

# A POPULATION HEALTH APPROACH TO OBESITY IN CANADA – PUTTING THE PROBLEM BACK INTO CONTEXT<sup>8</sup>

## L'OBÉSITÉ AU CANADA SELON L'APPROCHE DE SANTÉ DES POPULATIONS - METTRE LE PROBLÈME DANS SON CONTEXTE

Stéphanie A. Prince, MSc, Doctoral Student  
Institute of Population Health  
University of Ottawa

### Abstract

Overweight and obesity have become increasingly prevalent in Canada and across the world. It is now recognized as a global pandemic, even affecting developing nations. It has become increasingly important to understand how populations are affected differently and identify key determinants; therefore, the objective of this paper is to apply a population health approach to examine the problem of obesity specifically within a Canadian context. This paper applies a population health approach to examine the problem of obesity specifically within Canada. Current prevention and treatment strategies are discussed with regard to their appropriateness for decreasing the prevalence and risk factors of obesity not only at the individual level, but at the population level. In order to emphasize the interactive roles of various determinants of health, levels of influence and sectors for intervention, population health frameworks are discussed to emphasize gaps in the literature and propose directions for future research and development.

### Résumé

L'obésité devient de plus en plus répandue au Canada et à travers le monde. Cette condition est maintenant reconnue comme une pandémie mondiale, affectant même les pays en développement. Il est devenu de plus en plus important de comprendre comment les populations sont différemment affectées et d'identifier les déterminants clés; donc, l'objectif de cet article est d'appliquer une approche de santé des populations pour examiner le problème de l'obésité en particulier dans un contexte canadien. Cet article utilise une approche de santé des populations pour examiner le problème de l'obésité en particulier au Canada. Les stratégies actuelles de prévention et de traitement sont discutées en ce qui concerne leur pertinence pour diminuer les facteurs de prévalence et de risque d'obésité, non seulement sur le plan individuel, mais aussi sur le plan des populations. Pour faire ressortir les rôles interactifs des divers déterminants de la santé, des niveaux d'influence et des secteurs d'intervention, divers modèles conceptuels de santé des populations sont discutés pour souligner les écarts dans la littérature et proposer des directions pour la recherche et le développement futur.

Correspondance: [s.prince.ware@gmail.com](mailto:s.prince.ware@gmail.com)

---

<sup>8</sup> CITATION: Prince, S.A (2009). A population health approach to obesity in Canada – Putting the problem back into context. *Transdisciplinary Studies in Population Health Series*, Vol. I (1), p. 22- 33.

## Introduction

Overweight and obesity are chronic conditions that have become increasingly prevalent in the past 15-20 years. Obesity has come to be recognized as both a Canadian “epidemic” and a global “pandemic” (1-3). Globally, it has affected even the poorest nations with developing countries now experiencing upward shifts in their average body mass indexes (BMIs) (4). The World Health Organization (WHO) recognizes obesity as a global health issue with one billion adults worldwide identified as overweight and an additional 300 million obese (1). It has become increasingly important to understand how populations are affected differently and identify key determinants; therefore, the objective of this paper is to apply a population health approach to examine the problem of obesity specifically within Canada.

Canada has also seen an increase in the proportion of its citizens who are classified as overweight/obese over the past several decades. The 2004 Canadian Community Health Survey (CCHS) is the most recent survey to have collected measured height and weight data in a representative sample of Canadians. The 2004 CCHS identified that 23% of Canadians aged 18 or older were considered obese and an additional 36% were classified as overweight (5). This obesity rate is higher than the 14% reported in the 1978/79 Canada Health Survey, which was the previous Canadian survey to have obtained measured height and weight data (6).

Obesity is associated with an increased risk for several non-communicable diseases including Type 2 diabetes, elevated blood pressure, heart disease, stroke, gallbladder disease, osteoarthritis, sleep apnea, and some cancers and mental health illnesses (7;8). Non-communicable diseases are threatening to overwhelm worldwide health care services and are projected to continue to rise while disease burden from communicable diseases (e.g. cholera, small pox, etc.) declines (9). For example, in 1990 disease burden from ischaemic heart disease, which is directly linked to obesity, was ranked fifth in the world using disability-adjusted life years (DALYs) and is estimated to become the leading cause of disease burden by 2020 (9).

Overweight and obesity are considered modifiable health factors for several diseases and are associated with high health care costs. In 2001, these costs were estimated at

\$4.3 billion or 2.2% of the total Canadian health care expenditure (10). The distribution of obesity-related health care expenditures in Canada varies between provinces likely as a result of varying prevalence rates and provincial funding for intervention and treatment. Interestingly, in 2004, Newfoundland and Labrador (33.9%), New Brunswick (29.2%), Saskatchewan (30.8%), and Manitoba (28.2%) were reported to have the highest prevalence rates of obesity and consequently the highest percentage of direct annual costs (11). British Columbia has in the past reported the lowest percentage of direct annual costs attributed to obesity (4.5%), likely reflecting the lowest provincial rates of obesity (19.2%) (11-13).

