Journal of Agromedicine

ISSN: 1059-924X (Print) 1545-0813 (Online) Journal homepage: http://www.tandfonline.com/loi/wagr20

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To cite this article: Barbara C. Lee, Casper Bendixsen, Amy K. Liebman & Susan S. Gallagher (2017) Using the Socio-Ecological Model to Frame Agricultural Safety and Health Interventions, Journal of Agromedicine, 22:4, 298-303, DOI: 10.1080/1059924X.2017.1356780

To link to this article: http://dx.doi.org/10.1080/1059924X.2017.1356780

Accepted author version posted online: 01 Aug 2017.
Published online: 01 Aug 2017.

JOURNAL OF AGROMEDICINE
2017, VOL. 22, NO. 4, 298–303
https://doi.org/10.1080/1059924X.2017.1356780

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COMMENTARIES

Using the Socio-Ecological Model to Frame Agricultural Safety and Health Interventions

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ABSTRACT

The Socio-Ecological Model (SEM) is a conceptual framework depicting spheres of influence over human behavior that has been applied in public health settings for nearly five decades. Core principles of all variations of the SEM are the multiple influences over an individual's behaviors, the interactions of those influences, and the multilevel approaches that can be applied to interventions intended to modify behaviors. A project team modified the standard SEM to address interventions for protecting children from agricultural disease and injury. The modified SEM placed the "child in the farm environment" at the core with five interrelated levels (spheres) of influence over the child. This framework provides guidance on how a multifaceted, multilevel intervention can maximize the potential for impact on behaviors and decisions made by parents/adults responsible for the safety of children on farms. An example of how this model could work to safeguard youth operating tractors is provided.

KEYWORDS

Agriculture; safety; socio-ecological model; theory

Background

Occupational safety and health advocates are constantly searching for strategies that offer sustainable interventions that reduce risks of injury and disease. These strategies are often based on education, engineering, environmental, and/or enforcement approaches. To strengthen and potentially measure their impact, they can be based on principles of safety and hygiene, past experience, and sometimes a theoretical model. Agricultural safety and health interventions have lagged behind other occupational safety and public health approaches but increasingly are adopting evidence-based strategies guided by theories and models that have demonstrated success in changing unsafe traditions into safe behaviors. This paper describes how a well-known public health model has been modified for agricultural safety and health to multiply and maximize the impact of agricultural safety interventions.

Introduced in the 1970s, the Socio-Ecological Model (SEM) is a broad-based conceptual model depicting basic ecological principles of human behavior.[1] The SEM has undergone numerous updates and modifications for different applications.[2] The World Health Organization and U.S. Centers for Disease Control and Prevention are among the many users of this model, which illustrates multiple dimensions and complex human interactions that influence behaviors.[3,4] At the core of the model is an individual whose behavior is the primary interest. A figure of enlarging circles added above the core individual demonstrates how spheres of increasing influence have higher degrees of impact on individual behavior (Figure 1). The next level of influence is his/her interpersonal relationships such as relatives, peer groups, or healthcare providers. Following this is the organizational level, which includes organizations, schools, churches, and workplaces. Next is the community level, which represents relationships between organizations. Finally, at the outer sphere of the figure, is the public policy level that includes federal/state regulations with enforcement options. Terminology for the middle levels of the model is

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Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/wagr.

Figure 1. Socio-ecological model: framework for prevention, centers for disease control. Available from the Centers for Disease Control and Prevention (CDC). http://www.cdc.gov/violenceprevention/overview/social-ecologicalmodel.html.[4]

typically altered depending on the user's needs and the model's application.

In an extensive review of various ecological models of health behaviors published in 2008, authors explain that the core principles of an ecological model are: (1) there are multiple influences on an individual's behaviors, including factors at the intrapersonal level, interpersonal level, with increasing influence at levels of organization, community, and public policy; (2) influences interact across these different levels or spheres of influence; (3) use of this model should be applied to specific behaviors; and (4) multilevel approaches can be the most effective interventions for changing behaviors.[5] The evolution of the SEM is based in part on five different theories explaining human behavior, dating from 1951 to 2006, as well as eight different theories used to guide behavior change, dating from 1953 to 2005. The influence of different theorists and their applications of conceptual models over time can explain both the strength and the various visual depictions of the SEM for different audiences.

