A Framework for Improving Household Indoor Air Quality and Reducing Childhood Asthma Inequities

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The Wellesley Institute works to improve health equity in the Greater Toronto Area through action on the social determinants of health.

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Introduction

Asthma is the most common childhood chronic disease, with approximately 13 percent of children in Ontario diagnosed with the condition (Ministry of Health and Long-Term Care, 2013). Childhood asthma is associated with higher rates of disability, school absences, and poor academic performance (MOHLTC, 2013). This condition also incurs a huge cost to Ontario's health care system, accounting for one-third of the total OHIP expenditure on asthma (Institute for Clinical Evaluative Sciences, 2004).

The household environment is a key determinant of health for those living with asthma (Public Health Agency of Canada, 2013). Living in substandard housing can increase children's asthma symptoms and their related use of health care services. Deteriorating homes or homes kept in poor repair are full of indoor air allergens, such as mould, rodents, dust mites, and cockroaches. Other factors such as smoke and pet hair can further exacerbate asthma symptoms. There is evidence that these allergens play an important role in asthma development (Lin, Jones, Munsie, et al., 2012; Belanger, Beckett, Triche, et al., 2003; Rauh, Chew, & Garfinkel, 2002). Low-income families are more likely to live in substandard housing with higher amounts of indoor air allergens (Kitch, Chew, Burge et al., 2000). In Toronto, one in two families live in aged buildings that are in unstable condition (Paradis et al., 2013). Furthermore, studies from the United States show that minority, low-income children are disproportionately affected by asthma (Bryant-Stephens, 2009). Higher childhood asthma morbidity among low-income children could increase child health inequities in Toronto.

Since childhood asthma is a complex condition, interventions aimed at addressing multiple indoor air allergens through multiple approaches (multi-trigger, multicomponent) are best at reducing asthma morbidity among low-income children (Wellesley Institute, *in.p*). Previous reviews have found that these interventions are effective at reducing asthma symptoms and related health care usage and that these approaches improve productivity and health-related quality of life (Croker et al., 2011; Krieger, 2010; WI, *in.p*). These interventions are low-cost and provide a good value for dollars spent (Nurmagambetov et al., 2011). However, we have a limited understanding of how these interventions work to improve asthma outcomes among low-income children and, ultimately, how they bridge the gap in asthma inequities.

This paper describes how current multi-trigger, multicomponent interventions (from my systematic review) are working. It also addresses the fidelity of these interventions to evidence-based health equity practices (WI, in.p). At the time of writing this report, no initiatives in Toronto focus on reducing allergens within the homes of low-income families with asthmatic children. Public health units, hospitals, and community organizations in the Greater Toronto Area could use this framework to improve housing quality for these families.

How are intervention characteristics working?

The multi-trigger, multicomponent interventions studied in this systematic review focus on three key characteristics: holistic, collaborative, and targeted. These characteristics facilitate a comprehensive delivery of interventions, involving multi-sectoral stakeholders that play a critical role in child health and provide tailored components to meet the specific needs of participants.

Holistic

A holistic approach to health posits that health is simultaneously influenced by human biology, personal behaviour, psychosocial environment, physical environment, and natural environment (Hancock & Perkins, 1985). Multi-trigger, multicomponent interventions are developed based on holistic strategies to improve asthma. First, these interventions use multi-level strategies, which include improving the household environment, behavioural practices, and medicine use. Combining these different strategies is important for improving a complex illness like childhood asthma, which seldom responds to "simple, independent, and one-off solutions" (Riley et al., 2015: 48). Second, in addition to improving clinical symptoms and environmental triggers, interventions provide referrals to other medical and social services such as tenants' rights, food banks, and assistance with paying electricity bills. These referrals facilitate improvements in other areas of life, which connect to participants' health. Third, rather than focusing on the reduction of one allergen, these interventions remediate multiple allergens within the home. This multi-trigger approach allows for a more comprehensive improvement in household quality.

The use of various holistic approaches has been recognized in Canada and internationally as important for achieving health equity (Canadian Council on the Social Determinants of Health, 2015). Existing literature demonstrates that interventions to improve asthma outcomes for low-income children should include both medical parameters as well as overall well-being and quality of life (Sennhausen et al., 2005; Mansour, Lanphear, & DeWitt, 2000). An improvement in the overall quality of life among low-income children can close the gap in asthma morbidity.