In order to effect change and design appropriate interventions that will target these inequalities, it is important to understand the risk factors that explain why rates differ between population groups and within them. This paper will apply a population health approach to examine the problem of obesity specifically within Canada. Current prevention and treatment strategies are discussed with regard to their appropriateness for decreasing the prevalence and risk factors of obesity not only at the individual level, but at the population level. Geographical differences in obesity rates and the prevalence of risk factors (e.g. physical activity rates, health care expenditures) exist and as such, the social and physical environments are discussed as key determinants of obesity. These environmental determinants along with individual biological and behavioural determinants play important roles in the development and prevention of physical inactivity, unhealthy eating, and obesity. In order to emphasize the interactive roles of various determinants of health, levels of influence and sectors for intervention, population health frameworks are discussed to emphasize gaps in the literature and current prevention strategies and propose directions for future research and development.

## Current Prevention and Treatment Strategies

The high costs and poor health outcomes associated with obesity have caused a recent shift of public focus and attention to the identification of possible risk factors and prevention and treatment strategies. Current population level prevention strategies are mainly composed of health promotion and education activities. Canadian initiatives

include such endeavors as Canada's Food Guide (14), Canada's Physical Activity Guide (15), Canada's Nutrition Labeling program (16), restaurant programs (e.g. Heart and Stroke Foundation of Canada's Health Check) (17), surveillance programs (e.g. Canadian Health Measures Survey) (18), and recently the Pan-Canadian Healthy Living Strategy (19).

Treatment strategies are generally delivered at the individual level and largely involve dietary therapy (consumption of a low calorie diet) and exercise therapy (increased physical activity); however, other methods exist such as drug therapy (i.e. appetite suppressants), surgery in the case of morbid obesity (e.g. gastric bypass, gastric banding), behavioural therapy (e.g. cognitive behavioural modification, skills training), and dietary counseling (i.e. lifestyle and dietary modifications) (20).

The Pan-Canadian Healthy Living Strategy was recently developed with a goal to achieve a 20% increase in the proportion of Canadians who are physically active, have healthy eating habits, and are at healthy body weights by the year 2020 (19). This initiative still appears to reflect the main message emitted from current prevention and treatment activities with promotion strategies that place much of the onus on individuals to 'eat less and be more active' in order to reduce their risk of obesity. To date, however, these efforts have yet to appear effective in decreasing rates of obesity in Canada.

Data from the 2004/05 CCHS identified that 52% of Canadian women and 48% of Canadian men were inactive (expending <1.5 kcal/kg/day) in their leisure time, equated to walking less than half an hour every day and unable to reap the associated health benefits of regular physical activity (21). The prevalence rates of physical inactivity have also been reported as higher among obese Canadian men and women (22). It is important to recognize that these data are based on self-reported measures and may not accurately represent current physical activity levels (23). Regardless, many Canadians are not meeting the Canadian Physical Activity Recommendations. In 2001, the economic costs of physical inactivity in Canada were estimated at \$5.3 billion or 2.6% of the total direct health care expenditures and \$3.7 billion in indirect costs (10). Physical inactivity is a risk factor for obesity and is likely responsible for a portion of obesity-related health care expenditures. It has been estimated that an annual

increase of 10% in the prevalence of physical activity could result in savings of \$150 million/year (24). These estimates illustrate that even a modest increase in physical activity could have a significant impact on the health of Canadians and the economy.

Not only is physical activity at suboptimal levels in Canada, but consumption of unhealthy foods is also at an all-time high. The increased availability of energy dense foods that promote the storage of fat (e.g. chocolate, chips, soda, etc.), the high cost of healthy food (e.g. fruits, vegetables, whole grains, etc.), and a rise in the number of fast food venues have all affected Canadians' eating practices (25). Individuals living in lower income households, are more likely to report purchasing fewer milk, fruit and vegetable products (26), and men and women who consume fruit and vegetables less than three times a day are more likely to be obese than those eating these foods five or more times a day (5). In developed societies, individuals at the lower end of the economic gradient have been shown to have a higher risk for obesity (4).

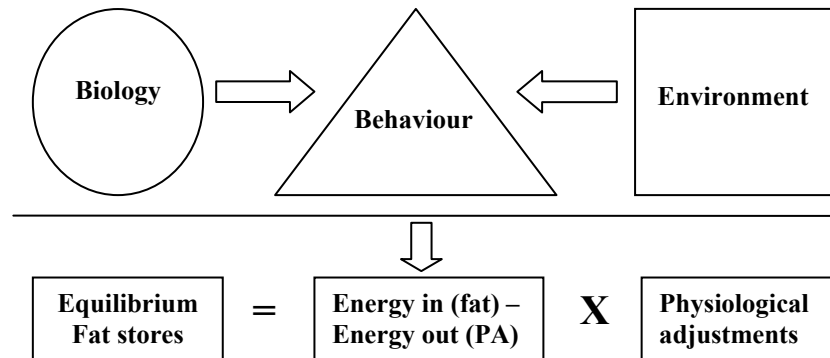
## **The Role of the Physical and Social Environments in Creating and Sustaining Inequalities**

