

Poverty and the extent of child obesity in Canada, Norway and the United States

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Summary

The goal of this paper is to compare the extent of child obesity in Canada, Norway and the United States. As child poverty is an important correlate of child obesity, we wish to examine the potential role of international differences in child poverty in explaining international differences in the extent of child obesity. We use three representative microdata surveys containing parental reports of child height and weight collected in the mid-1990s in Canada, Norway and the US. We calculate both the prevalence and proportional severity of child obesity for 6–11-year-old children in each country, and represent the ‘extent’ of obesity diagrammatically. Differences in patterns of child poverty are similarly depicted. Obesity extent is also compared for poor and non-poor children in Canada and the US. Finally, child obesity in the three countries is compared using only non-poor children where we find that the extent of child obesity is much lower in Norway than in Canada or the US. The pattern apparent for obesity is remarkably similar to that found for child poverty. In Canada and especially in the US, we find a much greater extent of obesity for poor than non-poor children. However, when we compare only non-poor children in the three countries, although the magnitude of difference is smaller, it remains clear that Norwegian children are much less likely to be obese. Policy and research directed towards reducing the extent of child obesity in both Canada and the US should pay particular attention to issues of child poverty.

Keywords: child obesity, international comparisons, poverty.

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Introduction

Recent research has indicated increases over time in the prevalence of obesity in both Canada and the United States (1–6). These reported trends are worrisome given established links between child obesity and adult obesity (7), between adult obesity and adult health (8,9), and between child obesity and child well-being today (2,10). Although it is clear from country-specific studies that obesity rates are rising over time in many countries, research which attempts directly to compare child obesity across countries is limited (11), so comparison of child obesity across countries with both different policies and different obesity outcomes offers one strategy for learning about possible solutions (12).

In this paper, we compare both the prevalence and severity of child obesity in three affluent countries: Canada, Norway and the US. These three countries are an interesting set to study because, while similarly affluent [the gross domestic product (GDP) per capita in 1994 for Norway was \$22 588, \$21 590 in Canada, and \$26 636 in the US, all in 1994 US dollars (13)] they have made quite different social policy choices and have correspondingly different socioeconomic outcomes for children. Canada and the US are both characterized as having welfare states with relatively low levels of public spending (14) [15.4% of GDP for social expenditures in 1994 in the US; 20.6% in Canada (15)], income transfers which are targeted to the poor rather than universally available, and relatively high rates of child poverty [24.5% in the US in 1994; 15.4% in

Canada (16)]. Norway offers policy contrast with much higher levels of public spending [26.4% of GDP in 1994 (14)], more universal and generous benefits and much lower rates of child poverty – 4.3% in 1994 (15). To the extent that socioeconomic status is a known correlate of child obesity (17), we might expect to see differences across the countries in patterns of child obesity.

Methods

We first compare child obesity across the three countries; we next compare child poverty experiences. For Canada and the US, we compare child obesity for poor and non-poor children; finally, we compare child obesity for non-poor children in each country.

To make comparisons of child obesity, we use three nationally representative cross-sectional surveys carried out during roughly the same time period. For Canada, we use the 1994 National Longitudinal Survey of Children and Youth (NLSCY). The 1994 cross-section is representative of all Canadian children aged 0–11 years (with the exception of those living in the North, on reserves, or in institutions). The NLSCY uses the Labour Force Survey sampling frame and is thus a multistage probability sample with geographical stratification and clusters within strata. Only children with valid height and weight responses are included in the analysis sample. In 1994, total sample size for children aged 6–11 years was 9227. For the US, we use the National Health and Nutritional Examination Survey 1988–1994 (NHANES III) which is a nationally representative survey of adults and children in the US from 1988 to 1994 with 2408 children aged 6–11 years. The 1995 Health Survey for Norway (NHS) is representative of the full population in Norway with 766 children who are 6–11 years old.

Height and weight information for children aged 6–11 years is comparably reported by parents (or other knowledgeable adults) in each data set. In other work (18), we have emphasized that it is vital in comparative research to use data which measure child height and weight in the same way. While we have also argued that parent reports tend to over-state child obesity, this bias should be equally present in each of the three data sets used here. (Canada does not have a nationally representative sample of children with anything other than parental reports, the NHANES III provides height and weight measures taken during the interview, but we do not use these here as they will not be comparable with the Canadian and Norwegian data.)