Collaborative

Multi-trigger, multicomponent interventions are developed by the collaboration between a range of stakeholders who play a key role in child health. These include local schools, researchers, housing authorities, local public health units, and participants' health care providers. For instance, with the goal of increasing community capacity to address asthma, one program facilitated partnerships between local and state health departments, the American Lung Association of Washington, health care agencies, the tribal health authority, the school district, and the local university (Primomo et al., 2006). Another intervention, led by the University of Massachusetts, included local collaborators to integrate service provisions, such as federally funded community health centre, housing authority, multi-service community action agency, and first time home buyers' education program (Turcotte et al., 2014).

Partnership building plays an important role in facilitating action on the social determinants of health (Canadian Council on the Social Determinants of Health, 2015). There is evidence that partnerships and service coordination between schools, housing, public health, and health care play a key role in improving low-income children's asthma outcomes (Karen, 2011). This is because collaborative partnerships amongst these sectors form alliances to share knowledge, resources, integrate services, and ultimately to reduce childhood asthma inequities (Ontario Healthy Communities Coalition, 2011).

Targeted

Multi-trigger, multicomponent interventions use targeted approaches to meet the specific needs of individual participants. Targeted approaches provide tailored strategies focused toward groups of people who meet the highest need of intervention (National Collaborative Centre for Determinants of Health,

n.d.). For instance, home-trigger reduction education sessions and remediation strategies were based on findings from in-home environmental assessments that identified specific allergens in each home. Moreover, asthma management education was based on findings from skin tests that identified children's allergies. These tailored approaches address specific problems that exist within each household, rather than implementing a one-size-fits-all intervention.

Rose (2001) highlights the importance of targeted strategies in intervention development. A targeted intervention "produces outputs that are appropriate to the particular individual advised to take them, offering a more cost-effective use of resources and time" (430). Therefore, concentrating resources where the need is the highest produces the greatest benefit. The National Collaborative Centre for Determinants of Health (n.d.) further corroborates Rose's statement by stating that low-income communities greatly benefit from this approach, as it helps close the gap in inequities by leveling the field between privileged and under-privileged households.

How do intervention strategies improve behaviours and reduce exposure to indoor air allergens?

Multi-trigger, multicomponent interventions focus on three key strategies: social support, education, and environmental remediation. These strategies influence behaviours to manage asthma and keep a clean indoor environment, as well as directly reduce exposure to indoor air allergens.

1) Social support

Multi-trigger, multicomponent interventions provide social support through home visits conducted by Community Health Workers (CHWs) or trained professionals (Nurses, Respiratory Therapists, Environmental Officers). During home visits, CHWs or professionals model behaviours that showcase how to manage asthma and reduce home triggers. Also, they monitor participants' behaviours and provide reinforcements for positive and negative behaviours. In some cases, CHWs advocate for clients and make referrals to community resources for childcare, food, housing, employment, insurance coverage, and citizenship assistance.

The provision of social support facilitates positive behaviours (asthma management, home cleaning, and trigger identification) among caregivers of asthmatic children (Gallant, 2003; Andrews et al., 2013; Zotter, n.d.). The link between social support and behaviour change is further explained by the Social Cognitive Theory, which posits that an individual's behaviour can be modified by observing others (Bandura, 1989). According to this theory, when people are rewarded or punished for a behaviour, their belief about the outcome influences their choice to replicate said behaviour (Bandura, 1989). Consequently, this network of supportive relationships influences a person's confidence that they can achieve their desired outcome. An increase in self-efficacy is a big determinant of behaviour change (Gallant, 2003).

2)Education

Through home visits, implementers of multi-trigger, multicomponent interventions provide comprehensive education to influence behaviour change. Educational sessions are provided to caregivers of asthmatic children on general asthma symptoms, proper medication administration, a review of asthma triggers, and use of an asthma action plan. These educational sessions aim to improve knowledge of

asthma management as well as indoor air triggers.