Current strategies place much of the onus on the individual and describe obesity as a result of consuming too many calories and a lack of exercise (27). However, the rise in the prevalence of overweight and obesity indicates that current individual-level strategies are likely not effective in reducing the rates within the Canadian population. It therefore becomes important to conceptualize the problem of obesity within multiple levels of influence and consider the possible gene-environment and behaviour-environment interactions. Individual body weight and body composition are determined by the interactions between their genetics and the environment in which they live (28). Both human biology and the environment in which populations inhabit can affect behavioural patterns and body composition (see Figure 1). The environment can influence body weight through the facilitation of behaviours such as increased calorie consumption and decreased physical activity that generally lead to a positive energy balance. The physical environment can promote overeating through such variables as food availability and

portion sizes, and physical inactivity through facility access, modes of transportation, safety, etc. Interventions focused on the individual are unlikely to succeed if the environmental conditions in which they are delivered are not supportive. Therefore, there is a need to address the

environmental factors associated with behaviour prior to the development and delivery of individual-level interventions (29).

**Figure I:** An ecological model for understanding obesity (PA = physical activity)



Source: Swinburn B, Egger G, Raza F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Preventive Medicine*. 1999; 29: 563-70. Used by permission.

Environments that act as promoters of obesity or “obesogenic” environments result from the additive influences of surroundings, opportunities, or conditions in which an individual lives (30). The social environment, which can be examined using such markers as income and education levels, relative deprivation, social support, crime rates, current policies and standards, cultural beliefs, and behavioural norms, has a great impact on what food people consume and how much physical activity they obtain. It often determines why individuals make various choices and the behavioural patterns they subsequently adopt. The physical environment generally refers to what is available to an individual and includes such things as the physical surroundings (e.g. bike paths, green spaces, facilities, etc.) and other less tangible things such as the weather and climate that can affect the capacity of an individual to access and use their surroundings. Both the physical and social environments present barriers and enablers to obtaining adequate levels of physical activity and eating healthily.

For instance, between 1994/95 and 2002/03, members of the highest quintile of household income were less likely to become obese than were those in the lowest

income category (31). A similar relationship has been observed for physical activity levels, with lower income individuals less likely to be physically active than individuals with higher incomes (32). Lower income individuals are less able to afford healthier food options (i.e. fruit and vegetables, whole grains, etc.) which in Canada have higher associated costs than more energy dense foods. With the existence of a social gradient, the disparities between populations and the proportion of citizens who are obese or at risk for obesity will likely persist.

Inequalities in the social environment as defined using area level deprivation have also been shown to be associated with and influence access to recreation facilities including green spaces, parks, gyms, recreation centres, and bicycle and walking trails, such that proximity and access differ across areas with different socioeconomic circumstances (33-38). Furthermore, access to recreational facilities have been associated with physical activity levels and obesity (39-48), identifying the capacity of the physical environment to influence an individual’s diet and physical activity levels, as well as promote obesity.

Urban design, including land mix use, car time, and distance walked have all been shown to be significantly associated with obesity (49). Individuals who are located in areas that have more commercial and other non-residential land use walk more such as those in urban centres, get more physical activity, and are less likely to be obese (49). In 2004, Canadian adults living in cities (census metropolitan areas or CMAs), were less like than those outside of CMAs to be obese (20% vs. 29%) (50). Individuals living in municipalities outside of CMAs and census areas (CAs) who are farthest from urban centres (i.e. less able to commute by foot) were more likely to be obese than those who lived in municipalities which were more strongly influenced by metropolitan design (50). It is hypothesized urban sprawl is associated with negative consequences such as the decreased motivation to walk to locations, an increased reliance on automobiles for travel, and reduced opportunities to exercise in facilities because of time required for travel (50).

Generally, higher obesity rates have been reported in non-CMAs, except for in Newfoundland and Labrador and New Brunswick, which are the provinces with the lowest number of residents living in CMAs and CAs. Also interesting is the comparison between the proportion of residents who are obese and the proportion of individuals living in CMAs and CAs by province. The highest proportions of obesity are seen in the provinces with the lowest number of individuals living in CMAs and CAs (51).

Our current environment is increasingly conducive to automobile use, television viewing, decreased occupational activity, greater consumption of food outside of the home, and increased portion sizes (25). Current prevention and treatment strategies concerning lifestyle and health generally ignore systematic influences and instead focus much of their efforts on individual responsibility. Strategies are often deliverable at a population level, but are largely focused on the individual. If we are to develop prevention and treatment strategies that are to be effective, there is a need to avoid methods that are aimed at individuals in isolation of a societal level of intervention (52). Rather, it has become increasingly important to adopt individual interventions in conjunction with supportive social change. Anti-smoking campaigns in Canada are prime examples of effective intervention types that were implemented at the society level. The campaigns represented an effective