Modified model

In 1996, the National Institute for Occupational Safety and Health (NIOSH) launched its National Childhood Agricultural Injury Prevention Initiative.[6] As a component of that initiative, the National Children's Center for Rural and Agricultural Health and Safety (NCCRAHS) was established to link public and private sector initiatives based upon a national plan of action.[7] In 2014, with two decades of experience, the NCCRAHS wanted to base its current and future endeavors on a theoretical model that would maximize potential impacts. The SEM was chosen as a logical fit for the center's theme of *strengthening public-private partnerships to address childhood agricultural injury prevention*.[8] The model has long-standing acceptance by public health agencies, and it has applications in multiple settings on topics ranging from adding positive nutritional habits and physical activity to avoiding risky practices such as smoking and unsafe sex. To the best of our knowledge, the SEM had not specifically and proactively been applied in agricultural safety and health interventions or program evaluations, nor has it been modified in any specific way to address the well-being of children.

A comprehensive review of childhood agricultural safety interventions conducted by Gallagher in 2012[9] assessed 26 peer-reviewed studies that reported the effectiveness of childhood farm safety interventions. It was determined that most interventions focused on the individual level of the SEM and typically used education as the primary strategy to increase knowledge and influence behavior change. Based upon these findings, the author provided eight recommendations for the future, framed around the principles of the SEM, such as multilevel partnerships; repeated interventions; approaches beyond education (e.g., engineering, policy); diversity in funding; and sustained, widespread dissemination.[9]

A planning team at the NCCRAHS reviewed literature and versions of the SEM and discussed the impact of the spheres of influence relevant to the political, social, and individual environment affiliated with agricultural communities. The team incorporated concepts from non-agricultural projects including experiences using the model for low-income workers.

Our modified version of the SEM (Figure 2) placed the "child in the farm environment" at the core of the figure, with the knowledge that a child (up to 18 years) who lives, visits, or works on a farm is not in a position to change safety practices

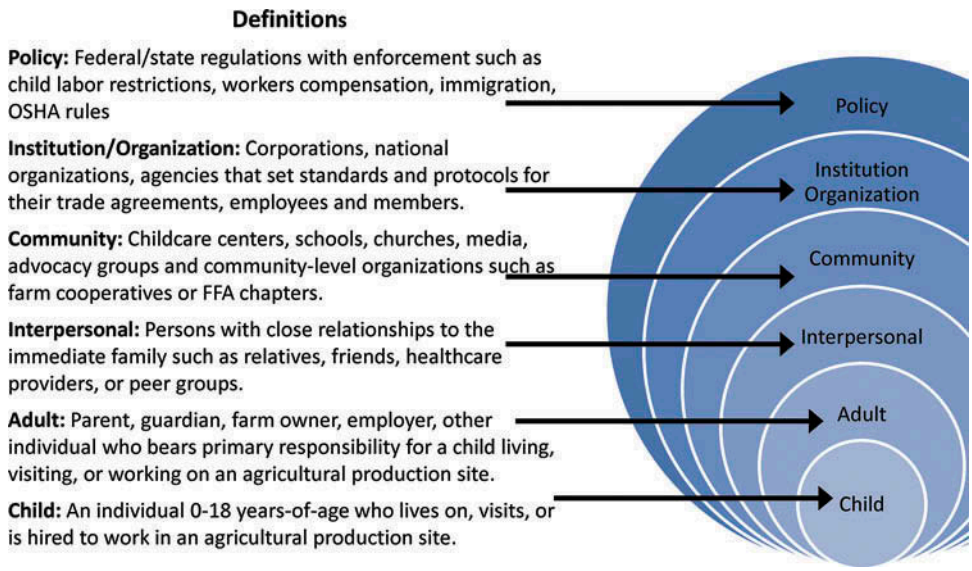

Figure 2. Socio-ecological model modified to address agricultural safety and health interventions.

him/herself. Rather, the focus of interventions is to influence the behaviors of those adults who have the authority and knowledge to reduce the risk of injury and disease affecting children. We believe that all children deserve equal protection from preventable disease and injury, and adults hold full responsibility for safeguarding children under their care.