An increase in awareness about symptoms and the home environment through education facilitates improvements in asthma management and home-trigger reduction behaviours (Azjen & Fishbein, 1980; Heather, 2006; Rashidian & Russel, 2012). The impact of education on behaviour change is also supported by the Theory of Reasoned Action developed by Azjen and Fishbein (1980), which posits that behaviour intentions are determined by three components: 1) attitudes, the belief that a particular behaviour will result in desired outcomes, 2) the subjective norms, a person's beliefs about what other people think they should do, and 3) self-efficacy, a person's confidence that they will achieve their desired outcomes. As mentioned above, higher self-efficacy is positively linked to behaviour change (Rashidian & Russel, 2012).

3) Environmental remediation

Multi-trigger, multicomponent interventions provide minor, moderate, and/or major household remediation to reduce the amount of indoor air allergens. Minor remediation includes the provision of allergen-impermeable bedding covers, pest baits, doormats, storage bins, and cleaning supplies. Moderate remediation includes provision of high-efficiency particle (HEPA) filtration, dehumidifiers, vacuum cleaners, filling cracks in walls, installing ventilators, and integrated pest management. Major remediation includes removing mold and moisture, cleaning/repairing gutters, water damaged building materials and carpets, making alterations to the heating and cooling systems, and providing customized structural interventions. Providing a combination of minor, moderate, and major remediation has shown to produce greater reductions in asthma symptoms and health care usage (WI, *in.p*).

The provision of remediation strategies to modify household environment reduces the amount of indoor air allergens present in a household (Wright & Phipantanakul, 2014). The importance of improving indoor environments for better health of asthmatic children has been widely documented (Wellesley Institute, 2012; PHAC, 2015). Compared to educational strategies that put the onus on individuals to change behaviour, this strategy directly reduces indoor air allergens in the homes of low-income children.

How do healthy behavioural practices and indoor air environment improve asthma morbidity?

Reduced exposure to indoor air allergens improves asthma exacerbation among low-income children in three ways. First, an improvement in asthma management behaviours of caretakers directly reduces asthma exacerbation among their children (Walker et al., 2008). Second, caretaker participation in trigger reduction behaviours minimizes exposure to asthma activators, which ultimately leads to improved indoor air quality (Nishioka, 2006). Finally, better household indoor air quality decreases asthma exacerbation among children living in substandard housing (Lin, Jones, Munsie, et al., 2012; Belanger, Beckett, Triche, et al., 2003).

A decrease in asthma exacerbation among low-income children reduces overall asthma morbidity. Reduction in asthma triggers leads to a decrease in healthcare usage, as children are less likely to visit doctors, emergency departments, and hospitals (Bahadori et al., 2009). In addition, reduced asthma exacerbation improves productivity because children miss fewer school days and caregivers miss fewer work days (Sullivan et al., 2013; Bahadori et al., 2009). Health-related quality of life is also improved as children experience better sleep, are able to partake in physical activities, and experience reduced levels

of disability in performing daily tasks (Lloyd, Price and Brown, 2007). As such, there is an overall reduction in asthma morbidity among low-income children living in substandard housing.

Contextual Factors

Although the links between the aforementioned delivery strategies, facilitators, and outcomes have been well established in the literature, there are some contextual factors to consider. Drawing on the four dimensional framework (Shah, Mizrahi, & McKenzie, 2011), there are four levels of factors that may mediate the relationships explained in this framework: 1) exposure to individual-level factors, 2) exposure to ecological-level factors, 3) interaction between individual and ecological factors, and 4) time.

1. Individual-level factors: The effectiveness of intervention components on asthma morbidity is dependent on the inherited risk, as well as on social factors. In addition to genetic and biological risk factors, individual factors could include experiences of stress, parental behaviours, caregivers' readiness to change behaviour, and childhood adversities (Bloomberg et al., 2005; Farber et al., 2008; Kate et al., 2008).

2. Ecological-level factors: At the ecological level, certain factors could impact environmental risk. These ecological factors include parental education, social advantage, outdoor air allergens/pollution, indoor air quality in schools or day care centres, and housing policy context (Cesaroni et al., 2003; Neidell, 2004; Amr et al., 2003). For example, if a child spends more time in daycare with poor indoor air quality, the implementation of this intervention in a home setting may result in only a minor impact.

3. The interaction between individual and ecological factors: Ecological factors may decrease or increase the effect of individual factors on asthma morbidity. For instance, high parental education could facilitate a greater readiness in behavioural change, increasing the likelihood of maintaining an allergen-free home environment. Similarly, interaction between exposure to outdoor air pollution and parental stress increases the effect on childhood asthma incidence (Shankardass et al., 2009).

