
Socioecological Models: Strengthening Intervention Research in Tobacco Control

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Abstract

Some aspects of the tobacco control field have been informed by a broader conceptualization of the complex factors that determine population health. Tobacco control programs increasingly include multi-level interventions and policy changes to influence context. Further, socioecological concepts (e.g., strategies targeting intrapersonal, interpersonal and socioenvironmental interactions) are implicit in many comprehensive tobacco reduction policies. In contrast, tobacco intervention research lags behind this progression, with individual level strategies continuing to dominate the research agenda. New research methods are suggested to strengthen intervention research in tobacco prevention and cessation. Developmental transitions are briefly explored to consider the impact of developmental vulnerability and resiliency on youth tobacco use, providing an expanded focus and new opportunities for intervention research.

Keywords: *tobacco, intervention research, socioecological models, multiple interventions*

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Introduction

Contemporary tobacco control programs increasingly apply multi-level and multi-strategy approaches (Ontario Tobacco Research Unit, 2003; Campaign for Tobacco-Free Kids, 2003; Centres for Disease Control and Prevention, 1999; O'Connor et coll., 2001). These programs are consistent with our deepening understanding of the complex and nested determinants that influence patterns of tobacco use (Smedley et Syme, 2001; Green, 1996). Researchers have contributed substantial insights into these determinants, yielding more sophisticated socio-ecological models to guide comprehensive tobacco control programs. However, a gap exists in that *intervention research* on tobacco prevention and cessation does not fully incorporate the same socio-ecological perspective. We suggest that the field of intervention research on tobacco control needs to use a socio-ecological perspective to better reflect how underlying determinants and their corresponding pathways interact.

The purpose of this paper is to discuss how socioecological models might better inform intervention research in the field

of tobacco control. We make a distinction among the terms “intervention research”, “programs” and “policies”. Intervention research refers to the evaluation of cessation treatments or prevention innovations for efficacy or effectiveness. We use the term “programs” to refer to community-based services that may or may not be evaluated. Policies refer to broad strategic priorities that guide planning and programs within a geopolitical jurisdiction. Determinants refer to the independent variables or factors associated with tobacco initiation, use or cessation; nested determinants reflect the hierarchical, interdependent or reciprocal relationship among some variables, such as youth smoking attitude that is nested with the larger issue within family and peer smoking patterns.

We begin with a brief discussion of socioecological models. We then present the state of the evidence on tobacco control interventions vis-à-vis our growing understanding of underlying determinants. We provide examples of comprehensive tobacco control programs and policies consistent with a socioecological approach. To advance the field of intervention research, we discuss the implications of using a socioecological framework to guide the selection of research designs and methods for intervention studies. Finally, using the case example of adolescents and developmental transitions, we then illustrate how the refined and nuanced thinking behind socioecological models illustrates intersecting pathways and provides new opportunities for tobacco control points of intervention.

Exploring Socio-ecological Models

Socio-ecological models describe the relationship between health behaviors and interpersonal, organizational, community and social subsystems (Green, Richard, & Potvin, 1996; Richard, Potvin, Kishchuk, Prlic, & Green, 1996; Sallis et Owen, 1997). Such models help articulate the complexities of health

determinants and the environmental influences on health (Green, et coll., 1996). This type of systems thinking points to the need to create environmental conditions that support and promote effective and sustainable behavior change.

Over the last few decades a shift has occurred in health promotion conceptual frameworks. Practitioners and researchers have come to recognize the limitations of focusing on individual behaviour change and have moved toward approaches that respond to the reciprocity between biology, health behaviours and the environment (Green, 2006). Canada has been a world leader in this shift, conceptualizing health from a broad perspective (Lalonde, 1974; WHO, 1986; Epp, 1986; Labonte, 1993) and correspondingly describing the environmental and social influences on health (Federal, Provincial, and Territorial Advisory Committee on Population, 1999; Health Canada, 2002).

