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EUSPR's 3rd International Conference and Members' Meeting

Methods of quantifying change in multiple risk factor interventions

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THESIS

- Risky behaviors -- smoking, alcohol abuse, physical inactivity, and poor diet -- are detrimental to health, costly, and often co-occur.
- Greater efforts are being targeted at multiple health behavior change (MHBC) to more comprehensively address the health needs of individuals and populations.
- With increased interest in MHBC, the field will need ways to conceptualize the issue of overall behavior change.

OVERVIEW

- Definitions
- Prevalence & costs of multiple risks
- Pros & Cons of MHBC
- Review of MHBC trials
- Quantifying change in MHBC outcomes
- Dissemination considerations
- Looking forward

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- **Definitions**
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Risk Behaviors

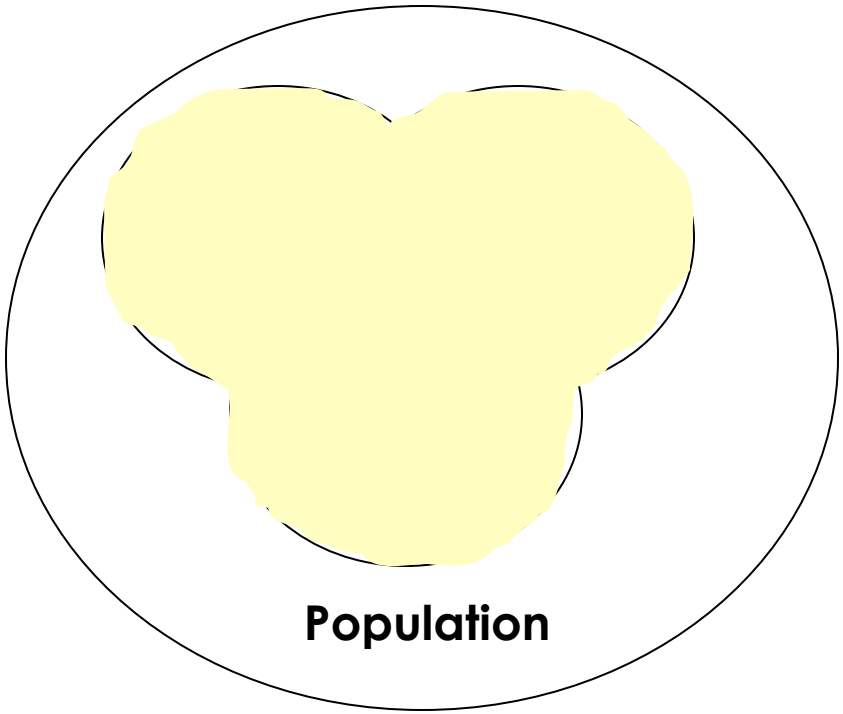
- Actions that impact health
  - Health supporting
  - Health compromising
- Examples:
  - Tobacco, ETOH, illicit drugs, risky sex
  - Physical inactivity & poor diet
  - Cancer screening, immunizations, etc.
- Detrimental to health, costly, and often co-occur

MRBC Interventions

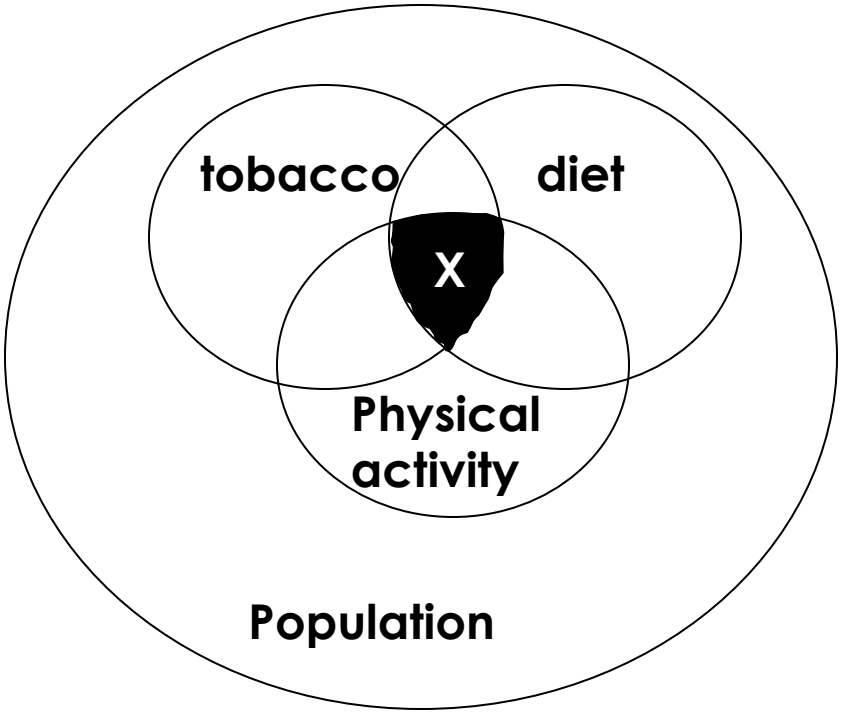
- 2 levels: **Population** vs. **Individual**

MRBC Interventions within **Populations**

- Program of interventions offered to a community with members treated only for behaviors identified as at risk
- With greater behavioral targets, the relevance of the intervention is increased as all members are likely to be at risk for at least one of the targeted behaviors



MRBC Interventions within **Individuals**



- All individuals receive intervention on all targeted behaviors
- The potential impact on an individual's health is increased, as are the behavior change demands
- May be relevant to only a select high-risk group, since participants need to be at risk for all targeted behaviors

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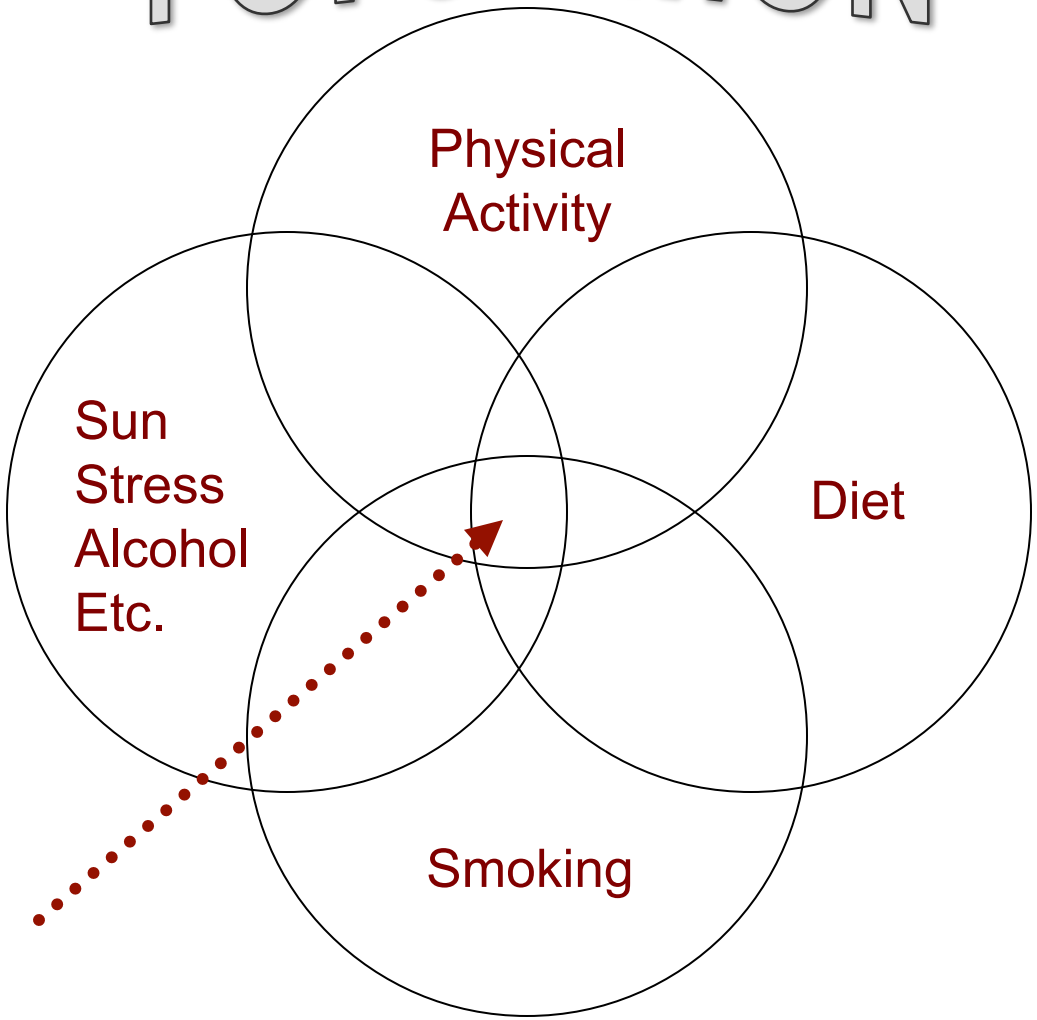
POPULATION



HIGH RISK INDIVIDUALS

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Major causes of death are influenced by multiple risk behaviors

	Cancer	CVD	Diabetes	Obesity
Smoking				
Diet				
Exercise	X			
Alcohol	X	X		
Sun	X			

$2.26 trillion spent on medical care in the US each year

- Pharmaceutical costs: 14%
- Behavioral costs: 60%

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Healthcare Burden

- Multiplies with an increasing number of risks in terms of medical consequences and costs (Edington et al, 1997)