At the model's core is the child under the influence and protection of the adult(s). There are five spheres with interrelated-levels of influence over the child. The adult sphere includes parents, guardian, farm owners, employers, and any other individual(s) who may have responsibility for youth in the agricultural production site or a farm homestead. The next level of influence is interpersonal—this includes persons with close relationship to the immediate family such as relatives, friends, and peer groups. It can also include health care providers and child care providers who regularly interact with the family. At the third sphere above the child is the community level, which can include local businesses such as farm cooperatives and community-based organizations such as FFA chapters, schools, faith-based groups/churches, and child care centers. At a higher level of influence are institutions and organizations that span beyond the local region. This includes agricultural companies such as property/casualty insurance providers, trade associations, agribusinesses that set standards and guidelines for purchasing agricultural products, national/international trade agreements, bankers and lending agencies, and national media that influence public opinion. The highest level of influence is policy. For the most part, this represents federal and state regulations regarding the role of youth in agricultural work. It can also represent issues such as immigration, federal/state workers compensation laws, and Occupational Safety and Health Administration (OSHA) enforcement standards.

Degrees of influence of the various spheres are subject to many factors. Each superordinate level influences the subordinate level. For example, a public policy may influence a community program that influences an adult to make responsible decisions regarding work assigned to a child living on a farm.

When applying this modified SEM concept to agricultural safety and health interventions, the ideal approach is to have an interrelational link that crosses through as many spheres as possible. We have solid evidence from interventions in non-agricultural settings that a multilevel approach with repeated interventions has the greatest likelihood of achieving the desired outcome. For example, a 2014 report described how the SEM was used in a multilevel intervention to reduce health inequities among low-income workers.[10] Another example is an assessment to propose community outreach interventions to improve

fruit and vegetable intake among inner-city African Americans. Literature was reviewed on past interventions addressing this topic. Relevant interventions were categorized by SEM level then, based upon intervention effectiveness, and recommendations for a multifaceted community-based approach became the basis and rationale for "Best Practices" ecological nutritional programs for African Americans.[11]

Applying the SEM for agricultural safety

What would an ideal intervention based on this SEM concept look like? For explanatory purposes, consider an unsafe practice that puts youth at high risk of an agriculture-related injury. What is the desired behavior change? And what approach could be used at multiple levels to influence the adults that bear primary responsibility for youth involved in that unsafe practice?

Agricultural safety

Equipment manufacturers and safety professionals recommend that all tractors used for production activities include basic safety principles of seatbelts and Rollover Protection Structures (ROPS). It has been shown that this safety standard of a tractor being equipped with a seatbelt and ROPS (or enclosed cab) can virtually eliminate tractor-related fatalities when the operator appropriately uses these safety features.[12,13]

Burden

For youth working in agriculture, tractors are the leading cause of death. An analysis of occupational fatality cases from 2001 to 2013 among U.S. workers under the age of 18 revealed that of the 406 recorded fatalities across all occupations, about 50% of deaths occurred in agricultural jobs, of which nearly all were associated with transportation and equipment.[14] Young workers are often asked to operate tractors that do not meet safety standards, because the older unsafe tractors may be smaller, less expensive, and less complicated to operate, and farm owners do not want young people operating their high-powered, expensive equipment. There are no child labor regulations that mandate safety standards of tractors operated by youth. Further, in the United States, family farms are exempt from child labor in agriculture regulations. In occupational settings, the parent or work supervisor bears responsibility for ensuring that a young worker is safeguarded. However, agricultural work activities can be complicated, making close supervision and oversight difficult to maintain, especially when workers are doing field operations with tractors and trailed implements.

Solution

To minimize the toll of serious injuries and deaths among young workers in agriculture, a solution would be to ensure that youth (14–18 years) who are assigned agricultural work involving tractor operations be allowed only to operate tractors equipped with ROPS, and that these youth be required to wear the tractor seatbelt at all times. Implementing this solution would entail a multilevel, integrated approach that alters long-standing practices and might challenge family and/or cultural traditions. Applying the SEM to a multilevel, integrated intervention would involve each sphere of influence approaching the problem from a different angle, but all with the same desired outcome of improving safety.