Height and weight information is used to calculate the body mass index (BMI) for each child. Consistent with most recent literature on child obesity (3,19), obesity is defined using the Center for Disease Control (CDC) thresholds which vary by child sex and age. The CDC growth

charts are based on information for US children from the 1960s to 1990s. For comparability, the same thresholds are used for all countries. We have also calculated all measures reported in this study using the recently proposed international definition of obesity (20). As the Cole thresholds are higher, obesity prevalence rates were lower for all countries causing small sample problems for Norway.

We first compare the prevalence of child obesity in the three countries. However, when comparing child obesity across countries, it seems both plausible and important that the ‘severity’ of obesity could differ across countries with similar prevalence rates. For example, country A and country B could both have child obesity prevalence rates of 10%. However, if the obese children in country A are much more severely obese, it would be misleading to base the cross-country comparison on prevalence alone. Given the same prevalence, more *severe* obesity (i.e. higher BMI’s) is, for adults, associated with more negative health consequences (21–25). To present a more complete comparison of child obesity in Canada, Norway and the US, we thus also calculate the average proportional ‘severity’ of obesity for all children with a BMI greater than the relevant CDC threshold [i.e. (child BMI – appropriate age/sex threshold)/threshold].

Finally, we summarize the overall ‘extent’ of obesity (19) in the population as the product of prevalence and average proportional severity. Following the literature on poverty measurement, which deals with the same issues of incidence and depth of poverty, we note that the ‘extent’ of child obesity in each country can be depicted diagrammatically in ‘obesity boxes’ which illustrate prevalence on the horizontal axis and average severity on the vertical axis.

Notice that the extent measure implicitly weights prevalence and severity equally (as the two are simply multiplied together). However, it is not obvious whether it is worse for population health to have a higher prevalence of child obesity and lower severity or vice versa.

To compare child poverty, we employ microdata from the Luxembourg Income Study (LIS). The LIS is a collection of microdata sets, housed in Luxembourg but accessible to remote users via the internet. Individual countries have contributed their own data sets, but LIS staff have made every effort to ensure, where possible, comparability (26). For each country, we choose the year of LIS data which is closest to the year for which we have child BMI information. We use LIS data rather than the income information available in the health microdata sets for our discussion of child poverty as it provides more detail than is available in the health data sets. For Canada, the LIS data set is the 1994 Statistics Canada Survey of Consumer Finance; for the US, the 1994 March Current Population Survey; for Norway, the 1995 Income and Property Distribution Survey. We again focus on children aged 6–11 years for the poverty calculations.

Poverty lines are comparably chosen as 50% of median ‘adjusted’ disposable income in each country. Disposable income includes income from all sources, including government transfers; personal taxes are deducted. Family income is adjusted by dividing by the square root of family size made to account for the differing needs of families of different sizes. This approach to poverty assessment is standard in the international poverty literature (27,28).

For each country, we calculate the incidence of child poverty (percentage of children with income less than poverty level) and average proportional depth of child poverty (income shortfall divided by the poverty line averaged over all poor children). We also compute the ‘intensity’ of child poverty (29) as the product of incidence and proportional depth. Notice that the summary indicator of child poverty status is thus entirely analogous to that used to indicate the extent of child obesity. (However, the two literatures have developed separately and use different terminologies to describe effectively the same concepts – prevalence of obesity/incidence of poverty; extent of obesity/intensity of poverty.) We again employ ‘poverty boxes’ to diagrammatically summarize the intensity of child poverty in each country.

All statistical analyses were carried out using Statistical Analytical Software (SAS); sample weights are used to account for survey design.

Results

‘Obesity boxes’ for 6–11-year-old children are illustrated for Canada, Norway and the US in Fig. 1. (Table 1 reports all of the numbers used to construct the boxes.) Quite clearly, child obesity is a smaller problem in Norway than in either Canada or the US. This is largely the result of lower prevalence (6.3% in Norway compared with 16.1% in Canada and 20.7% in the US). For children who are obese in Norway, the ‘severity’ of obesity is similar to that evident in the other countries (on average, 19.6% of the

relevant CDC threshold in Norway compared with 20.3% in the US). In fact, while Canadian children have a higher prevalence of obesity than Norwegian children, Fig. 1 indicates that the average severity of child obesity in Canada is slightly less than in Norway (though notice in Table 1 that because there are so few obese children, standard errors on the estimates of proportional severity are large relative to the mean, so the point estimates are not statistically different). Taking both prevalence and severity into account, however, the extent of child obesity is clearly greater in Canada than in Norway; the extent of child obesity is greatest in the US.