Socio-ecological models help with the identification of determinants at different system levels and suggest relationships between and among them. Determinants such as smoking policies, peer networks and income are commonly understood, derived from research examining links between risk factors and tobacco use. More embedded or implicit determinants, such as cultural expectations, for instance, may be overlooked. Socio-ecological models also suggest complex interconnections among these determinants. For example, not only do the determinants affect the outcome, but the determinants may also influence or modify each other. Taxes on cigarettes have a strong influence on cigarette consumption when disposable income is limited. Another example of a system complexity is the presence of determinants or elements of the system that are dynamic in nature, e.g., an economic recession may demonstrate different tobacco usage patterns than during economic prosperity. Understanding the complexities of tobacco-related determinants and relationships among them, facilitated through the use of

socio-ecological models, offers much potential in advancing tobacco control interventions.

The on-going process of discerning socio-ecological determinants of health problems is foundational for subsequent intervention research. Yet, there remains a disconnect between our understanding of the determinants of tobacco use and our application of the same in intervention research for tobacco prevention and cessation. A solid understanding of the inter-relatedness between and among health determinants will yield the processes and interactions required in planning and evaluating effective tobacco control interventions. Socio-ecological models are required to properly construct interrelationships among determinants, subsequently leading to tobacco control research interventions targeted at multiple levels of the system (Edwards, et coll., 2004).

Does Research on Tobacco Control Interventions Reflect our Understanding of Socioecological Determinants of Tobacco Behaviour?

The determinants literature has generally established an association between tobacco-related outcomes and factors stemming from a variety of socioecological levels. In other words, tobacco behaviour is related to individual level attributes as well as social, physical and environmental settings and conditions. For example, determinants of youth smoking include intra-level factors (rebelliousness), inter-level factors (socioeconomic status, peer pressure, peer influence, sibling influence, parental influence) as well as community-level factors (access and availability of cigarettes) (Best, et coll., 1988; Conrad, Flay & Hill, 1992; Flay, et coll., 1983; Tyas & Pederson, 1998).

To examine the extent to which determinants are reflected in the tobacco cessation and prevention intervention research literature, we reviewed two important sources of research on tobacco control, the Cochrane database and recent articles in the journal *Tobacco Control*. The Cochrane database is a primary source of reviews on clinical trials and effectiveness studies. Forty-two reviews in the field of tobacco are currently in the database. The majority of these reviews examine individually-oriented interventions such as behavioural and pharmacological tobacco cessation interventions. A minority (less than 25%) examines interventions targeted at other levels of the socioecological model (e.g. social marketing and media strategies) and most of these have explored the impact of these strategies in isolation from each other.

The abstracts for all articles in the journal of *Tobacco Control* were reviewed for the past 5 years. *Tobacco Control* has an international focus and addresses an array of tobacco control approaches, including evaluations of policies, programs as well as behavioural research. It was expected that studies targeting the wider range of tobacco determinants would be identified. Articles were categorized as follows: a) single interventions anti-tobacco, b) multiple intervention anti-tobacco (i.e., two or more intervention strategies targeted at two or more levels of the system), c) interventions pro-tobacco (usually lead by the tobacco-industry), d) determinants of tobacco use, e) other (e.g., methods, measurement, prevalence, surveillance etc.). Results are shown in Table 1, which demonstrates that the intervention research published in this journal predominantly reflects single rather than multiple modalities.

Given the growing body of literature on the social determinants of tobacco behaviour, a growing body of tobacco intervention literature could be expected to focus on joint human-environmental interactions and broad social contextual factors. The intervention research literature in the Cochrane database and *Tobacco Control* does not seem to reflect this expectation.

Table 1 : Articles published in Tobacco Control from 2001-2006

	2001	2002	2003	2004	2005	2006
Single Interventions anti-tobacco	4	5	10	12	5	7
Multiple Interventions anti-tobacco	0	0	0	0	0	0
Interventions by Tobacco Industry	7	8	8	9	4	8
Determinants of Tobacco Use	4	5	7	6	7	7
Other	34	35	37	41	43	20
Total	49	53	62	68	59	42

Socio-ecologically Based Tobacco Control Programs and Policies

In contrast to the research intervention literature on tobacco control, there are numerous comprehensive programs and policies that incorporate a socio-ecological perspective to tobacco control. Program and policy evolution has exhibited increasing attention to the complex interrelationships between determinants of tobacco use, and although not grounded necessarily explicitly in a socio-ecological perspective, nonetheless demonstrate consistency within this approach. We illustrate these using two North American and an international example.