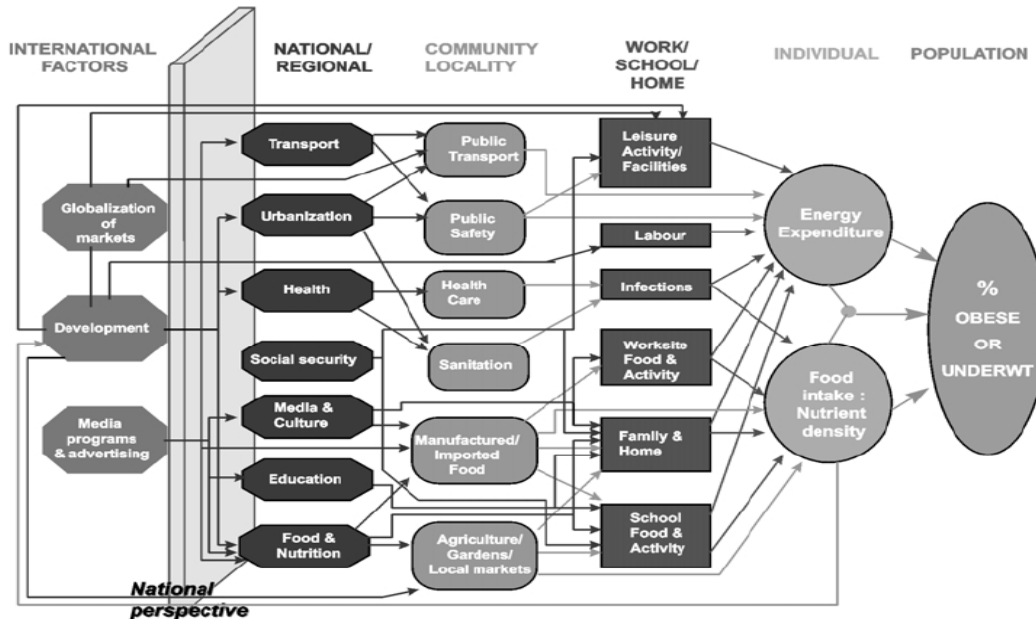
public health effort that included both physical and social environmental changes. Public health messages, increased cigarette taxes, and by-laws preventing individuals from smoking in public places have shown to be effective in decreasing the prevalence of smoking to the lowest rates ever (53).

## Adding a Population Health Approach

To elicit change it becomes increasingly important to address the multiple determinants of health across multiple levels and sectors, all factors that are inherent to the application of a population health approach. Kindig and Stoddart have proposed that population health be defined as: “the health outcomes of a group of individuals, including the distribution of such outcomes within the group” (54). Applying this definition of population health to the study of obesity would look to identify the interrelated factors and conditions that increase the risk to the population over the life course, and identify possible systematic variations, such as the social gradient, in order to develop policies and strategies that are effective in reducing risk. Population health frameworks provide the skeleton from which obesity and other health problems can be researched and for which appropriate interventions can be developed. In order to reduce the prevalence of obesity and decrease inequities, strategies should consider both behavioural risk factors (i.e. individual variability, genetics, lifestyles, etc.) and environmental influences (i.e. income, education, urban sprawl, etc.). A population health framework should incorporate determinants at all levels including the macro (international, national), the proximate (community, home/work/school), and the micro or individual level.

The International Obesity Task Force (IOTF) developed a population health framework (or causal web) that organizes the determinants of obesity (see Figure II). The IOTF framework maps out the societal policies and processes with direct and indirect influences on the prevalence of obesity, and acknowledges that the lines between determinants will differ between populations (4). It presents many contextual factors such as urbanization, globalization, and social security that have historically been ignored by research and prevention and treatment strategies. Although not explicitly, it acknowledges the transdisciplinary approach required to study the problem. Stakeholders and disciplines from all

Figure II. International Obesity Task Force Obesity Framework



Source: Kumanyika SK, Jeffrey RW, Morabia A, Ritenbaugh C, Antipatis VJ. Obesity prevention: the case for action. *International Journal of Obesity* 2002;26:425-36. Used by permission.

levels such as geography, sociology, epidemiology, kinesiology, nutrition, medicine, business/industry, health care, the public, and politics must be incorporated to understand the mechanisms by which obesity develops and persists. Obesity research and strategies have unfortunately, generally lacked the cooperative involvement of several stakeholders from all contextual levels. The framework identifies that obesity is not solely an individual or governmental manifestation, but one that is impacted on on several levels.