Figure 2 illustrates ‘poverty boxes’ for 6–11-year-old children in the three countries, and the first startlingly obvious point to make is that Figs. 1 and 2 are hard to distinguish (numbers used to construct the poverty boxes are provided in Table 2). Patterns observed for the intensity of child poverty experienced in the three countries are nearly identical to the patterns of child obesity. Child poverty incidence is much lower in Norway than in either Canada or the US; depth of poverty given a child is poor is not as different. Again, while Canadian incidence of poverty is higher, poor children in Norway actually have slightly greater depth of poverty than their poor Canadian counterparts. Overall, it is again evident that there is more child poverty in Canada than in Norway; the most child poverty is evident in the US.

Figures 3 and 4 present obesity boxes for poor compared with non-poor children in Canada and the US. We were not able to carry out a similar analysis for Norway because there were only 49 obese children. Note, however, that Norway having numbers so small as to preclude statistical analysis is in itself an extremely important point!

The main message of Figs 3 and 4 is that the extent of obesity is greater for poor children than for non-poor children in both Canada and the US, though the difference between the two groups is more pronounced for children

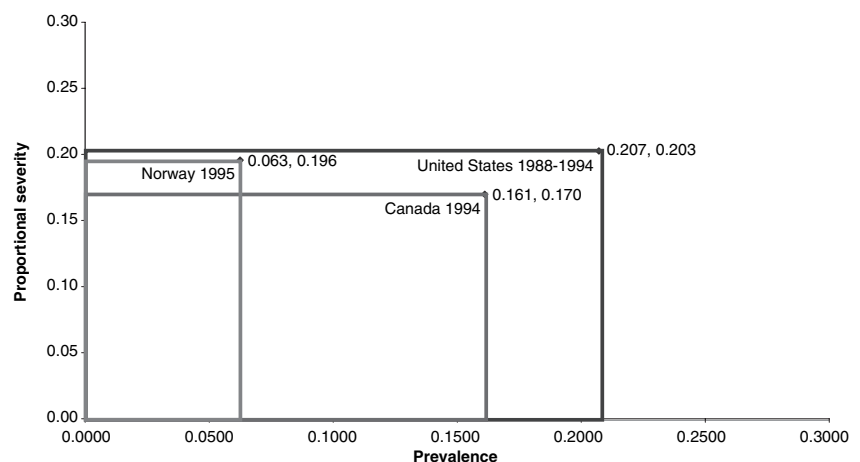


Figure 1 Obesity extent – children ages 6–11, Canada 1994, United States 1988–1994, Norway 1995. Source: National Longitudinal Survey of Children and Youth (Canada); National Health and Examination Survey III (United States); Norwegian Health Survey (Norway).

Table 1 Prevalence and proportional severity of obesity, child ages 6–11, Canada 1994, Norway 1995 and United States 1988–1994

	All children 6–11			Not poor children 6–11			Poor children 6–11		
	Canada 1994	Norway 1995	United States 1988–1994	Canada 1994	Norway 1995	United States 1988–1994	Canada 1994	Norway 1995	United States 1988–1994
Prevalence	16.1% (0.38)	6.3% (0.88)	20.7% (0.83)	15.2% (0.43)	6.1% (0.92)	18.2% (1.0)	19.4% (0.83)	NA	17.1% (1.6)
Proportional severity	17.0% (0.46)	19.5% (7.5)	20.3% (0.92)	16.5% (0.53)	21.8% (8.9)	17.2% (1.0)	18.4% (0.88)	NA	25.1% (1.9)
Extent (prevalence x severity)	273.7	122.9	420.2	250.8	132.9	313.0	357.0	NA	680.3

Standard errors in parentheses.
NA, not available.

in the US. In Canada, obesity prevalence for poor children is 27.6% higher (19.4% compared with 15.2%) whereas in the US, obesity prevalence for poor children is 49.5% higher (27.1% compared with 18.2%). In Canada, there is only a very small difference between poor and non-poor children in the proportional severity of obesity for children who are classified as obese (18.3 vs. 16.5%); in the US, severity of obesity for those who are obese is also much greater for poor than non-poor children (25.1% compared with 17.2%).