- Effectively treating 2 behaviors reduces healthcare costs by about $2000 / year (Edington, 2001)

Annual Medical Charges by Age & Health Risk Group

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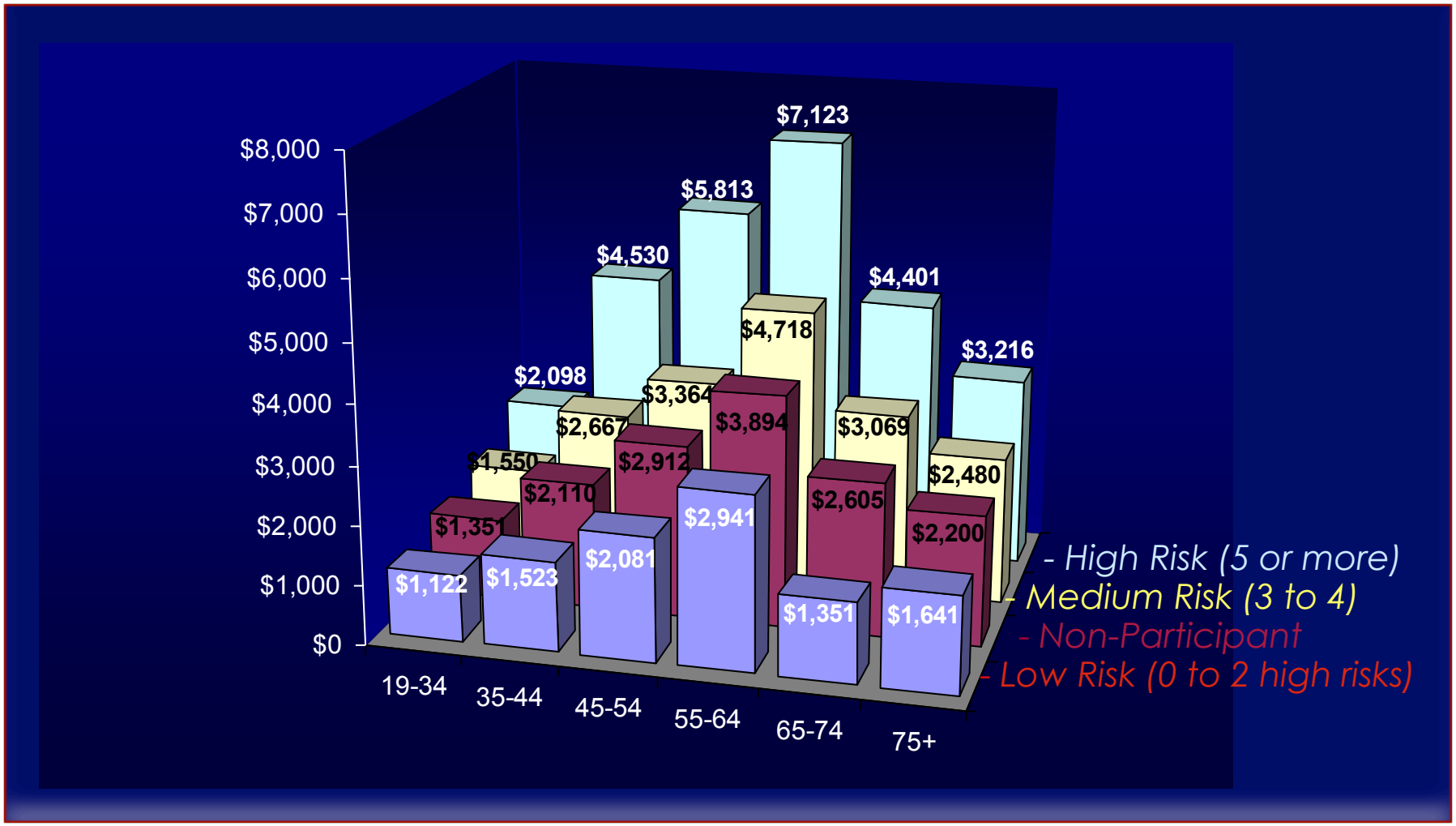

Edington. AJHP. 15(5): 341-349, 2001

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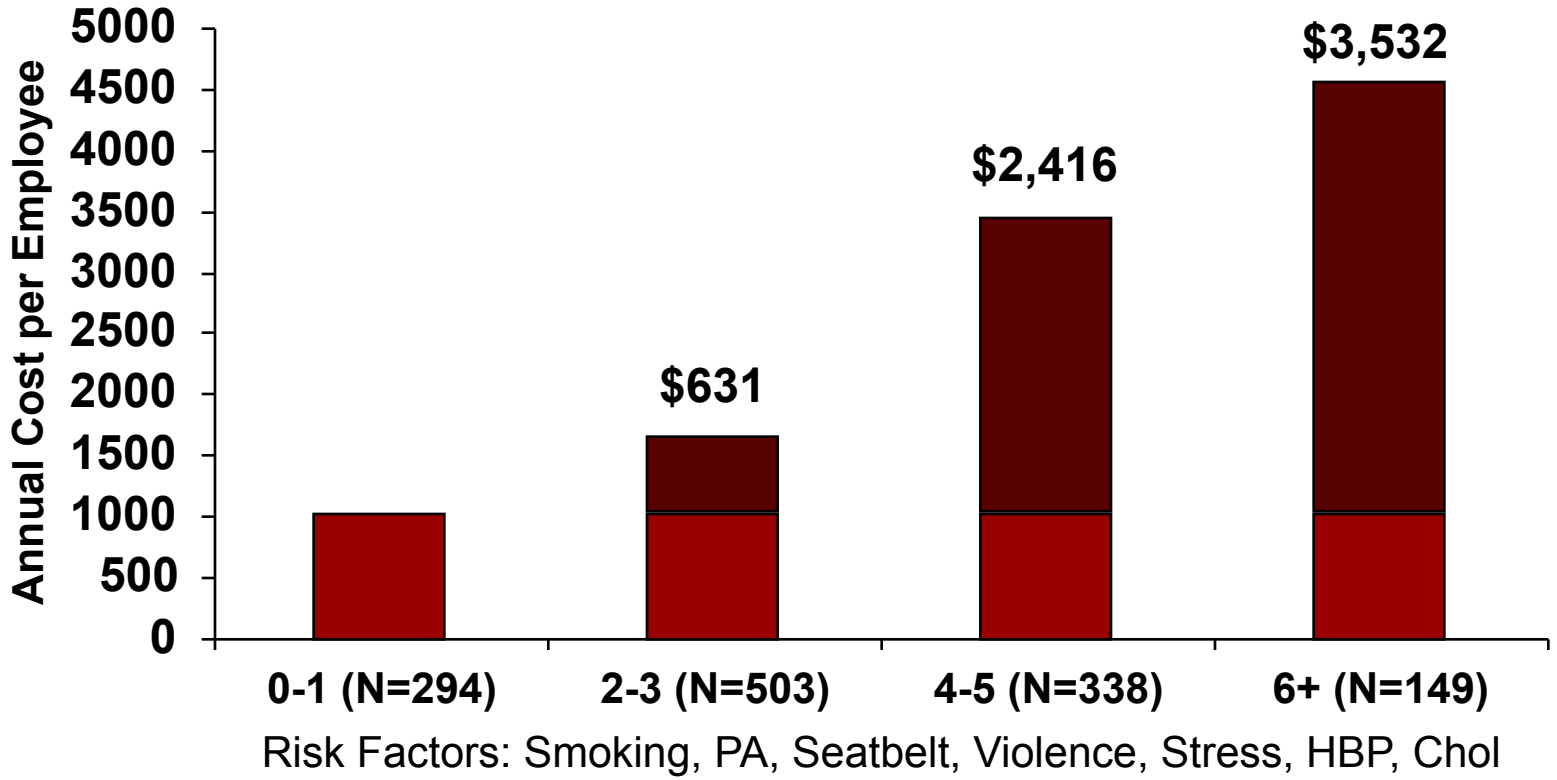
Medical Claims & Absenteeism Costs by Number of Behavioral Risk Factors

Steelcase Hourly Employees

Yen, Edington, Witting (1992) JOM, 36, 428-435



52-Nation INTERHEART Study

- Tobacco use, obesity, lipids, and psychosocial factors
  - Accounted for **90% of the population-attributable risks** for myocardial infarction
- Fruit and vegetable intake and exercise
  - Identified as protective