Example 1: The California Tobacco Control Program

The California Tobacco Control Program is an example of a comprehensive program. It was created in 1989 following the increase of California State tobacco taxes and concurrent commitment by government to support tobacco control (Rohrbach

et coll., 2002). Objectives of the Program included reducing environmental tobacco exposure, opposing positive tobacco messages, minimizing tobacco access to youth, and tobacco cessation (Rohrbach et coll., 2002, p. 977). The Program was a novel approach to tobacco control in the United States at the time of its inception, and prompted several other states to follow suit.

According to Rohrbach et coll. (2002, p. 976), the interventions encompassed by the Program can be clustered into three categories, including 1) an anti-tobacco media campaign using diverse media formats; 2) tobacco control policies and public education programs delivered at local and regional levels; and 3) school based policies and programs. These program strategies were directed at decreasing tobacco consumption at a population level by altering socio-political norms in communities and diminishing the acceptability of smoking (Rohrbach et coll., 2002). The media campaign was an especially effective intervention in this program, focusing on exposure of tobacco marketing initiatives, and attempting to influence public perceptions of tobacco sponsorships.

Example 2: The Ontario Tobacco Control Strategy

The government of Ontario began to initiate a provincial tobacco control strategy in the mid-90s with a call to action by the Chief Medical Officer of Health. The Premier's Health Council set out tobacco reduction targets and identified priority population sub-groups. A provincial tobacco strategy was put forward. The Ontario Tobacco Control Act, enacted in 1994, banned the sale of tobacco in vending machines and made it illegal to sell or supply tobacco to anyone under the age of 19 years. Various program initiatives were undertaken during the intervening years including media campaigns, an increase

in tobacco taxes, monitoring and surveillance strategies and the establishment of a task force on smoking.

In 1999, Ashley et coll. outlined the essential elements of a comprehensive strategy in a report to the Minister of Health. Critical components included intensive mass media, tobacco taxes, legislation requiring that all public places be smoke-free, smoking cessation assistance, public education programs, school-based programs and marketing bans. The Ontario Tobacco Control Strategy reflects how determinants of smoking contribute cumulatively to the risk of tobacco use, and how programming may be directed at specific determinants and the relationships between determinants. Among the benefits of the comprehensive program projected by the team were the prevention of 3,000 premature deaths and a reduction in 140,000 hospital days within 10 years of program initiation.

Example 3: WHO Framework Convention on Tobacco Control

A more recent international initiative and perhaps the most celebrated tobacco control initiative is the WHO Framework Convention on Tobacco Control (2003a). WHO (nd) defines a framework convention as “a binding international legal instrument, which establishes broad commitments and a general system of governance for an issue area”. WHO further explains that as a consequence of globalization, countries can no longer control tobacco production and consumption simply through domestic legislation.

This landmark document is the result of international collaboration, with nations invited to sign as contracting parties and requiring a minimum of 40 countries required for the Convention to come into force (WHO, 2003a, 2003b). The Convention became enforceable by a country’s law 90 days following national ratification (WHO, 2003a). The current total

of contracting countries is 168, in various stages of national ratification, with a total of 131 Party nations (WHO, 2006a, 2006b). The FCTC entered into force on Feb 27, 2005.

Based on articles of the Convention, contracting parties commit to a wide range of tobacco control interventions, extending from policy changes, to ensuring provision of smoking prevention and cessation programs. Articles 6-19 (WHO, 2003a, p.7-17) detail the most applied elements of the Convention. General clusters of action include 1) reducing tobacco demand through price and non-price controls; 2) product content, marketing, and sales restrictions; 3) environmental exposure control measures; 4) education and public awareness; and, 5) liability and industry reorientation to economically viable alternative activities. Thus, the specific actions are targeted toward broad determinants of tobacco consumption including availability of tobacco products to minors and pricing; mediating factors such as marketing campaigns and product content; and contextual determinants such as governmental policies and trade agreements.

These examples clearly reflect an application of what we know about the underlying socio-ecological determinants of tobacco use, and incorporate a multi-level approach to tobacco control. We argue that socio-ecological frameworks should also provide a critical perspective for intervention research related to tobacco control programs.

Methodological Approaches Reflecting a Socioecological Lens

The incorporation of a socioecological perspective in tobacco control intervention research requires innovative methodological designs and methods. Integrative reviews, hierarchical multilevel modeling, cross-case reviews and network mapping are possible emerging techniques that can be used to

overcome the methodological challenges in tobacco control intervention research.