4. Time: Sufficient exposure at a particular point in time to individual or ecological factors may be needed to amplify the impact of interventions. For instance, an increased length of time in the interaction between stress and outdoor air pollution could reduce the intervention's effect on asthma morbidity. Likewise, receiving the intervention in early years of life, as opposed to later years, has a higher probability and sustainability of impact (Wahn & Mutius, 2001).

Limitations

Although this framework provides comprehensive and well-established linkages between intervention components and asthma morbidity, there are two limitations to consider. First, this framework presents evidence on the importance of targeted interventions. Although individuals with high risk factors may benefit from interventions specifically targeted at them, the effect on the overall morbidity of the disease may be limited in the absence of a population-oriented approach. A population approach is more effective at addressing societal influences on individuals by improving structural conditions that shape health outcomes (Rose, 2001). Second, this framework mainly focuses on behavioural and environmental factors of childhood asthma, overlooking the social context. For instance, without policies ensuring that low-income families have the opportunity to live in safe and affordable households, behavioural and environmental remediation may have minor impacts. As such, this framework should be appraised critically, with considerations to the broader context that dictate the social and economic conditions of

low-income families (Wright & Subramanian, 2007).

Conclusion

Low-income children living in substandard housing may be disproportionately affected by asthma. Because asthma is a complex disease that affects many children, multifaceted comprehensive interventions that combine evidence-based strategies are essential to closing the gap in childhood asthma morbidity (WI, *in.p*). This paper explains that holistic, collaborative, and targeted characteristics of these interventions are grounded in evidence-based health equity practices. Moreover, the provision of social support, education, and household remediation leads to improved behaviour change and reduction in exposure to indoor air allergens. This reduction, in turn, improves household air quality and reduces asthma morbidity. Public health units, hospitals, and community organizations could use this framework to improve housing quality for low-income children in the Greater Toronto Area, and ultimately reduce asthma-related health inequities.

References

Ajzen, I. & Fishbein, M . (1980). Theory of Reasoned Action, In M. N. Al-Suqri & A. S. Al-Aufi (Eds.), *Information Seeking Behavior and Technology Adoption: Theories and Trends* (188-204). PA, USA : IGI Global.

Amr, S. (2003). Environmental allergens and asthma in urban elementary schools. *Annals of Allergy, Asthma & Immunology*, 90(1): 34-40.

Bahadori, K., Doyle-Waters, M., Marra, C., Lynd, L., Alasaly, K., Swiston, J., & FitzGerald, M. (2009). Economic burden of asthma: a systematic review. *BMC Pulmonary Medicine*, 9(24): doi:10.1186/1471-2466-9-24

Belanger, K., Beckett, W., Triche, E., Bracken, M., Holford, T., Ren, P.,... Leaderer, B. (2003). Symptoms of wheeze and persistent cough in the first year of life: associations with indoor allergens, air contaminants, and maternal history of asthma. *American Journal of Epidemiology;* 158(2): 195-202. doi: 10.1093/aje/kwg148

Bloomberg, G., & Chen, E. (2005). The relationship of psychologic stress with childhood asthma. *Immunology and Allergy Clinics of North America*, 25(1): 83-105.

Canadian Council on the Social Determinants of Health. (2015). A Review of Frameworks on the Determinants of Health. Retrieved from http://ccsdh.ca/images/uploads/Frameworks_Report_English.pdf

Cesaroni, G., Farchi, S., Davoli, M., Forastiere, F., & Perucci, C. (2003). Individual and area-based indicators of socioeconomic status and childhood asthma. *European Respiratory Journal*, 22(4): 619-624.

Farber, H., Knowles, S., Brown, N., Caine, L., Luna, V., Qian, Y.,... Wilson, S. (2008). Secondhand tobacco smoke in children with asthma: sources of and parental perceptions about exposure in children and parental readiness to change. *Chest*, 133(6): 1367-1374. doi:10.1378/chest.07-2369

Institute for Clinical Evaluative Sciences. (2006). The Burden of Asthma in Ontario. Retrieved from http://www.ices.on.ca/~/media/Files/Atlases-Reports/2006/The-burden-of-asthma-in-Ontario/Full%20report.ashx

Kitch, B., Chew, G., Burge, H., Muilenberg, M., Weiss, S., Platts-Mills, T.,... G., Gold, D. (2000). Socioeconomic predictors of high allergen levels in homes in the greater Boston area. *Environmental Health Perspective,* 108(4): 301-7.