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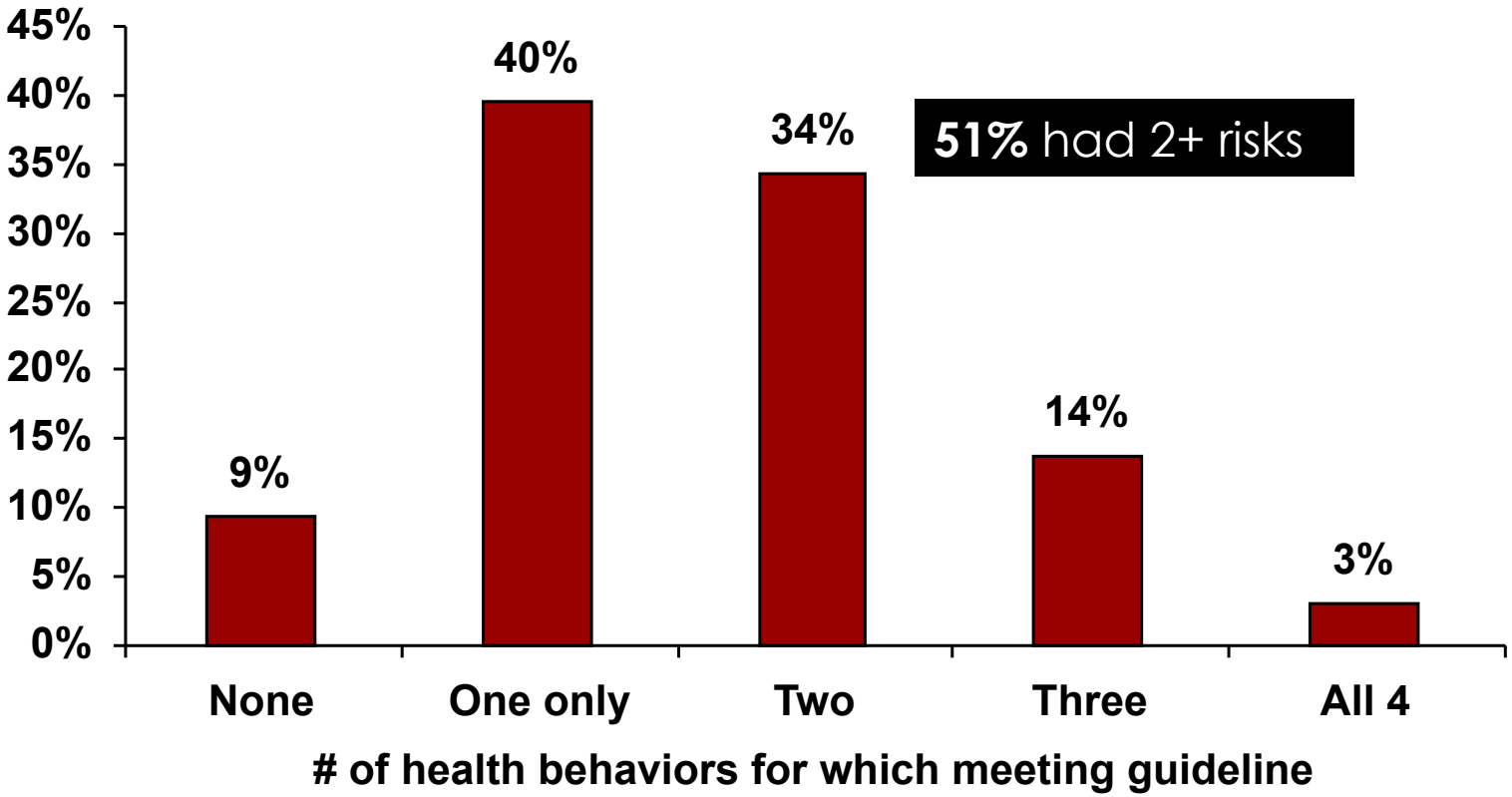
US National Data, BRFSS 2000

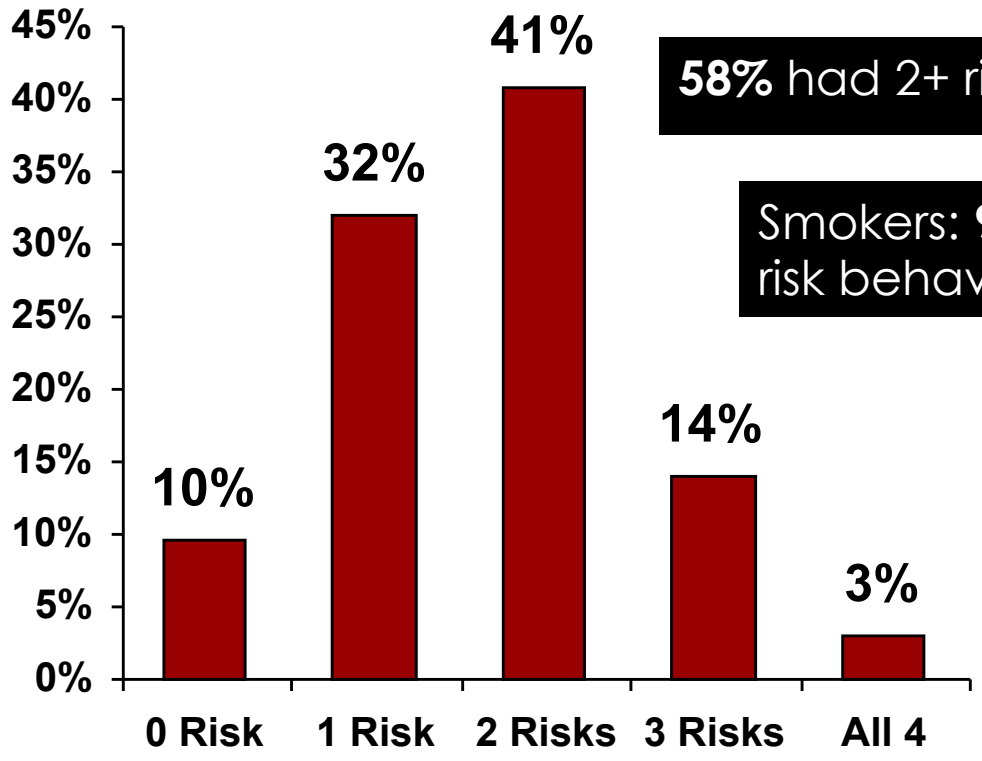
Assessed 4 modifiable lifestyle characteristics—nonsmoking, healthy weight, adequate fruit and vegetable consumption, & physical activity



Reeves & Rafferty (2005)

2001 National Health Interview Study

- Assessed 4 risks—tobacco, risky alcohol use, physical inactivity, and overweight



58% had 2+ risks

Smokers: **90%** had 1+ additional risk behavior

Fine et al. (2004)

NHANES III (Berrigan et al., 2003)

- Examined risk factor combinations for:
  - Tobacco, alcohol, exercise, dietary fat, F/V
- 6% not at risk for any of the 5
- 5% at risk for all 5
  - Lower education/income, younger
- Most common pattern (15%):
  - inactive, high fat, low f/v, but not smoking/alcohol
- Smokers: 98% had 1+ additional risk

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New Concept: "Cardiovascular Health" (Shay et al., 2012 Circulation)

	Poor	Intermediate	Ideal
Tobacco use	Current	Former, quit ≤ 12 mo	Never or quit > 12 mo
BMI	≥ 30	25.0 – 29.9	< 25.0
Physical a… min/wk			…75 VPA, …VPA
H…			
Total cholesterol, mg/dl	≥ 240	200-239 or treated to goal	<200 untreated
Blood pressure mm HG	SBP ≥ 140 or DBP ≥ 90	SBP 120-139, DBP 80-89, or treated to goal	<120 / < 80 untreated
Fasting blood glucose, mg/dl	≥ 126	100-125 mg/dl or treated to goal	< 100 mg/dl untreated

< 1% of US adults met all 7 metrics of ideal CV health

RISK FACTORS for MULTIPLE RISKS

- Lower education
- Uninsured
- Higher mental distress
- Tobacco use
- Alcohol or illicit drug abuse/dependence

❖Increased risk for morbidity and premature mortality and incur greater health care costs

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RISK BEHAVIORS in PSYCHIATRIC POPULATIONS

- Smoking rates 2 to 4 x's that of the general population
- Elevated alcohol / illicit drug use
- Increased overweight and obesity risk
- Increased sleep disturbance
- ✸ Dying on average 25 yrs prematurely with major causes being chronic dzs

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Multibehavioral interventions have the potential to:

+ Offer greater health benefits
+ Maximize health promotion opportunities
+ Reduce health care costs
+ Address participants' complex behavior profiles

MHBC Interventions

- Few successes
- Concern that treating multiple risks will detract/reduce treatment effect on single risk
  - Overwhelm participants
  - Behavioral interference
- **No clear methods for quantifying change in multiple risks**

Survey of 24 Benefits & 31 Challenges of MHBC Interventions

- Emailed to listservs of Society of Behavioral Medicine members
- 69 respondents
- 43% MHBC SIG members
- Focus of work:
  - 87% research
  - 14% clinical practice
  - 24% teaching
  - 4% other

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Top 10 Rated Benefits & Challenges of MHBC Interventions

1	Provide greater real-world applicability (bxs don't occur in a vacuum)	B
2	Potential to result in greater improvements in quality & length of life	B
3	Address the multiple health risks of individuals & populations, more holistic	B
4	Facilitate translation of research into health care b/c most pts have multiple risks	B
5	Provide more information about effective treatments for behaviors that commonly co-occur	B
6	May reduce costs of treatment of diseases for patients and society	B
7	Make behavioral medicine more relevant to the system, health professionals, and individuals served: matches the needs of real-world settings	B
8	Can address the attitudes and beliefs common across behaviors	B
9	Can teach people what is important for a healthy life	B
10	Can help determine common mediators of change across behaviors	B
20	Are challenged by the need for developing "integrated" systems	C

Relationship between Benefits & Challenges

- Ratings of benefits & challenges unrelated
- MHBC respondents rated the total benefits of MHBC significantly higher than:
  - Individuals focused on individual risks
  - The challenges of MHBC

