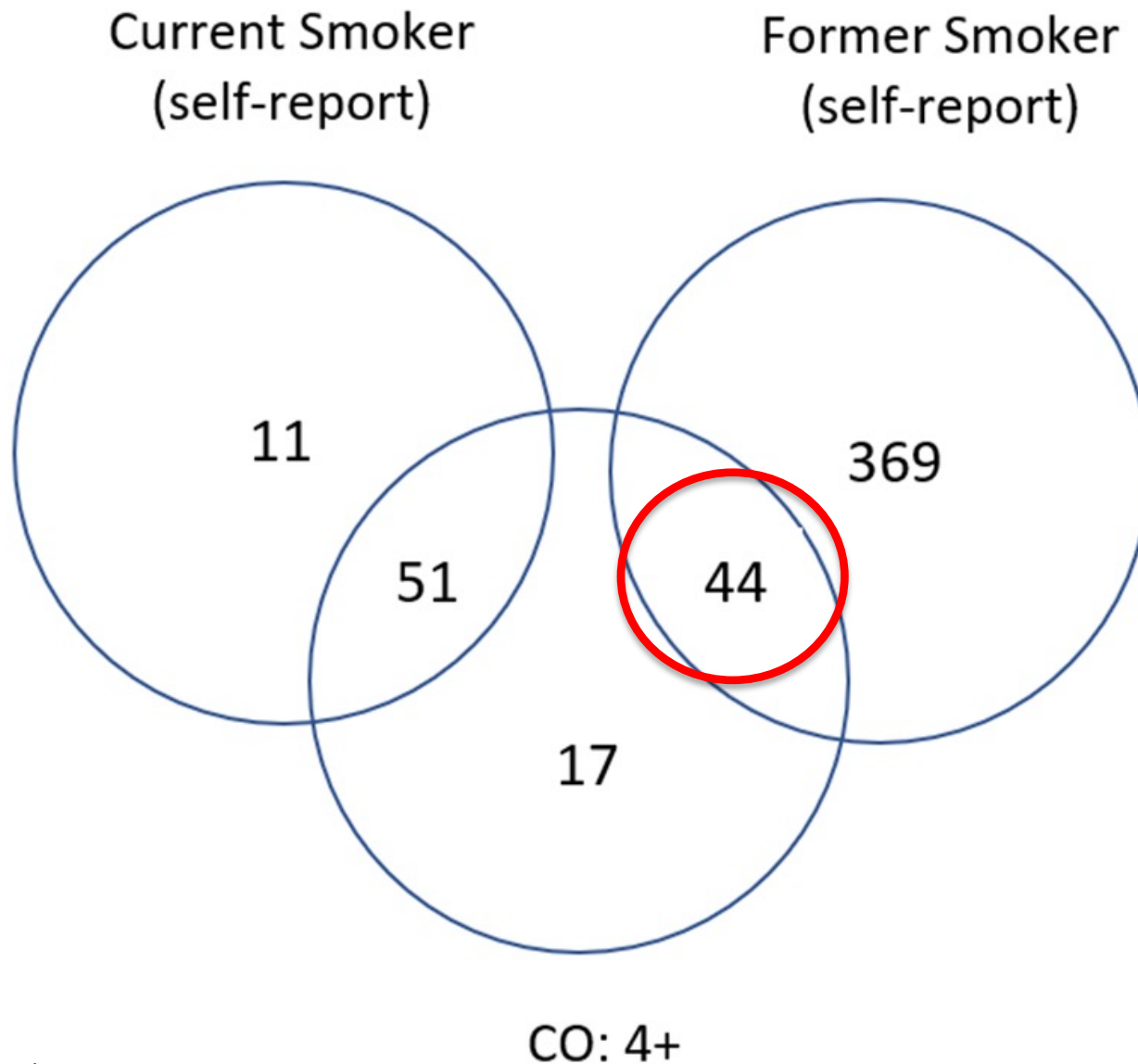The University of Vermont

CO Monitoring in Cardiac Rehab

- UVMMC CR Program serves greater Burlington, VT area
  - ~500 patients/year
- Objective CO monitoring
  - CO level (coVita Micro Smokerlyzer®)
  - Implemented in CR Program April 2018
- 853 patients screened
  - Demographics
  - Clinical characteristics
- Outcomes
  - Discrepancies between objective and self-reported smoking status
  - Characteristics by CO level (<4/≥4ppm)