The scenario below (Table 1) describes an intervention, based on the SEM, of a national-level campaign to "Safeguard youth operating tractors." The scenario above is an idealistic picture of how the SEM could work, involving entities at all levels of the SEM, and proposing they would agree and engage in a unified way. Realistically, this would be time and resource intensive and difficult to execute. But undoubtedly, if this scenario were set into operation, there could be a profound change that would drastically reduce the toll of injuries and deaths to youth operating tractors.

Implications

Putting the SEM into practice in agriculture is possible. Over the past five decades, much has been learned about the etiology of farm injuries through data on the incidence of injuries and details on changing trends in types of injuries.

Table 1. An intervention, based on the SEM, of a national-level campaign to "Safeguard youth operating tractors."

Policy	Federal child labor laws in agriculture would be changed to set a minimum age of 16 years to operate tractors on public roads and 14 years to operate tractors on private land. The family farm exemption would be eliminated. Federal and state OSHA would establish minimum age limits for all safety standards and would require workers younger than 18 years to wear seatbelts and operate only tractors with ROPS. OSHA standards regarding tractor operations would be enforceable on all farms regardless of number of employees.
Institution/organization	Tractor manufacturers (e.g., via Association of Equipment Manufacturers [AEM] trade association) would publicly announce a position statement that supports the OSHA standard. Agribusinesses would require compliance with federal/state laws and OSHA standards as an expectation of entities from whom they purchase products. National FFA would set a national standard that their Student Agricultural Experience (SAE) ensure youth are in settings where they comply with this safety standard and announce their position via National FFA communication mechanisms that reach advisors, members, and alumni. Other organizations such as the American Academy of Pediatrics would post a position on this safety standard. The national media would publish stories about this national campaign to protect young tractor operators. Media stories of lives saved would begin to shift traditional thinking about guidelines for young people operating tractors.
Community	A comprehensive social marketing campaign would be launched to "Safeguard Youth Operating Tractors." The campaign would be crafted with messages and dissemination strategies based on stakeholder input. Using targeted campaign messages, including social media outlets at the regional and local level, FFA Chapters, schools, and faith-based groups would facilitate efforts of farm owners to ensure any tractors operated by youth are safely equipped. Incentives would be provided by local insurers and bankers, offering economic aid for farmers needing financial assistance to upgrade their tractors operated by youth. These community groups would promulgate the campaign messages and, where appropriate, the position statements issued by national-level organizations. School-based activities would no longer promote "ride your tractor to school" events but would emphasize campaign messages and facilitate tractor safety certification programs. Community-level advocates for the campaign would be trained to deal with controversies surrounding the tractor topic.
Interpersonal	Peer groups, friends, and relatives would share "Safeguard youth operating tractors" campaign materials and openly encourage farm owners and parents to adopt the recommended practices and OSHA standards. These people would reach out to underserved, hard-to-reach farm owners (e.g., niche farms, special populations) with the same information and expectations regarding youth involved in agricultural work.
Adult	Farm parents, farm owners, and employers would acknowledge the multilevel pressure being exerted to change farm practices and comply with the new OSHA standard by not allowing youth to operate tractors unsafely.
Child/youth	Young tractor operators would have strict safety standards set, having access only to ROPS tractors as well as knowing and understanding they are required to wear seatbelts.

Our biggest challenge moving forward is improving safety interventions and taking approaches that will have the biggest impact on reducing the toll of injuries. These multilevel and interrelated interventions have the potential of shifting the "culture" of agriculture to have a greater emphasis on and respect for a "safety culture" in agriculture. It also broadens the general public's perspective on the issue, rather than solely relying on direct interventions by parents or policy-level changes. The diversity of individuals and organizations involved strengthens the capacity to change practices, resulting in lives saved.

Conclusions

Public health demonstration programs have shown us the SEM is a strong and effective way to change individual behaviors by influencing those behaviors at multiple levels. We propose to modify the SEM for application in agricultural safety and health promotion programs. As this model is applied, evaluated, and improved over time, our hope is to have a measurable and sustained improvement in safe practices that create a true culture of safety in agriculture.

Funding

Efforts toward developing this dedicated issue of the *Journal of Agromedicine* with a focus on the Socio-Ecological Model were funded in part by the National Institute for Occupational Safety and Health via the National Children's Center for Rural and Agricultural Health and Safety (NIOSH 2U54OH009568) and the National Farm Medicine Center.

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