Integrative Reviews

Unlike meta-analyses and systematic reviews, integrative reviews refer to a synthesis of primary studies with different designs and methods. For example, the method allows experimental, non-experimental and qualitative primary studies to be combined (Whitemore et Knafl, 2005). Socio-ecological intervention research may be characterized by a number of mini-studies that evaluate each intervention's effectiveness separately. Thus, integrative reviews represent an approach to comprehensively understand the effectiveness of interventions on smoking behaviour as a whole. This is especially important to understand given the (predicted) synergistic effect of related multiple interventions. Integrative reviews are an approach that brings together insights from both reductionist and context-rich methods. Furthermore, the technique helps researchers deal with the reality that certain intervention approaches are amenable to research that is quantitatively oriented (e.g., behavioural interventions) and other approaches that are better examined through qualitative and/or mixed methods (e.g., impact of policy).

Multilevel Modeling

Single level regression analysis is useful for understanding the multiple determinants, at the individual level, of smoking behaviours. Socioecologically-based interventions operate at *multiple levels*, and therefore require a different analytical approach than single level regression models. Hierarchical multilevel modeling (MLM) is an analytical method that generates regression models at different levels of the system to identify predictors of individual outcomes (Kothari et Birch, 2004). These models are separate but are estimated simultaneously. For

example, one could identify potential predictors of smoking cessation at the intra-personal level (knowledge), at the inter-personal level (peer influence) and at the social level (access to tobacco products). MLM maintains the integrity of these nested determinants. It represents a quantitative way to obtain a rich description of different levels of influence, as well as cross-level influences, on individual outcomes (for example, see Kothari et coll., under review). It also provides a detailed understanding of differences in outcomes across settings. This technique is ideal for the secondary analysis of population-based surveys, or for primary studies designed to examine an adequate number (30 or more) of hierarchical units (stores, schools, neighbourhoods).

Multiple Case Studies

Intervention research using a socio-ecological lens includes attention to contextual determinants, defined as the place-based as well as macro-level influences in the social, political and economic environment (e.g., tobacco trade agreements, class action law suits). The case study method is “. . . an exploration of a bounded system or a case (or multiple cases) over time through detailed, in-depth data collection involving multiple sources of information rich in context.” (Creswell, 1998, p.61) (for example, refer to Dyke, 2004). In the situation where socio-ecological intervention research results in studies conducted in a small number of cities or organizations, systematic methods are required to draw inferences across these jurisdictional contexts. Rigorous cross-case analysis (Yin, 2003) allows the particular context, as the unit of analysis, to remain intact. This yields useful insights into the ways in which complex interventions have an impact on determinants nested within particular jurisdictional and socio-political contexts.

Social Network Analysis

Compared to traditional measures of individual behaviour change, social network analysis may yield a better understanding of collective change processes and of those interconnections across levels of the system that may be essential to produce sustained change. Social network analysis is an established technique (Wasserman et Faust, 1994) that might find new application in socioecologically-based tobacco control intervention research. The technique attempts to measure the way that groups of people are linked, engaged, and communicate and share resources, such as expert knowledge. It has been used previously in tobacco studies (e.g., Krauss, et coll., 2004), but it is highlighted here as a way to measure change result from a combination of interventions focused at the broader contextual level. For example, Valente (1996) describes how social network analysis can be used to determine the degree to which collective action has been successful or, as an intervention itself, Valente and Fosados (2006) describe how social networks can be used as delivery vehicles to influence key opinion leaders. Social network analysis provides a means with which to examine social structures that cross levels of the socioecological system – it yields a matrix of relationships and highlights linkages within and between system levels.

Socio-ecological Models Offer New Directions for Intervention Research: The Example of Adolescents

The application of a socio-ecological model to adolescent smoking brings an expanded focus for conceptualizing possible intervention points. Further, the model more closely resembles the dynamic nature of change at each of the system levels. This “change” refers to that which might be promoted

through interventions as well as changes occurring naturally (e.g., developmental changes). The application of the socio-ecological model has implications in terms of designing intervention research and selecting outcome indices.