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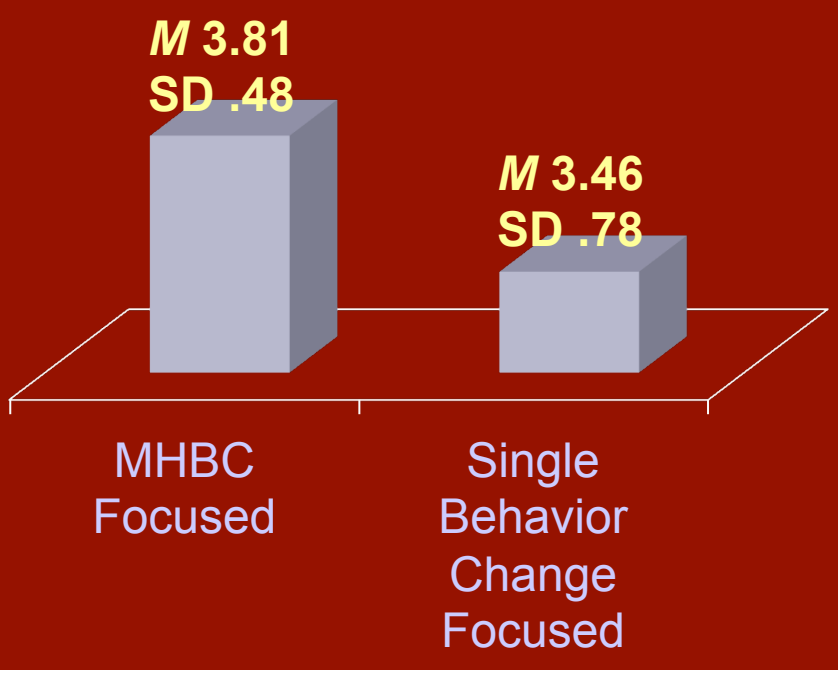
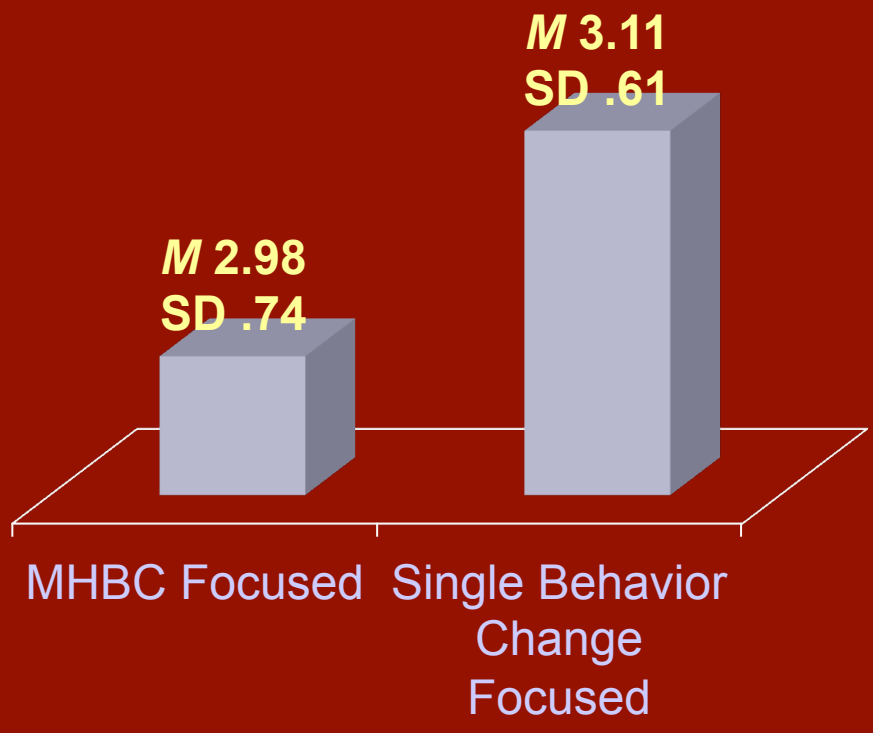
Benefits & Challenges

Rated on a scale from 1 (not) to 5 (extremely) important

Total Mean Score MHBC Interventions Benefits



Total Mean Score for MHBC Interventions Challenges



MHBC Survey & Theory

- 75% used Social Learning/Cognitive Theory

- MHBC researchers/practitioners more likely to use Transtheoretical Model (74%) than single behavior change researchers/practitioners (42%)

Action Paradigm

- Historically used by researchers
- Prescribes immediate action for behavior change
- When instructed to change multiple behavioral risks, individuals may become overwhelmed, disillusioned, and ineffective at making any changes

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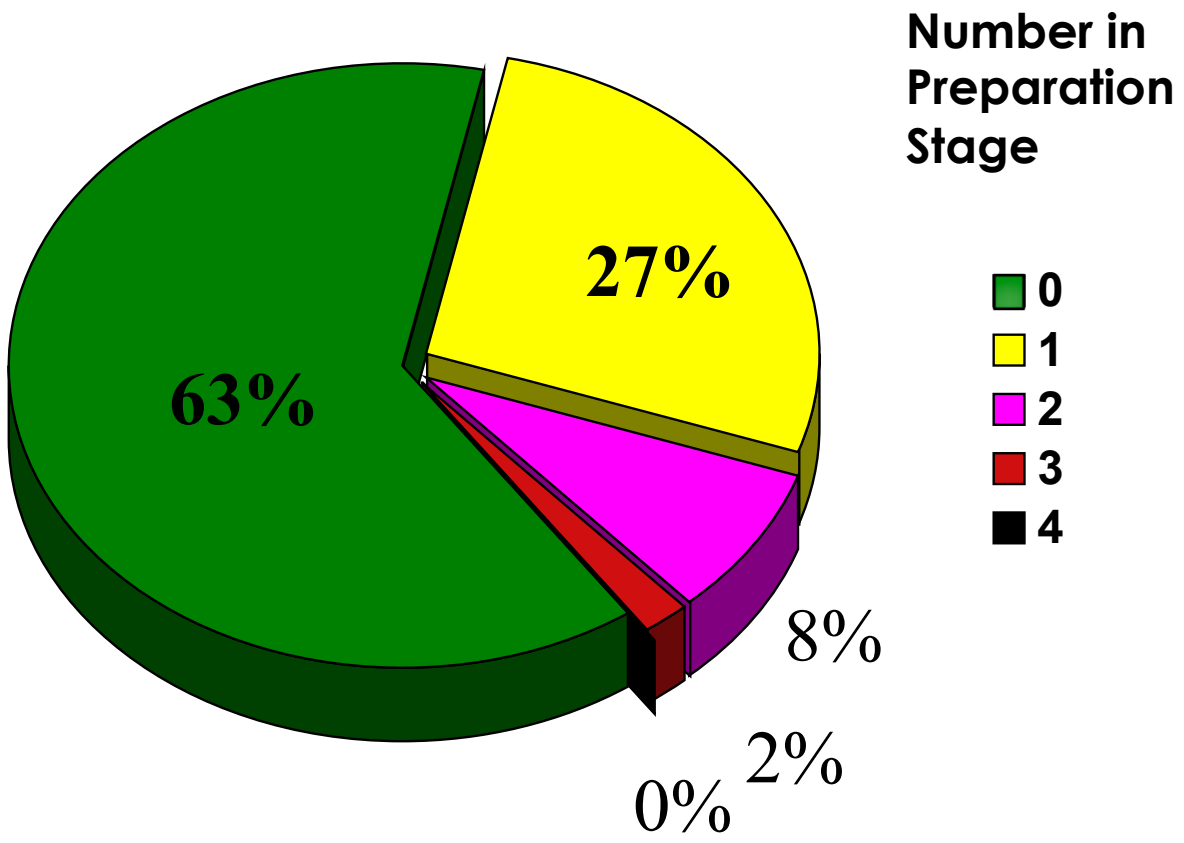
Number of Risk Factors in Preparation Among 3,616 Current Smokers



Risk Factors: Smoking, Avoid High Fat, Regular Exercise, Use Sunscreen

Transtheoretical Model (TTM)

- Contrast to action-oriented paradigms
- Tailoring of strategies to individual's intention and readiness to change

  -- J.O. Prochaska, DiClemente, & Norcross (1992)

- 5 Stages of Change:
  - Precontemplation → Contemplation → Preparation → Action → Maintenance
- Relevant to over 20 problem or target behaviors

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Project Jumbo

- Factorial design to evaluate the independent contributions and joint effects of targeting diet, physical activity, and smoking habits in a single trial
- Deemed too costly and never conducted

MHBC Interventions in Populations

- Cochrane Review (Ebrahim et al., 2006)
  - *Multiple Risk Factor Intervention Trial (MRFIT), North Karelia Project, Stanford Three- and Five-City Projects, Pawtucket and Minnesota Heart Health Programs, etc.*
- 20% Net reduction in smoking prevalence
- Changes in dietary and physical activity behaviors not reported
- Pooled effects suggested no effect on mortality

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MHBC Interventions in Individuals in Primary Care

- Goldstein et al. (2004) reviewed MRBC interventions in primary care
- Large gaps remain in our knowledge about the efficacy of interventions to address multiple behavioral risk factors
- Strongest evidence aimed at secondary rather than primary prevention (diabetes, CVD)

AJLM Review

- RCTs of MHBC interventions for primary prevention (2004-2009)
- < 150 studies identified
- Few tested MHBC vs. single bx change
  1. Energy Balance (PA/Diet)
  2. Addictive (tob/alc/illicit drugs)
  3. Dz-related (CVD, Cancer)

Prochaska & Prochaska (2011) AJLM

Energy Balance

- 31 unique studies youth BMI
  - 9 significant effects, 5 in both genders
- 23 unique studies youth PA/diet
  - 3 significant both bxs, 1 PA only, 1 diet only
- For adults:
  - Single interventions more effective at increasing the behaviors
  - MHBC interventions more effective for wt loss & wt gain prevention