Given that we know both that child poverty rates are much lower in Norway and that poor children are more likely to be obese (30–33), an interesting question is then whether overall obesity appears lower in Norway because the population includes so few poor children? To address this question, Fig. 5 compares child obesity across the three countries only for *non-poor* children. The extent of child obesity in Norway is, of course, essentially unchanged by excluding poor children; in both Canada and, especially, the US, both prevalence and severity fall, reducing overall obesity extent. However, while the countries are certainly closer, it is still quite evident that the extent of child obesity, even among non-poor children in all countries, is much lower in Norway.

Discussion

Consistent with other literature on cross-national comparisons of poverty, we find that the intensity of child poverty is lower in Norway than in Canada or, especially, the US. Given known relationships between poverty and child obesity, it is then not surprising that we also find that the extent of child obesity is lower in Norway than in Canada or the US. For both Canada and the US, we also demonstrate that the extent of child obesity is greater for poor than for non-poor children, and this pattern is particularly marked for the US. This suggests that both policy and further research directed at reducing child obesity in North America should be particularly focused on issues surrounding poverty. That is, we need to improve our understanding *both* about how best to reduce child poverty and how to develop policies which can mediate solutions in the pathways from poverty to obesity in children (34). As noted above (30–33), links between poverty and obesity have been identified by a number of researchers. More recent work has begun to examine the pathways more closely. First, energy-dense foods such as those based on refined grains, added sugar and added fats are more affordable than lean meats, fish, and fresh fruits and vegetables making it difficult for low-income families to adopt a more healthy diet (35). Second, research (36) has suggested parents with limited resources and lower incomes are more likely to be stressed than those with more resources available; higher stress, in turn, can have a physiological effect on individuals whereby the body

Figure 2 Poverty intensity – children ages 6–11, after tax income, Canada 1994, US 1994, Norway 1995. Source: Authors' calculations using the Luxembourg Income Study.

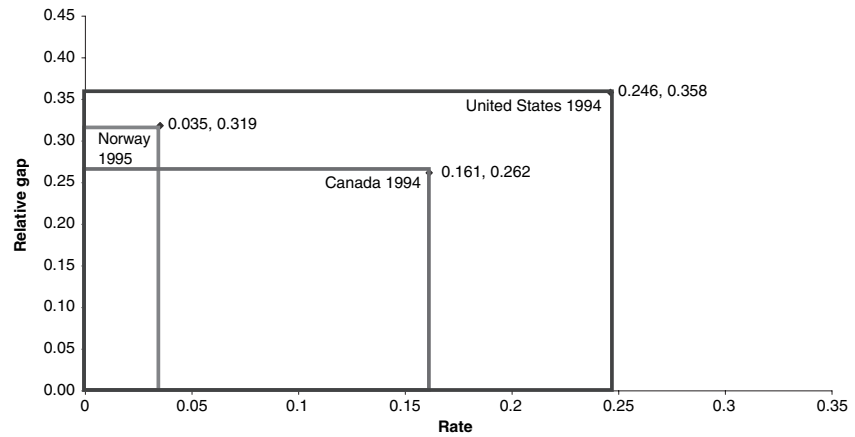


Figure 3 Obesity extent – poor and not poor, children ages 6–11, Canada 1994. Source: National Longitudinal Survey of Children and Youth (Canada).