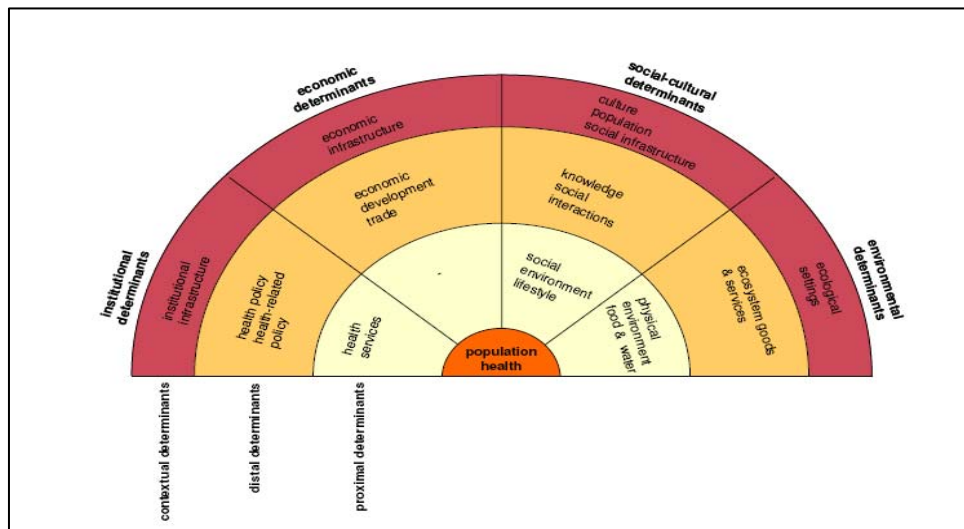
The framework, although developed exclusively for obesity, presents some challenges in its application. While being useful for identifying the transdisciplinary nature and contextual factors that lead to obesity in the population, it does so in a very linear and static fashion. The framework does not propose feedback from one level to the next nor the opportunity for the relationship to change directions. It directs the determinants down from the macro to the micro level and does not acknowledge the existence of inequalities at each level that often persist due to existing socio-economic gradients. As a result, in order to elicit changes at the

individual level, interventions should be considered in the context of the various levels.

Huynen and colleagues (2005) developed a multi-nature and multi-level framework (Figure III) for population health (55). While this framework was not developed exclusively for obesity it does provide a more dynamic alternative to the linear IOTF framework. It explicitly identifies the contextual level of the various determinants of obesity and within each determinant the broad system levels (proximal and distal) and factors. Their framework addresses the capacity of inequalities at various levels to exhibit non-linear impacts on others. Its dynamic nature identifies that each level and factor can impact another irrespective of direction. However, the model does not address the individual determinants of health such as individual susceptibility, genetic predisposition, and lifestyle/behaviour. It is important that health prevention and treatment strategies acknowledge the individual variability that is present within a population.

A combination of the more obesity-specific IOTF framework and the one presented by Huynen and

Figure III. Huynen *et al.* (2006) multi-nature and multi-level population health framework



Source: Huynen MMTE, Martens P, Hilderink HBM. The health impacts of globalisation: a conceptual framework. *Globalization and Health* 2005;1(14):1-12. Used by permission

colleagues may provide a more comprehensive population health approach to the study of obesity. Figure IV proposes such a framework and considers key determinants of obesity in a dynamic fashion that allows feedback from all levels. This framework presumes a less rigid cause-effect which is characteristic of the IOTF framework, and recognizes the contextual factors and complexity of obesity. It borrows from complexity theory and maintains a dynamic and open system between the various determinants of obesity. It incorporates many of the key variables of a complex system including: a large number of components, non-linear interactions with feedback loops, historical influence, and the openness of each system (represented by dashed lines) (56). By allowing the broader macro-level or distal factors to interact with the other proximal factors, it acknowledges the role of broader environmental factors in the development of individual behaviours. It also recognizes the historical influences of an individual or an individual's life course, a variable that is often missing from conceptual frameworks. Habits developed in childhood and childhood environments such as physical activity behaviours, have been shown to be important contributors to the development of adult obesity (57). Because it is a conceptual framework, it is not meant to provide a causal flow, but rather a paradigm for thinking about obesity as a population health problem. It lays the

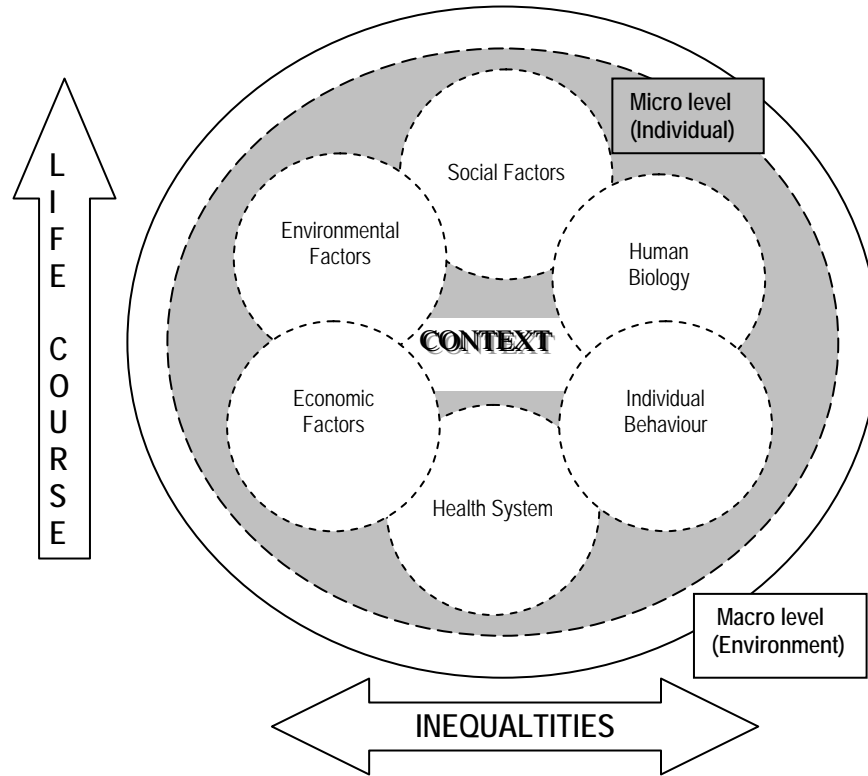
foundation for theory development and represents the broadest level of conceptualization (58).