Addictive Behaviors

- 1 of 13 PA-tobacco studies produced significantly more abstinence from smoking at long-term FU
- 19 trials Tob-Alc/drugs:
  - Significant post-tx tobacco
  - NS long-term tobacco
  - Significant long-term sobriety

Disease-Related

- 7 RCTs MHBC for cancer prevention
  - 20,000 participants
  - All trials significant effects on MHBC
  - 4 of 7 NS on tobacco but low power
  - More programmatic, same bxs with same tx, same theory (TTM)

Simultaneous vs Sequential

- Only 4 studies tested the issue directly
- No significant difference in outcomes by the timing of the intervention on multiple risks

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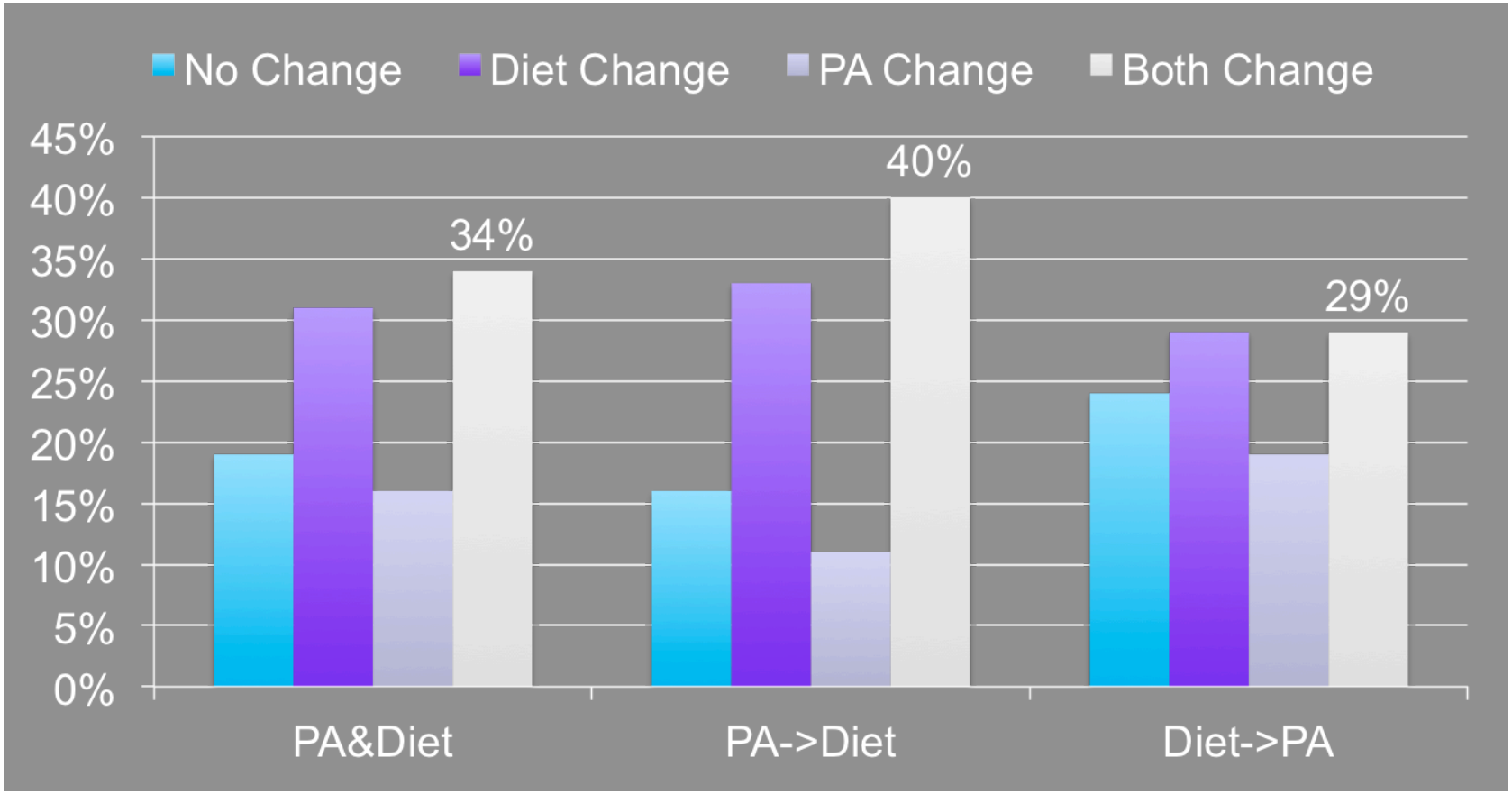
PA & Diet: Vandelanotte et al. (2008)



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Tobacco & Diet: Spring et al. (2004)

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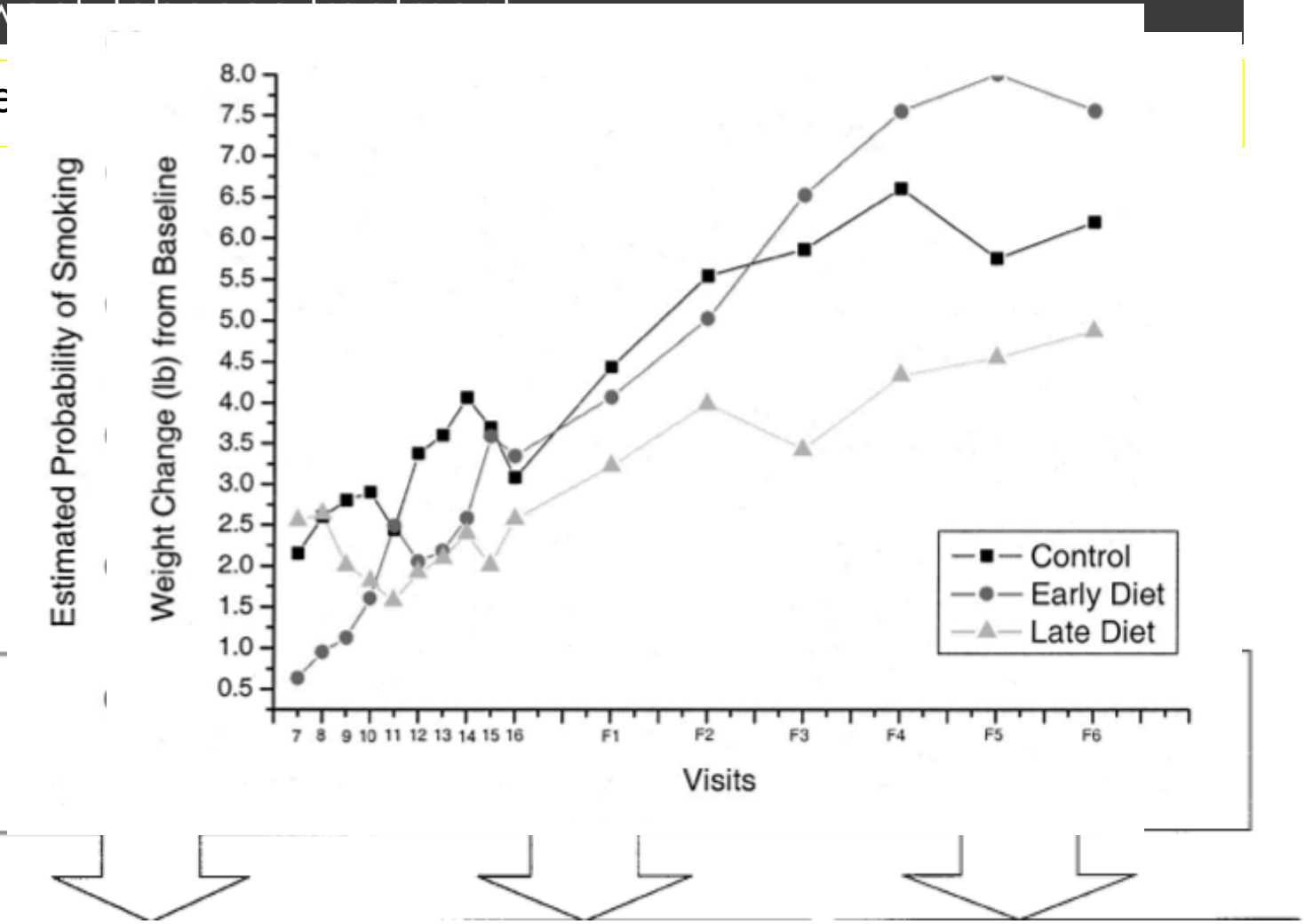

Alcohol & Tobacco:
Joseph et al. (2004)

- Concurrent group more likely to participate in smoking treatment than delayed group (78.5% vs 64.5%, p = .005)
- No significant difference in cessation rates at 18 months (12.4% vs 13.7%)
- Prolonged, 6-month abstinence from alcohol was significantly worse in the concurrent group at 6 but not 12 or 18 months

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Methods for Quantifying Change in MHBC Interventions

1. Report behavior changes individually
2. Create a combined statistical index
3. Use a behavioral index
4. Calculate an overall impact factor
5. Use overarching outcome measures
6. Identification of latent classes & transitions

1. Individual Behavior Changes

- The traditional approach of analyzing change in each behavior separately
- Use in the literature is widespread
- Diversity of outcomes and effects make it difficult to synthesize findings or determine overall impact on multiple behavioral risks