Gaalema et al., currently under review

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Smoking Status by Measurement Type
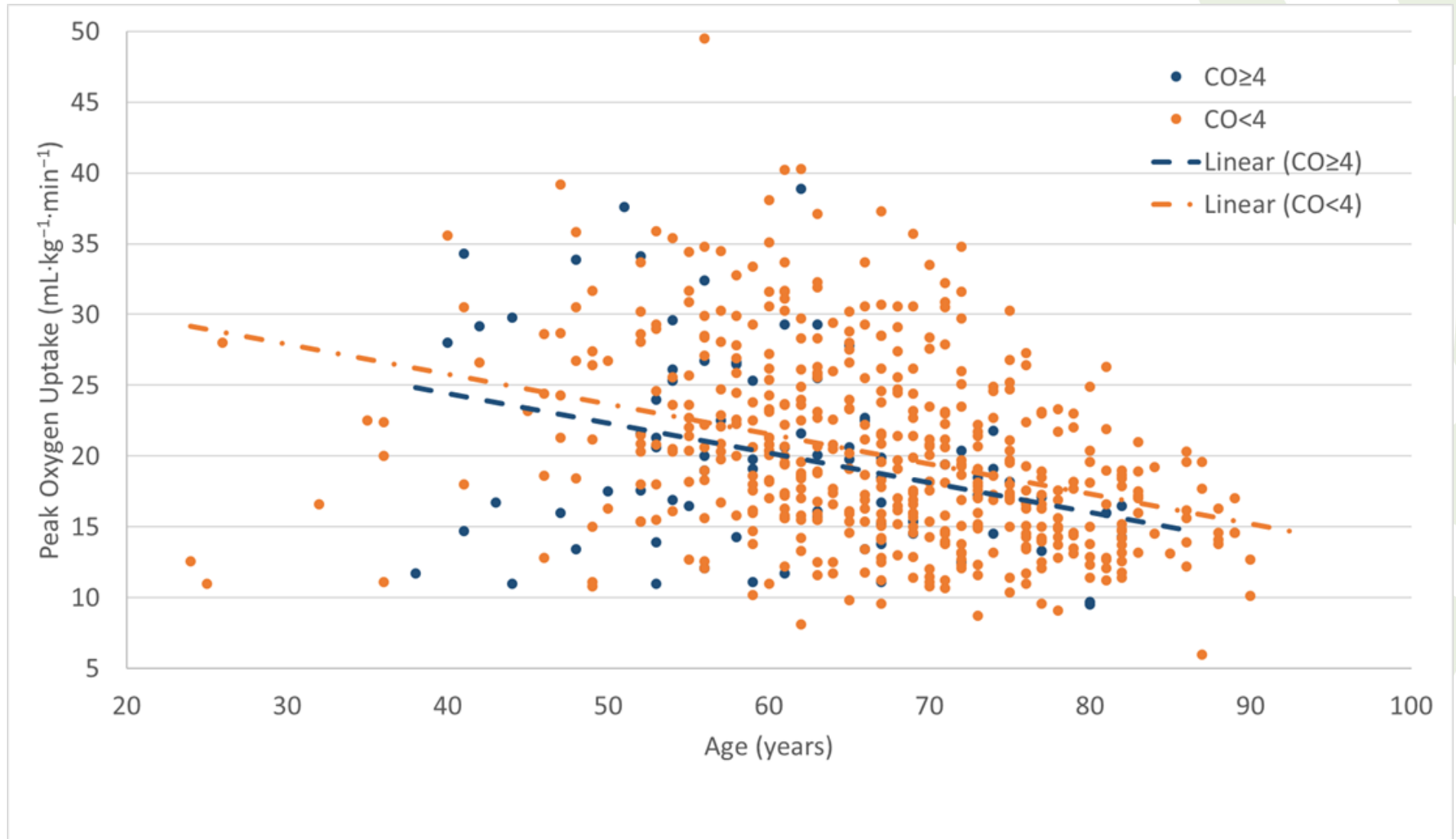
Smoking Status by Measurement Type