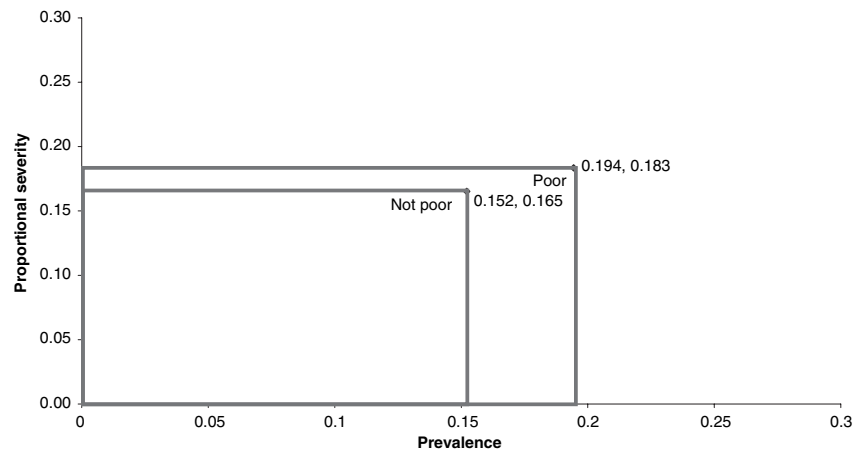


Table 2 Poverty rate, gap and intensity, children aged 6–11

	Canada 1994	Norway 1995	United States 1994
Poverty rate	16.1% (0.18)	3.5% (0.18)	24.6% (0.17)
Poverty gap	26.2% (0.25)	31.9% (1.1)	35.8% (0.20)
Poverty intensity (rate × gap)	421.8	111.7	880.7

Standard errors in parentheses.

Poverty is measured using one-half median equivalent household after tax income for each country.

The equivalence scale used is the square root of the number of individuals in the household.

Source: Authors' calculations using the Luxembourg Income Study.

releases glucocorticoids which has been shown to increase appetites and lead to over-eating (37–40).

As our results indicate, non-poor children in Norway have the lowest prevalence of obesity while non-poor children in the US the highest. Because the poverty population is not static, the non-poor population contains families at risk of future poverty and families with recent experiences of poverty – the higher the current poverty rate, the higher the proportion of the non-poor who have likely recently

experienced poverty or will experience poverty in the future (27). Thus, a greater percentage of the non-poor population will be subjected to risks associated with obesity, as noted above. As well in the US and, increasingly, in Canada, social programmes emphasize that individuals assume more of the risks for their own security (41), meaning more stress for those at risk of job loss. Finally, there are programmes in Norway which may help to reduce child obesity over all income levels such as laws

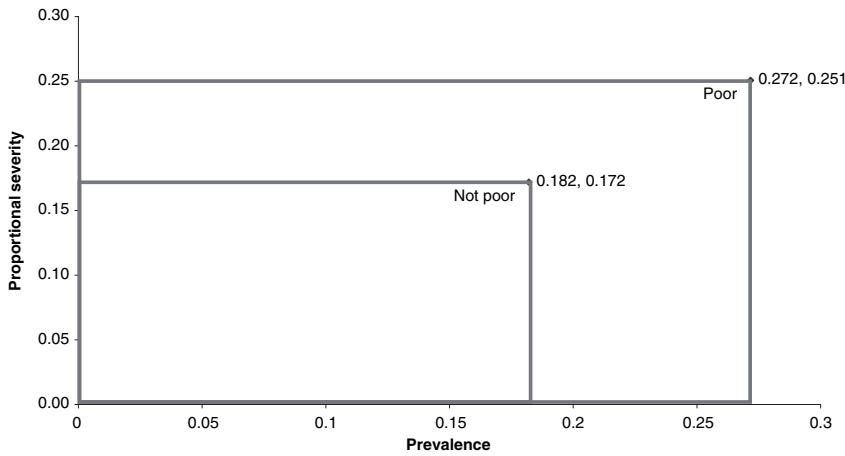


Figure 4 Obesity extent – poor and not poor, children ages 6–11, United States 1988–1994. Source: National Health and Examination Survey III (United States).