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Comparing Intervention Outcomes in Smokers Treated for Single versus Multiple Behavioral Risks

Judith Prochaska, PhD, MPH[1], Wayne Velicer, PhD[2], James Prochaska, PhD[2], Kevin Delucchi, PhD[1], Sharon Hall, PhD[1]

[1]*Department of Psychiatry, UCSF*

[2]*Cancer Prevention Research Center, URI*

Study supported by NIH Grants CA 50087 and CA 27821 and the California Tobacco Related Disease Research Program (#11FT-0013 and #13KT-0152)

Cancer Prevention Research Center

Health Psychology (2006) vol 25., no. 3, 380-388

TRC SAN FRANCISCO

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STUDY DESIGN

- 2326 smokers participating in three population-based, stage-tailored, multibehavioral, randomized trials targeting tobacco, high fat diet, and high-risk sun exposure.
- At baseline, participants at risk for:
  - Smoking only (13%)
  - Smoking +1 (37%)
  - Smoking +2 additional risk behaviors (50%)
- Assessments @ baseline, 12, and 24 months

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GEE Model Predicting: Smoking Abstinence

Parameter	OR	95% CI	Z	p-value
Female	.81	.62, 1.07	-1.45	.146
Age[†]	.87	.76, .99	-2.09	.036
Education	1.01	.97, 1.07	.59	.559
Stage of change at baseline				
Preparation vs. Precontemplation	2.42	1.71, 3.42	4.96	<.001
Preparation vs. Contemplation	1.79	1.32, 2.42	3.81	<.001
Cigarettes per day at baseline	.97	.95, .99	-3.64	<.001
Quit attempts past year	1.00	.96, 1.05	.21	.833
Longest previous quit attempt (yrs)	1.08	1.02, 1.15	2.55	.011
Time (24 vs. 12 months)	1.68	1.45, 1.95	6.87	<.001
Treatment (intervention vs. control)	1.47	1.15, 1.88	3.05	.002
Risk group				
Smoking Only vs. Smoking +1 RF	1.21	.81, 1.79	.93	.351
Smoking Only vs. Smoking +2 RF	1.34	.90, 2.00	1.44	.149
Study				
Employee vs. Patient	1.14	.79, 1.65	.68	.496
Parent vs. Patient	.97	.73, 1.29	-.20	.844
Missing parameter (complete data)	1.52	1.11, 2.08	2.62	.009

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GEE Model Predicting: Change in High-Risk Sun Exposure

Parameter	OR	95% CI	Z	p-value
Female	1.84	1.27, 2.67	10.43	.001
Age[†]	1.02	1.00, 1.03	4.04	.044
Education	1.01	.94, 1.09	.14	.709
Sun Stage of change at baseline				
Preparation vs. Precontemplation	7.13	4.61, 11.0	78.09	<.001
Preparation vs. Contemplation	2.26	1.35, 3.79	9.61	.002
Perceived health	1.06	.89, 1.26	.48	.490
Time (24 vs. 12 months)	1.11	.90, 1.37	.94	.332
Treatment (intervention vs. control)	1.42	1.02, 1.97	4.43	.035
Risk group				
Smoking + Sun vs. All 3 RFs	1.03	.72, 1.48	.03	.871
Study				
Employee vs. Patient	1.30	.79, 2.14	1.08	.299
Parent vs. Patient	1.25	.86, 1.80	1.40	.237
Missing parameter (complete data)	1.02	.70, 1.50	.01	.910

GEE Model Predicting: Dietary Change

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Parameter	OR	95% CI	Z	p-value
Female	1.94	1.42, 2.65	17.08	<.001
Age[†]	1.00	.99, 1.01	.01	.926
Education	1.05	1.00, 1.10	4.28	.039
Diet Stage of change at baseline				
Preparation vs. Precontemplation	1.80	1.35, 2.39	15.94	<.001
Contemplation vs. Precontemplation	1.49	1.02, 2.16	4.33	.038
Perceived health	1.27	1.10, 1.47	10.31	.001
Time (24 vs. 12 months)	1.22	1.00, 1.49	3.86	.049
Treatment (intervention vs. control)	1.27	.98, 1.65	3.32	.068
Risk group				
Smoking + Diet vs. All 3 RFs	1.30	.98, 1.73	3.30	.069
Study				
Employee vs. Patient	1.65	1.12, 2.42	6.54	.011
Parent vs. Patient	1.11	.82, 1.50	.49	.482
Missing parameter (complete data)	1.03	.74, 1.42	.02	.877

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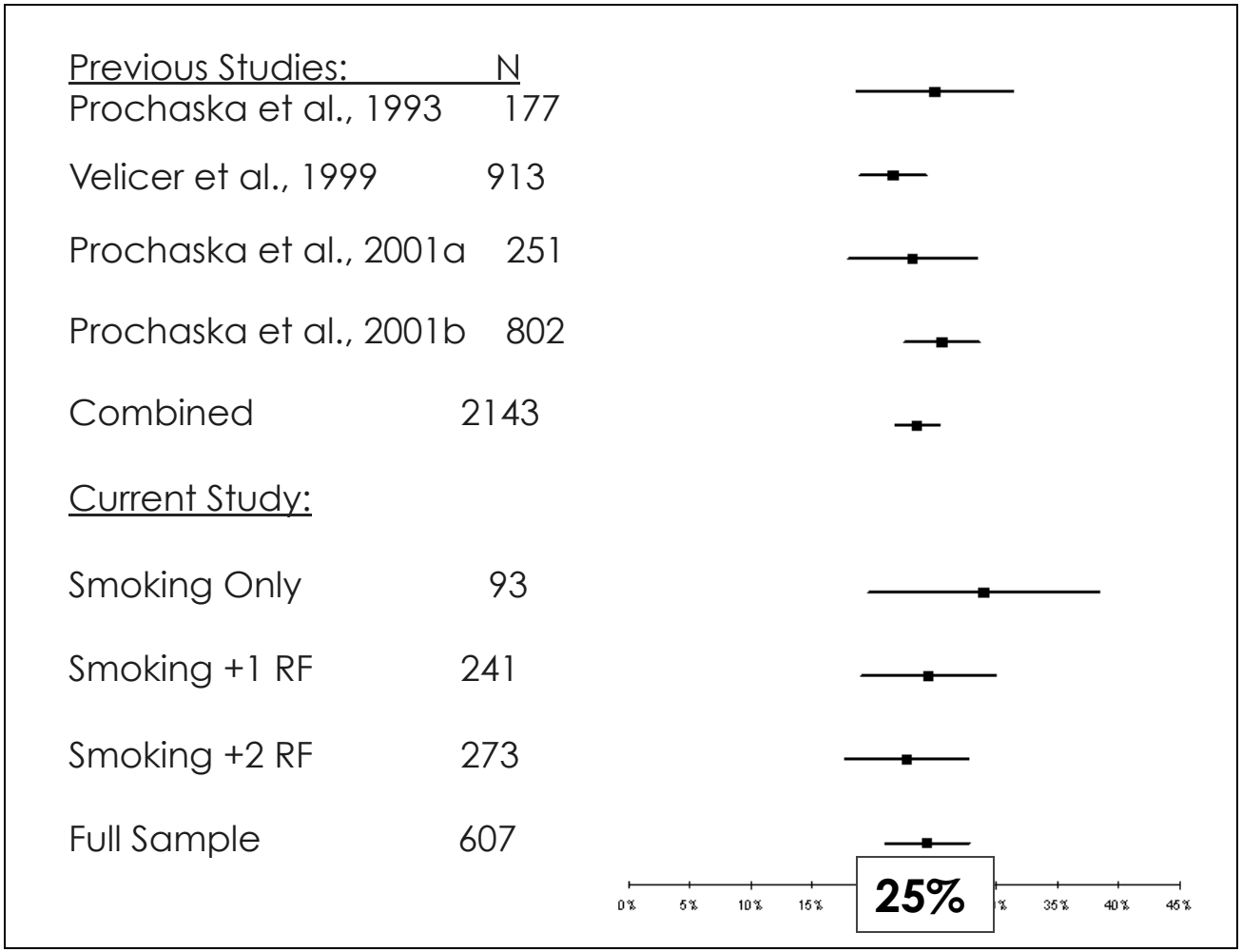
Comparison of 24-month Quit Rates to Previous TTM-based Expert System Smoking Only Studies