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Patient Characteristics, Overall and by Carbon Monoxide Level

Characteristic	All (n= 853)	CO <4 (n = 741)	CO ≥4 (n = 112)
Age (M ± SD)	66.9 ± 11.1	67.7 ± 11.0	62.2 ± 11.0*
Female (%)	229 (26.8)	201 (27.1)	28 (25.0)
Educational Attainment			
<High School/GED	53 (6.2)	41 (5.8)	12 (12.0)*
High School	227 (26.6)	180 (25.5)	47 (47.0)
Some college	182 (21.3)	159 (22.5)	23 (23.0)
4-year degree	171 (20.0)	160 (22.6)	11 (11.0)
Greater than 4-year degree	174 (20.4)	167 (23.6)	7 (7.0)
Smoking status (self-report)			
Never smoked	380 (44.5)	363 (49.0)	17 (15.2)*
Formerly smoked	411 (48.2)	367 (49.5)	44 (39.3)
Currently smoking	62 (7.3)	11 (1.5)	51 (45.5)
Diagnosis			
Surgical	195 (22.9)	176 (23.8)	19 (17.0)
Non-surgical	658 (77.1)	565 (76.2)	93 (83.0)
Fitness			
METS	6.0 ± 2.1	6.0 ± 2.1	5.9 ± 2.3
VO2	20.1 ± 6.6	20.2 ± 6.6	20.0 ± 6.7
BMI	29.7 ± 6.0	29.8 ± 5.9	29.3 ± 6.5
MOS-36	64.2 ± 26.9	64.3 ± 27.0	63.7 ± 26.1
PHQ-9	4.0 ± 4.1	3.7 ± 3.9	5.6 ± 4.8*
Sessions of CR completed	21.3 ± 13.2	21.9 ± 13.1	17.6 ± 13.4*

Gaalema et al., currently under review

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Gaalema et al., currently under review

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Effects on Fitness

Objective CO Monitoring Conclusions

- Current smokers are a high-risk group in CR
  - Health effects, depression, impaired fitness
- Screening is low-burden and highly acceptable to patients
- Results suggest that a substantial number of patients are misclassified by relying on self-report alone
- CO measurement also helpful for monitoring, goal setting

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Smoking in those with CVD is Challenging

- Continued smoking number one predictor of subsequent events
- Smoking also a huge predictor of not engaging in secondary prevention
- Cessation obviously difficult
- Need for better treatment

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Need for Intensive Treatment

- Brief/low touch interventions ineffective[1,2]
  - Advice to quit
  - Provision of self-help quit materials
  - Follow-up at post-hospital visit
  - Short-term benefits on quit attempts
  - 12-month follow-up no different

1. Rigotti et al., 2012; 2. Bolman et al., 2002.

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Successful Approaches to Cessation?

- Behavioral approaches with demonstrated efficacy[1]
- Intense counseling with follow-up
  - Initiated during hospitalization
  - Hour with cessation specialist
  - Regular follow-up by phone for at least one month
  - Increases quit rates
- Problem space
  - Most patients abstinent when in-patient
  - Motivated to quit
  - May not be seen again for 4-6 weeks
  - Median time to relapse 1-2 weeks[2]

1. Rigotti et al., 2012. 2. Riley et al., 2018.

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Conclusions

- Disparities in development of and outcomes from cardiac events
  - SES
  - Smoking
- These factors also predict engagement in secondary prevention
- Progress being made in improving engagement in CR among high-risk groups
- Smoking continues to be an issue in need of intense intervention

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Questions?

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