Applying this population health framework to the problem of obesity in Canada identifies that obesity is a complex problem with multiple determinants. For example, individuals may be at a greater risk for obesity because they have a genetic predisposition, are from a lower income family, live in a neighbourhood that does not promote physical activity (e.g. is unsafe and amenities are not walkable), has friends and family who are obese and/or does not have access to supportive medical services such as a dietician or a general practitioner. These factors can affect an individual directly or their effects can be cumulative and the determinants can also affect each other. For instance, an individual who is genetically predisposed to being overweight may come from a lower income family increasing their inability to afford to live in a neighbourhood that is conducive to walking which in turn makes them more sedentary and more likely to become obese. The framework shows how an individual's risk factor can be impacted by the environment in which they live.

### Gaps in the Literature

Rapid increases in the prevalence of obesity cannot be explained by genetic changes within populations. While

Figure IV. Proposed population health conceptual framework for the study of obesity



Source: Author's figure

genetics may have the capacity to determine individual susceptibility toward weight gain, it is likely social and environmental changes that are driving this global pandemic (4). Economic growth, modernization, urbanization, and globalization of food markets have all been identified as contributors to the sudden rise (4). Our modern society sees less individuals being physically active and an increased consumption of unhealthy, energy dense foods.

Although a large component of the answer lies in the physical and social environments, most research and strategies to date have focused on the individual level. In Canada, little information has been collected regarding the roles of the social and physical environments on the risk of obesity. Societal and structural changes are important contextual factors to be considered in the design and delivery of effective individual focused

prevention and treatment strategies. Environmental design in Canada has yet to be fully explored for its effects on health and health behaviours. The majority of research that has focused on environmental determinants of physical activity, nutrition, and obesity has been in the American context. Markers of the social environment (e.g. income and educational levels) in Canada are regularly collected; however, surveillance at the national level remains limited. Few smaller scale studies have examined the impact of the environment on physical activity and obesity, but these are not generalizable to the Canadian population. Furthermore, few prevention strategies have been implemented that involve environmental change. Most current prevention strategies have used a form of public health campaigns and education without changes to community infrastructure and program evaluations remain sparse.

## Conclusions and Recommendations

Surveillance of populations provides a means by which we can evaluate the association of various factors with obesity and an opportunity to compare changes over time. Natural experiments provide the best means by which social and structural changes could be evaluated. Further research is required to determine the more specific roles of the physical and social environments including the social gradient, on the prevalence of obesity. Canadian data is sparse and multilevel designs assessing the impact of various factors while recognizing their context may provide some suggestion as to where structural and societal changes could be implemented. Research to date has had little involvement of stakeholders at all levels or feedback from various disciplines. Transdisciplinary research and involvement of the public could provide new insight to this population

health problem and feedback regarding the effectiveness of various strategies.

If obesity is to cease as a population-level health problem, it requires a population health approach. The current prevention and treatment strategies are not effective and ignore both the individual variability and the context of the problem. The modern characteristics of the physical and social context in which Canadians live are likely to blame for the rapid increases in the rates of obesity. Social inequalities and environmental barriers are often ignored in obesity strategies and result in the growth of disparities and inequities in health. It is important that further research be conducted to assess the multilevel risk factors of obesity and that intervention work focus not only on individual strategies, but also on the use of contextual changes across multiple sectors.