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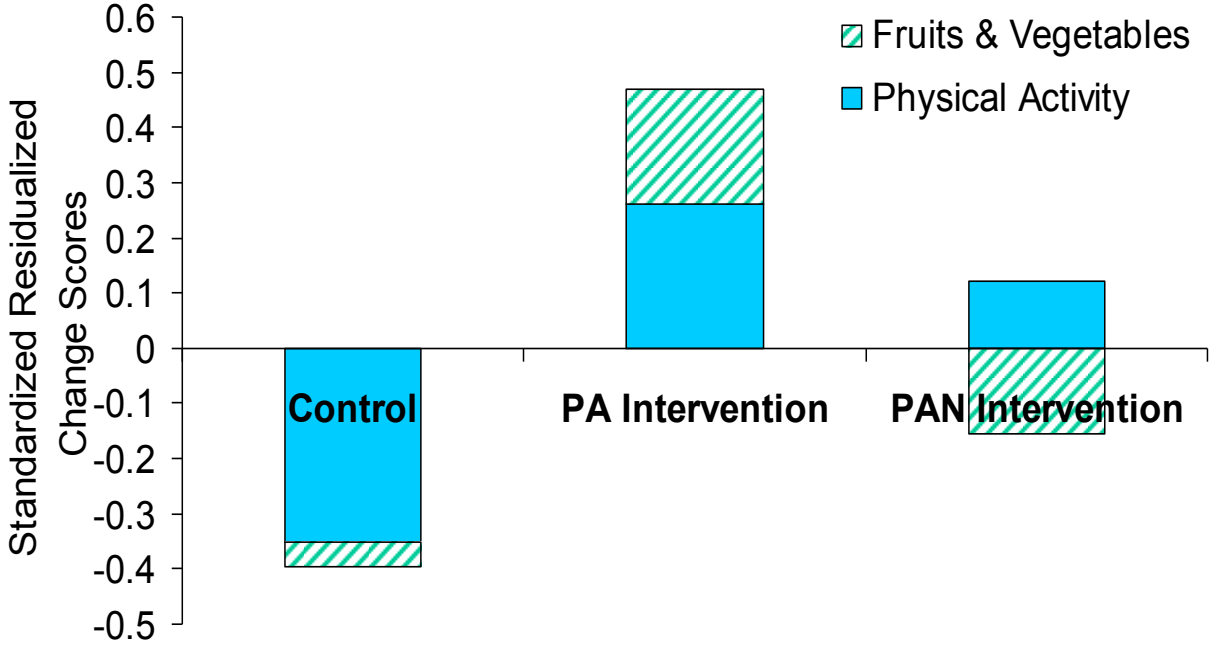
2. Combined Statistical Index

- Study evaluated change in physical activity and fruits and vegetables using **standardized residualized change scores**. The combined index allows for conceptualization of the overall amount of behavior change achieved as well as the relative contribution of each behavioral target.



J.J. Prochaska & Sallis (2004). *Health Psychology, 23,* 314-318

Benefits & Limitations

- Benefits:
  - Use of a continuous outcome (greater power)
  - Focus on change
  - Assignment of equal wts to each behavior (+/-)

- Limitations:
  - May lack meaning in terms of health benefits
  - Difficult for media/policy makers to interpret
  - Treats each behavior equally (+/-)
  - Not (yet) widely used & documented
  - Not suited to address if significant change across time overall (i.e., ignoring groups)

3. Behavioral Indices

- The Framingham Heart Study risk score
- The Cooper Clinic mortality risk index
- Cancer risk indices
- Dietary quality indices
- The Multiple Risk Factor Intervention Trial

Benefits & Limitations

- Benefits:
  - Directly address national goals
    - e.g., Health People 2020
  - Easy to interpret
  - Allows for comparison to single behavior interventions
- Limitations:
  - Difficult to decide on criterion for success,
  - Dichotomizing decreases sensitivity of outcomes
  - Credit gained only for reaching criterion

Recent Publication Example

- Physical activity & nutrition intervention
  - Moderate-to-vigorous PA
  - Sedentary time
  - Dietary fat
  - Fruits & vegetables

Carlson et al., 2012 Prev Med

Metric	Unstandardized B	95% CI	Standardized B
Standardized residualized change score	1.34**	0.86, 1.82	0.28**
Risk factor change index	-0.41**	-0.61, -0.20	-0.18**

4. Expanded Impact Formula

Impact (I) = $\Sigma_{\text{\# of behaviors(n)}} (E_n \times P_n)$

- Impact calculated as intervention efficacy (*E*) times participation (*P*) summed over the multibehavioral targets.
  - Within populations, *P* is the proportion of at risk individuals participating in the intervention for each behavior
  - Within individuals, *P* is the study recruitment rate
- Use of a common metric for efficacy, e.g., % no longer at risk (Action/Maintenance stages), allows for summation across behaviors

$Impact = \Sigma_{\#\ of\ behaviors(n)} (E_{fficacy} \times P_{articipation})$

Study	Target Behavior	% at Risk	Efficacy at 24 mo.	Individual Impact	Impact on Participants	Impact on Pop.
Primary Care Patients (JO Prochaska et al. 2005) **N=5407**	Smoking	22%	25%	.06	.43	.30 RR=.69
	Diet	68%	29%	.20		
	Sun Exposure	71%	23%	.17		
Parents of HS Students (JO Prochaska et al. 2004) **N=2460**	Smoking	29%	22%	.06	.53	.45 RR=.84
	Diet	74%	34%	.25		
	Sun Exposure	73%	30%	.22		

Significance of Impact Factor

- A measure for assessing the impact of interventions for treating multiple behavior risks, in individuals and populations

- Increased with greater intervention efficacy, # of behavioral targets, and participation among individuals in the target population

5. Overarching Measures

- Quality of Life
- Obesity or other disease state
- Cholesterol level, blood pressure
- Mortality

5. Overarching Measures of Change

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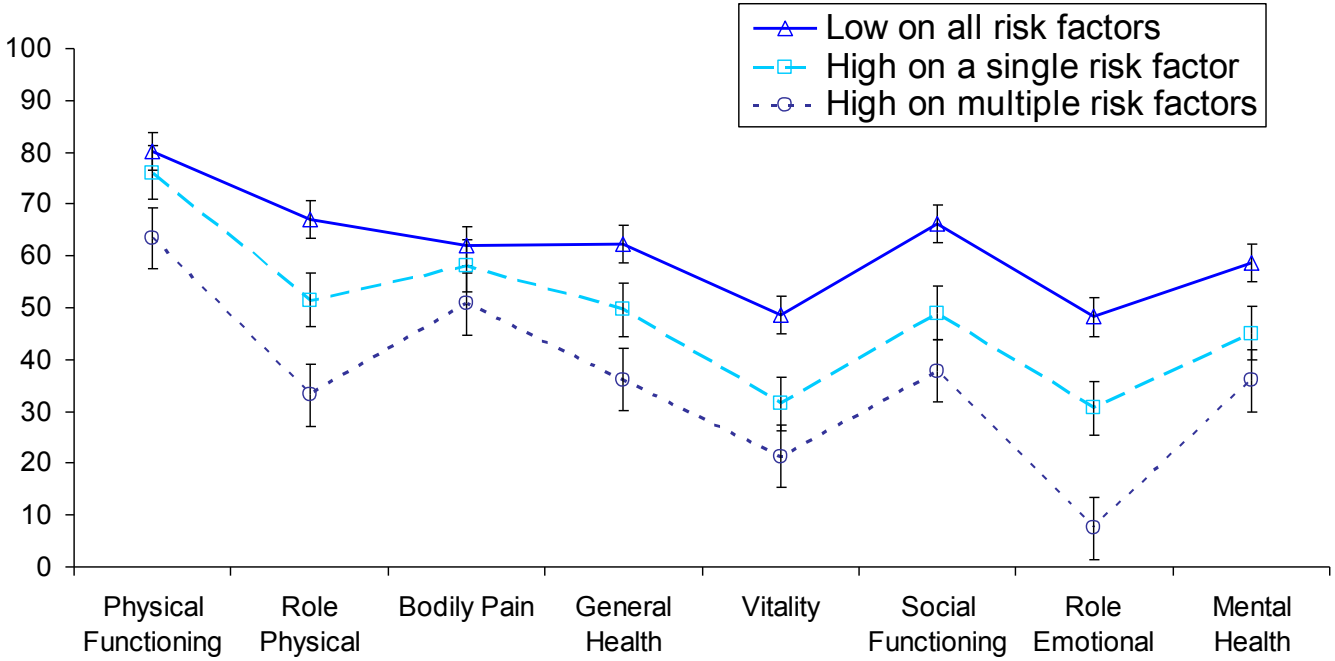
- Examined risk-related subgroups based on depression scores (BDI-II ≥ 20), cigarettes per day (≥ 1 pack), and opiate use (yes, no). The severity of risk factors was monotonically related to health functioning scores on the *SF-12 Medical Outcomes Study Short Form*.



JJ Prochaska et al. (2004). *Drug and Alcohol Dependence*, 78, 169-175

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Lifestyle Heart Trial (Ornish et al., 1998)

- An intensive intervention for patients with moderate to severe coronary artery disease
- Significant intervention effects with reductions in:
  - Weight
  - LDL cholesterol
  - Arterial diameter stenosis
  - Cardiac events

Mediterranean Lifestyle Program (Toobert et al., 2007)

- Randomized clinical trial for postmenopausal women with type II DM
- Changes in:
  - all targeted lifestyle behaviors
  - use of supportive resources
  - problem-solving
  - self-efficacy
  - quality of life

6. LATENT CLASS ANALYSIS (LCA)

- Identify unobservable groups or subtypes called "latent classes" of cases in multivariate categorical data
- Can be used to better understand the:
  - Impact of exposure to patterns of multiple risks,
  - Antecedents and consequences of complex behaviors,
  - Ways to tailor interventions to target subgroups that will benefit most
- Latent transition analysis (LTA) is a related method that allows scientists to estimate movement (change) between subgroups *over time*.