Lin, S., Jones, R., Munsie, J., Nayak, S., Fitzgerald, E., & Hwang, S. (2012). Childhood asthma and indoor allergen exposure and sensitization in Buffalo, New York. *International Journal of Hygiene and Environmental Health,* 215(3): 297-305. doi: 10.1016/j.ijheh.2011.08.017

Mansour, M., Lanphear, B., & Dewitt, T. (2000). Barriers to asthma care in urban children: parent perspective. *Pediatrics*, 106(3): 512-9.

Ministry of Health and Long-Term Care. (2013). Preventing and Managing Chronic Disease. Retrieved from http://www.health.gov.on.ca/en/pro/programs/cdpm/asthma.aspx

Neidell, H. (2004). Air pollution, health, and socio-economic status: the effect of outdoor air quality on childhood asthma. *Journal of Health Economics*, 23(6): 1209-1236.

Nishioka, K., Saito, A., Akiyama, K., & Yasueda, H. (2006). Effect of home environment control on children with atopic or non-atopic asthma. *Allergology International*, 55(2), 141-148.

Nurmagambetov, T., Beth, S., Jacob, V., Chattopadhyay, S., Hopkins, D., Crocker, D.,... Kinyota, S. (2011). Economic value of home-based, multi-trigger, multicomponent interventions with an environmental focus for reducing asthma morbidity. *American Journal of Preventative Medicine*, 41(2S1): 33-47.

Ontario Healthy Communities Coalition. (n.d.). Community Capacity Building. Retrieved from http://

www.ohcc-ccso.ca/en/community-capacity-building-0

Primomo, J., Johnston, S, DiBiase, F., Nodolf, J., & Leanne, N. (2006). Evaluation of a community-based outreach worker program for children with asthma. *Public Health Nursing*, 23(3): 234-241.

Rauh, V., Chew, G., & Garfinkel. (2002). Deteriorated housing contributes to high cockroach allergen levels in inner-city households. *Environmental Health Perspective*, 110(2): 323-327.

Riley, B., Robinson, K., Gamble, M., Finegood, D., Sheppard, D., Penney, T., Best, A. (2015). Knowledge to action for solving complex problems: insights from a review of nine international cases. *Health Promotion and Chronic Disease in Canada*, 35(3): 47-53.

Shah, J., Mizrahi, R., & McKenzie, K. (2011). The four dimensions: a model for the social aetiology of psychosis. *The British Journal of Psychiatry*, 199(1): 11-14.

Turcotte, D., Alker, H., Chaves, E., Gore, R., & Woskie, S. (2014). Healthy homes: in-home environmental asthma intervention in a diverse urban community. *American Journal of Public Health*, 104(4), 665-671.

U.S. Environmental Protection Agency. (1989). Report to Congress on Indoor Air Quality — Vol. II: Assessment and Control of Indoor Air Pollution. EPA/400/1-89/001C. Washington, D.C.: US EPA. Available at tinyurl. com/CCN-2013-R017E

Wahn, U., & Mutius, E. (2001). Childhood risk factors for atopy and the importance of early intervention. *Journal of Allergy and Clinical Immunology*, 107(4): 567-574.

Wellesley Institute. (2012). Housing and Health: examining the links. Retrieved from http://www.wellesleyinstitute.com/publications/housing-and-health-examining-the-links/

Wright, L. & Phipantanakul, W. (2014). Environmental remediation in the treatment of allergy and asthma: latest updates. *Current Allergy and Asthma Reports*, 14(3): 419. doi: 10.1007/s11882-014-0419-7

Wright, R., & Subramanian, S. (2007). Advancing a multi-level framework for epidemiologic research on asthma disparities. *Chest*, 132(5): 757-769.

Zotter, J. (n.d.). The role of the Community Health Worker in Addressing Modifiable Asthma Risk Factors in Massachusetts. Retrieved from http://pedicair.org/wp-content/uploads/2013/04/Zotter-CHW-in-MA.pdf