## References

1. Le Gales-Camus C. Address to the Informal Meeting of EU Health Ministers. World Health Organization 2006. Available from URL: [http://www.who.int/nmh/media/speeches/nmh\\_adg\\_speech\\_eu\\_april06\\_en.pdf](http://www.who.int/nmh/media/speeches/nmh_adg_speech_eu_april06_en.pdf)
2. Katzmarzyk PT. The Canadian obesity epidemic: an historical perspective. *Obesity Research* 2002;10(7):666-74.
3. Starsky S. The obesity epidemic in Canada. Ottawa, Ontario, Canada: Library of Parliament; 2005. Report No.: PRB 05-11E.
4. Kumanyika SK, Jeffrey RW, Morabia A, Ritenbaugh C, Antipatis VJ. Obesity prevention: the case for action. *International Journal of Obesity* 2002;26:425-36.
5. Tjepkema M. Adult obesity. *Health Reports (Statistics Canada, Catalogue 82-003-XIE)* 2006;17(3):9-27.
6. Shields M, Tjepkema M. Trends in adult obesity. *Health Reports* 17[3], 53-59. 2006.
7. Health Canada. Obesity. Her Majesty the Queen in Right of Canada; 2006. Report No.: HI3-7/20-2006E-PDF.
8. Pi-Sunyer FX. The obesity epidemic: pathophysiology and consequences of obesity. *Obesity Research* 2002;10(Supp 2):97S-104S.
9. Looking ahead: the health of the world in 2020. In: Murray CJL, Lopez AD, editors. The executive summary of the global burden of disease and injury series. Cambridge: Harvard University Press; 1996.
10. Katzmarzyk PT, Janssen I. The economic costs associated with physical inactivity and obesity in Canada: An update. *Canadian Journal of Applied Physiology* 2004;29(2):90-115.
11. Canadian Community Health Survey, Nutrition. Statistics Canada - Catalogue no. 82-620; 2004.
12. Colman R, Dodds C. The Cost of Obesity in Nova Scotia. GPI Atlantic 2000 Available from: URL: <http://www.gpiatlantic.org/pdf/health/obesity/ns-obesity.pdf>
13. Average earnings of the population 15 years and over by highest level of schooling, by province and territory (2001 Census). Statistics Canada 2004 [cited 2006 Dec 15]; Available from URL: <http://www40.statcan.ca/101/cst01/labor50b.htm>
14. Minister of Public Works and Government Services Canada. Canada's Food Guide to Healthy Eating. Health Canada 1997 Cat. No. H39-252/1992E Available from: URL: <http://www.hc-sc.gc.ca/fn-an/food-guide-aliment/index-eng.php>
15. Canada's Guide to Health Eating and Physical Activity. Her Majesty the Queen in Right of Canada; 2004.

16. Nutrition Labeling. Health Canada 2006. Available from URL: [http://www.hc-sc.gc.ca/fn-an/label-etiquet/nutrition/index\\_e.html](http://www.hc-sc.gc.ca/fn-an/label-etiquet/nutrition/index_e.html)
17. Health Check™...Helping you eat well. Heart and Stroke Foundation of Canada 2006. Available from: URL: [http://www.heartandstroke.com/site/c.iQlLcMWJtE/b.3483961/k.7B27/Health\\_Check.htm](http://www.heartandstroke.com/site/c.iQlLcMWJtE/b.3483961/k.7B27/Health_Check.htm)
18. Canadian Health Measures Survey. Statistics Canada 2006. Available from URL: <http://www.statcan.ca/english/survey/household/measures/measures.htm>
19. The Pan-Canadian Healthy Living Strategy. The Minister of Health; 2005.
20. Douketis JD, Attia J, Feightner JW, Feldman WF, with the Canadian Task Force on Preventative Health Care. Periodic health examination, 1999 update: 1. Detection, prevention and treatment of obesity. *Canadian Medical Association Journal* 1999;160(4):513-25.
21. Physical Activity Levels among Canadian Adults. Canadian Fitness and Lifestyle Research Institute 2005. Available from URL: [http://www.cflri.ca/eng/levels/adult\\_levels.php](http://www.cflri.ca/eng/levels/adult_levels.php)
22. Chen Y, Mao Y. Obesity and leisure time physical activity among Canadians. *Preventive Medicine* 2006;42:261-5.
23. Prince SA, Adamo KB, Hamel ME, Hardt J, Connor Gorber S, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity*. In press 2008.
24. Katzmarzyk PT, Gledhill N, Shephard RJ. The economic burden of physical inactivity in Canada. *Canadian Medical Association Journal* 2000;163(11):1435-40.
25. French SA, Story MA, Jeffery RW. Environmental influences on eating and physical activity. *Annual Reviews in Public Health* 2001;22:309-35.
26. Canadian Population Health Initiative. Improving the health of Canadians: promoting healthy weights. Canadian Institute for Health Information; 2006.
27. Friedman JM. A war on obesity: not the obese. *Science* 2003;299:856-8.
28. Hill JO, Peters JC. Environmental contributions to the obesity epidemic. *Science* 1998;280:1371-4.
29. Katzmarzyk PT, Baur LA, Blair SN, Lambert EV, Oppert J-M, Riddoch C. International conference on physical activity and obesity in children: Summary statement and recommendations. *International Journal of Pediatric Obesity* 2008;3(1):3-21.
30. Swinburn B, Egger G, Raza F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Preventive Medicine* 1999;29:563-70.
31. Le Petit C, Barthelot J-M. Obesity - A growing issue. *Health Reports (Statistics Canada, Catalogue 82-003-XIE)* 2006;17(3):43-50.
32. Parks SE, Housemann RA, Brownson RC. Differential correlates of physical activity in urban and rural adults of various socioeconomic backgrounds in the United States. *Journal of Epidemiology and Community Health* 2003;57(1):29-36.
33. Ellaway A, Kirk A, MacIntyre S, Mutrie N. Nowhere to play? The relationship between the location of outdoor play areas and deprivation in Glasgow. *Health & Place* 2007; 13:557-61.
34. Moore LV, Diez Roux AV, Evenson KR, McGinn AP, Brines SJ. Availability of recreational resources in minority and low socioeconomic status areas. *American Journal of Preventive Medicine* 2008;34(1):16-22.
35. Pascual C, Regidor E, Astasio P, Ortega P, Navarro P, Dominguez V. The association of current and sustained area-based adverse socioeconomic environment with physical inactivity. *Social Science & Medicine* 2007; 65(3): 454-66.
36. Powell LM, Slater S, Chaloupka FJ, Harper D. Availability of physical activity-related facilities and neighborhood demographic and socioeconomic characteristics: A national study. *American Journal of Public Health* 2006 Sep 1;96(9):1676-80.
37. Estabrooks PA, Lee RE, Gyurcsik NC. Resources for physical activity participation: Does availability and accessibility differ by neighborhood socioeconomic status? *Annals of Behavioral Medicine* 2003 Apr 9;25(2):100-4.
38. Popkin BM, Duffey K, Gordon-Larsen P. Environmental influences on food choice, physical activity and energy balance. *Physiology & Behavior* 2005 Dec 15;86(5):603-13.
39. Addy CL, Wilson DK, Kirtland KA, Ainsworth BE, Sharpe P, Kimsey D. Associations of perceived social and physical environmental supports with physical activity and walking behavior. *American Journal of Public Health* 2004;94(3):440-3.
40. Ball K, Bauman AE, Leslie E, Owen N. Perceived environmental aesthetics and convenience and company are associated with walking for exercise among Australian adults. *Preventive Medicine* 2001;33(5):434-40.
41. Blanchard CM, McGannon KR, Spence JC, Rhodes RE, Nehl E, Baker F, et al. Social ecological correlates of physical activity in normal weight, overweight, and obese individuals. *International Journal of Obesity* 2005 Jun;29(6):720-6.
42. Booth ML, Owen N, Bauman A, Clavisi O, Leslie E. Social-cognitive and perceived environmental influences associated with physical activity in older Australians. *Preventive Medicine* 2000 Jul;31(1):15-22.