Nylund, Asparouhov, & Muthen, 2007

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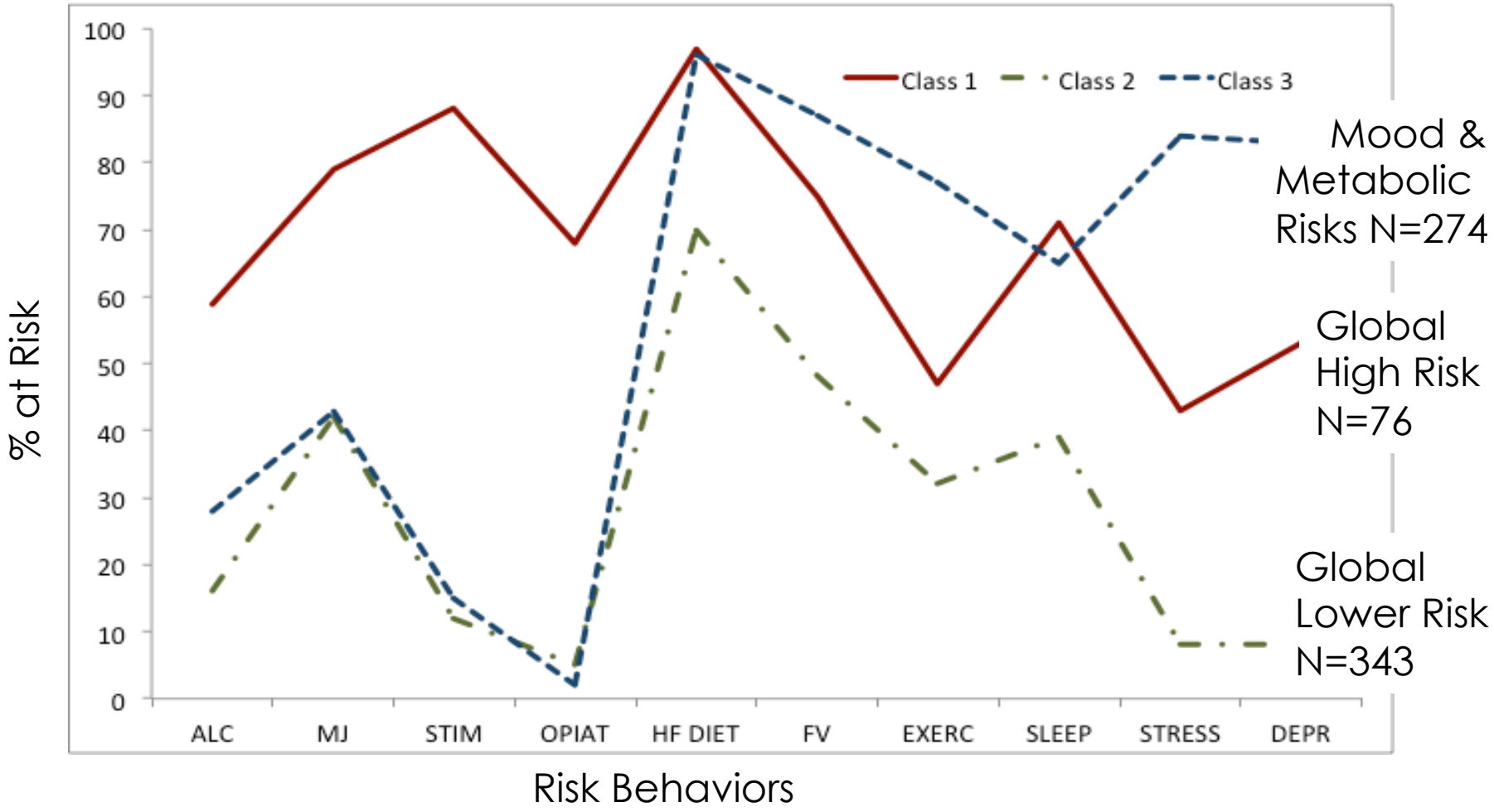
Multiple Risk Behavior Profiles of Smokers with Serious Mental Illness



Risk Profiles

- **Global High Risk Group**
  - Male (65%)
  - Younger (34 yrs)
  - Never married (72%)
  - Unstably housed (57%)
  - Poorer mental health
  - Bipolar Disorder (67%)
  - ADHD (65%)
  - ASPD (50%)
  - Heavier smokers (20 cpd)
  - Smoked younger (12 yo)
- **Mood & Metabolic Group**
  - Poorest mental health
  - Most severe depression
  - Lowest rating of social standing in US

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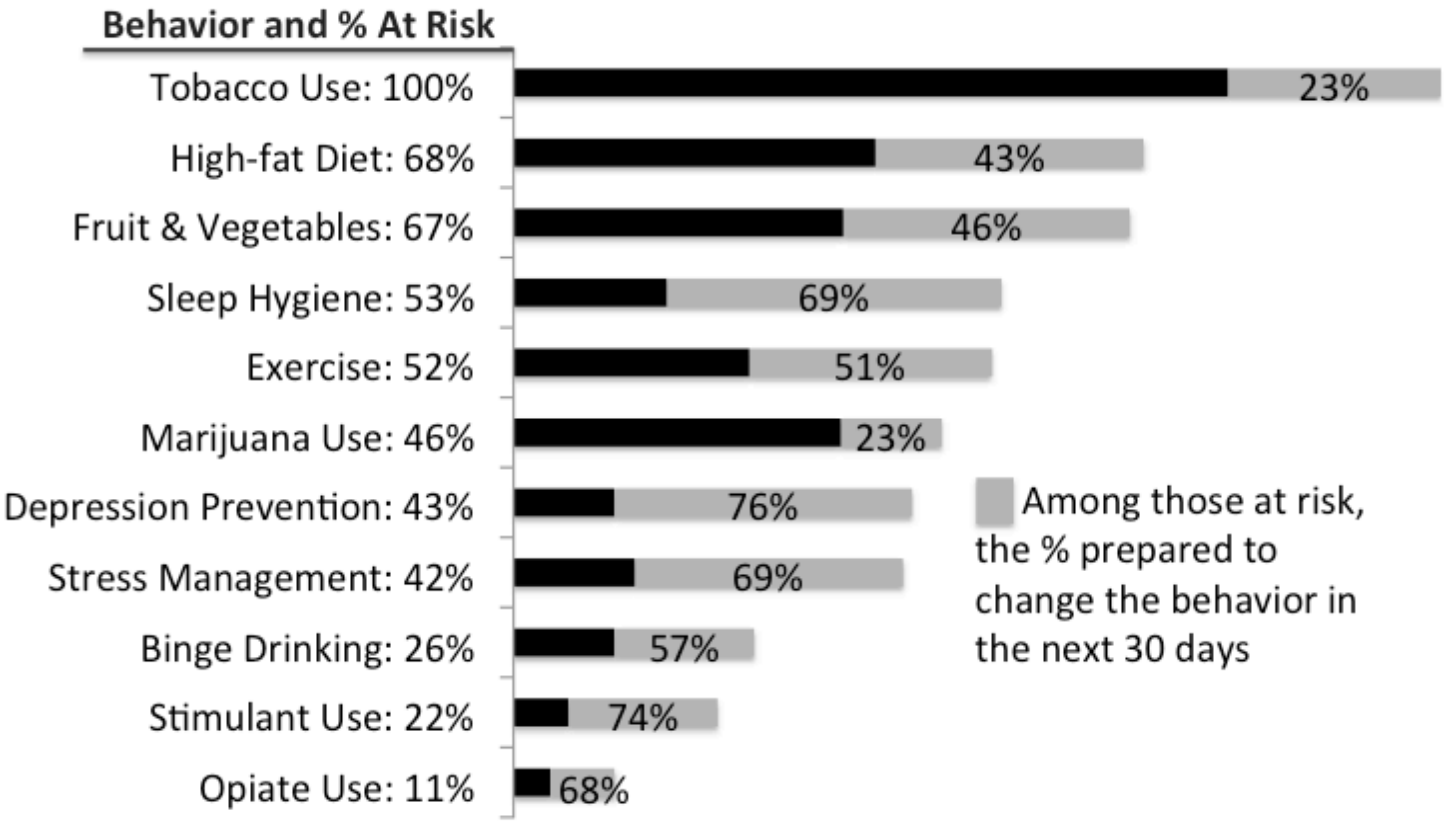
Readiness to Change Risk Behaviors



Recommendations

- In analyzing MHBC outcomes:
  - consider the perspectives of researchers, practitioners, policymakers, individuals & communities
- Employ and compare multiple methods in your publications

OVERVIEW

- Definitions
- Prevalence & costs of multiple risks
- Pros & Cons of MHBC
- Review of MHBC trials
- Quantifying change in MHBC outcomes
- **Dissemination considerations**
- Looking forward

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Dissemination Considerations

- Settings: clinics, schools, and worksites
- Current best practices: using interactive behavior change technologies and tailored feedback
  - e.g., computer-delivered, expert system interventions (online, CD-Rom)

Dissemination Considerations

- Challenging to make impact within short medical appointments
- Key considerations:
  - Involving the target population and organizations in intervention design and development
  - Reducing barriers to participation
  - Being mindful of feasibility issues and breadth of appeal to the target system

-- C. Nigg et al., 2002

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Need for More MRBC Research

- Questions remain with "whether, or in which situations, multiple risk factor interventions are *more* effective or efficient at reducing risk than targeted single interventions"

  -- Atkins & Clancy, 2004

- Does impact of sequencing vs. concurrent change goals differ for different behaviors
- MRBC theory, optimal analyses, developmental considerations, etc.

Vision for the Future

- Impacts will require shifts from:
  - An action paradigm → a stage paradigm
  - Reactive recruitment → proactive recruitment
  - Expecting participants to match the needs of program → having programs match their needs
  - Clinic-based → population-based programs
  - Single behavior change programs → Multiple health behavior change programs

Vision for the Future

- Health care systems increase services that improve health and reduce health care costs
- Effectively treating 2 behaviors reduces health care costs by about $2000/year (Edington, 2001)
- Over time, population-based MHBC programs could pay for themselves