Adolescence marks the start of the developmental transition period to young adulthood. It is commonly associated with higher rates of smoking experimentation and the initiation of physical and psychological dependence on tobacco, positioning this age group as a high priority for prevention and cessation interventions (Jairath et coll., 2003; Stanton et Smith, 2002). This transitional period elevates vulnerability to tobacco uptake due to evolving health beliefs and values which influence behavioural choices (Chassin et Presson, 2001). Furthermore, the early development of self-regulatory mechanisms (Novak et Clayton, 2001), lack of smoking resistance and self-efficacy (Tucker, et coll., 2002); willingness to experiment with risk behaviours given opportunity (Kremers, et coll., 2004; Wild, 2006); and heightened physiological responses to an addictive product may all interact to increase the risk of tobacco use among adolescents.

While the impact of developmental transitions on smoking behaviors has been the subject of previous study (Chassin et Presson, 2001), a socio-ecological model extends this dialogue by positioning the interaction between these transitional characteristics and external contextual factors as a topic of attention. Illustrative of this interaction is research examining the relationship between the school context and individual self-regulation characteristics. Novak and Clayton (2001) examined tobacco usage patterns among middle and high school students as determined by the interaction between three measures of self-regulation and two school environment variables. Emotional self-regulation was sensitive to differing school contexts associated with transitions in tobacco use. The authors postulated that strong emotional regulation acted as a protective factor

mitigating the possibility of tobacco use in high-risk contexts. Students reporting lower levels of emotional regulation within school environments with higher levels of faculty involvement and higher levels of teacher discipline were less likely to initiate smoking (Novak et Clayton, 2001), indicating that some school contexts can be protective for students with weak emotional regulation. Similar studies have been conducted by other researchers (Aveyard, et coll., 2004; Tucker, et coll., 2002; Kothari et coll., under review).

Developmental transitions represent an increased risk of moving from experimental tobacco use to daily smoking and addiction – a point of trajectory change. Consider recent studies that document the variable success of school-based tobacco reduction programs (Renaud et coll., 2003). While there are many possible reasons for this variability, it is possible that a lack of targeting the developmental transitions with respect to tobacco use, within a socioecological perspective, have hampered appropriate tailoring of interventions for this population. On the other hand, the model proposed by Breinbauer and Maddaleno (2005) integrates both developmental and ecological approaches to adolescent tobacco reduction.

Key intervention points are unique in that they may be positioned at the personal, intrapersonal, community and policy levels; they may be defined by developmental transitions (e.g., as adolescents move from living at home to living independently); or, they may be related to contextual transitions (e.g., cyclical nature of school vis a vis peer influence). Identifying key intervention points requires a better understanding of how various pathways (developmental, contextual or personal transitions, for example) interact. Socio-ecological models can help identify tobacco-related determinants, pathways and their interconnections.

Conclusion

While health promotion public health programs are increasingly responding to the complexities of health determinants, intervention research has lagged behind. Socio-ecological models offer ways to frame real world complexities that can help inform intervention research; research that captures the complex system of influences between and among determinants. Explorations of socio-ecological models have added a focus on multiple levels of intervention to promote health (Edwards, et coll., 2004; Hancock, 1993). Although we now know multiple interventions targeting multiple levels and sectors are likely to create sustainable change (Edwards, et coll., 2004; Crozier Kegler et coll., 2004; Mancini et Marek, 2004), there is still much to learn about health determinants and related strategies critical to environments that promote population health.

There are many vexing intervention questions that need to be addressed in the field of tobacco control. Sophisticated applications of socio-ecological frameworks lay the foundation for promising avenues of inquiry. Tobacco control health promotion practitioners and researchers need to collaboratively build on their understanding of socioecological models to advance the field. It is time to discover the “fit” of innovative methods that account for reciprocity among tobacco-related health behaviours and the environment, and to respond to the synergy between and among multi-level and multi-strategy interventions. Analytic techniques are required to examine the nested relationships among determinants and the reciprocal relationships between determinants and context.

Promising options for future tobacco control intervention research include the use of designs that reflect the dynamic transitions that are characteristic of the life course. As well, the application of methods that capture and explicate the links and relationships among people and their organizational and

jurisdictional contexts deserves attention for sustained cessation and prevention results.

Tobacco control has been at the forefront of health promotion research, program and policy application. It is now time for tobacco control intervention researchers to take the lead and appropriately reflect the levels of influence demonstrated by determinants research.

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