43. Brownson RC, Baker EA, Housemann RA, Brennan LK, Bacak SJ. Environmental and policy determinants of physical activity in the United States. *American Journal of Public Health* 2001;91(12):1995-2003.
44. De B, I, Sallis JF, Saelens BE. Environmental correlates of physical activity in a sample of Belgian adults. *American Journal of Health Promotion* 2003;18(1):83-92.
45. Gordon-Larsen P, Nelson MC, Page P, Popkin BM. Inequality in the built environment underlies key health disparities in physical activity and obesity. *Pediatrics* 2006 Feb;117(2):417-24.
46. Mobley LR, Root ED, Finkelstein EA, Khavjou O, Farris RP, Will JC. Environment, obesity, and cardiovascular disease risk in low-income women. *American Journal of Preventive Medicine* 2006 Apr;30(4):327-32.
47. Roemmich JN, Epstein LH, Raja S, Yin L, Robinson J, Winiewicz D. Association of access to parks and recreational facilities with the physical activity of young children. *Preventive Medicine* 2006 Dec;43(6):437-41.
48. Troped PJ, Saunders RP, Pate RR, Reininger B, Ureda JR, Thompson SJ. Associations between self-reported and objective physical environmental factors and use of a community rail-trail. *Preventive Medicine* 2001;32:191-200.
49. Frank LD, Andresen MA, Schmid TL. Obesity relationships with community design, physical activity, and time spent in cars. *American Journal of Preventive Medicine* 2004;27(2):87-96.
50. Shields S, Tjepkema M. Regional differences in obesity. *Health Reports (Statistics Canada, Cat No : 82-003-XIE)* 2006;17(3):61-7.
51. Population and Dwelling Counts, for Canada, Provinces and Territories by the Statistical Area Classification, 2001 and 1996 Censuses. 2006. Ottawa, Ontario, Canada, Statistics Canada.
52. Kumanyika SK. Minisymposium on obesity: Overview and some strategic considerations. *Annual Reviews in Public Health* 2001;22:293-308.
53. Canadian Tobacco Use Monitoring Survey (CTUMS) 2007 – Summary of annual results. Health Canada 2007. Available from URL: [http://www.hc-sc.gc.ca/hc-ps/tobac-tabac/research-recherche/stat/\\_ctums-esutc\\_2007/ann\\_summary-sommaire-eng.php](http://www.hc-sc.gc.ca/hc-ps/tobac-tabac/research-recherche/stat/_ctums-esutc_2007/ann_summary-sommaire-eng.php)
54. Kindig D, Stoddart G. What is population health? *American Journal of Public Health* 2003;93(3):380-3.
55. Huynen MMTE, Martens P, Hilderink HBM. The health impacts of globalisation: a conceptual framework. *Globalization & Health* 2005;1(14):1-12.
56. Gatrell AC. Complexity theory and geographies of health: a critical assessment. *Social Science & Medicine* 2005 Jun;60(12):2661-71.
57. Telama R, Yang X, Viikari J, Valimaki I, Wanne O, Raitakari O. Physical activity from childhood to adulthood: a 21-year tracking study. *American Journal of Preventive Medicine* 2005;28(3):267-73.
58. Carpiano RM, Daley DM. A guide and glossary on postpositivist theory building for population health. *Journal of Epidemiology and Community Health* 2005;60:564-70.