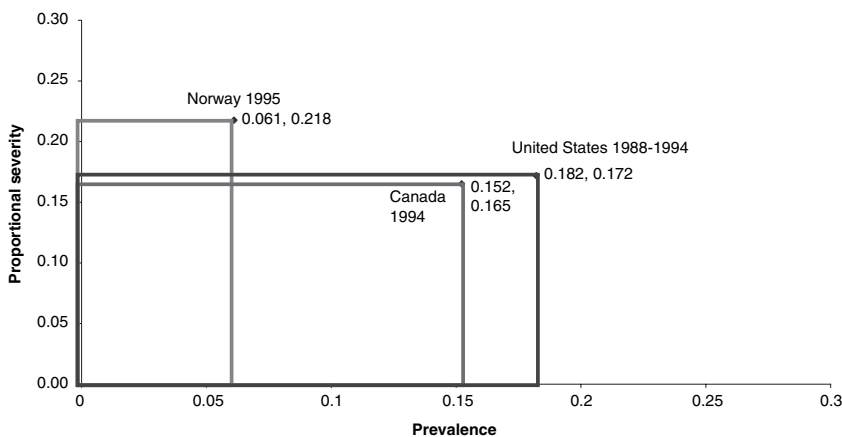


Figure 5 Obesity extent, not poor – children ages 6–11, Canada 1994, United States 1988–1994, Norway 1995. Source: National Longitudinal Survey of Children and Youth (Canada); National Health and Examination Survey III (United States); Norwegian Health Survey (Norway).

which prohibit advertising of unhealthy foods to children (42).

Although we have only been able to compare child poverty and child obesity across the countries at a single point in time, future research should attempt cross-country longitudinal comparisons. Are there ‘critical periods’ of weight gain (i.e. during infancy, childhood, adolescence) with particularly negative health effects (43,44)? Are similar patterns apparent in all countries or might these be mediated through different policies (e.g. longer maternity leave allowing longer periods of breast-feeding; different nutrition standards in daycare centres; different physical education programmes in public schools). Research providing longitudinal comparisons would also be useful for policy-makers in helping to understand linkages between poverty and obesity. Chronic or long-term poverty generally has larger negative associations with health status than current poverty (45). In particular, as there is a lag between weight gain and health deterioration, past household income may have important connections with child BMI.

Given that results indicate a lower overall prevalence of child obesity in Norway and higher levels in the US, future

research should include analysing outcomes across countries with varying policies which affect all children. For example, is there evidence that reducing the availability of junk foods in vending machines and/or increasing opportunities for physical activity in schools helps reduce obesity in children? There may be important differences across countries with respect to national standards for schools. As well, there may be more local parks and sidewalks which encourage exercise among children. Research has begun which analyses the association between number and intensity of fast food services and cardiovascular disease (46). Governments should continue to try and understand how to balance convenience and social policy which encourages healthy behaviours through international policy and outcome comparisons.

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References

1. Tremblay M, Willms JD. Secular trends in the body mass index of Canadian children. *CMAJ* 2000; **163**: 1429–1433.
2. Tremblay MS, Katzmarzyk PT, Willms JD. Temporal trends in overweight and obesity in Canada, 1981–1996. *Int J Obes Relat Metab Disord* 2002; **26**: 538–543.
3. Ogden C, Flegal K, Carroll M, Johnson C. Prevalence and trends in overweight among US children and adolescents, 1999–2000. *JAMA* 2002; **288**: 1728–1732.
4. Gortmaker SL, Dietz WH Jr, Sobol AM, Wehler CA. Increasing pediatric obesity in the United States. *Am J Dis Child* 1987; **141**: 535–540.
5. Troiano RP, Flegal KM. Overweight children and adolescents: description, epidemiology, and emographics. *Pediatrics* 1998; **101**: 497–504.
6. Troiano RP, Flegal KM, Kuczmarski RJ, Campbell SM, Johnson CL. Overweight prevalence and trends for children and adolescents. The national health and nutrition examination surveys, 1963 to 1991. *Arch Pediatr Adolesc Med* 1995; **149**: 1085–1091.
7. Monteiro PO, Victoria CG. Rapid growth in infancy and childhood and obesity in later life – a systematic review. *Obesity Rev* 2005; **6**: 143–154.
8. Birmingham CL, Muller JL, Palepu A, Spinelli JJ, Anis AH. The cost of obesity in Canada. *CMAJ* 1999; **160**: 483–488.
9. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. *JAMA* 1999; **282**: 1523–1529.
10. Schwimmer JB, Burwinkle TM, Varni JW. Health-related quality of life of severely obese children and adolescents. *JAMA* 2003; **289**: 1813–1819.
11. WHO Consultation on Obesity. *Obesity: Preventing and Managing the Global Epidemic*. World Health Organization: Geneva. 1997. WHO Technical Report Series no. 894.
12. Human Resources and Development Canada and Health Canada. *The Well-Being of Canada's Young Children: Government of Canada Report 2002*. Human Resources and Development Canada and Health Canada: Ottawa, 2002.
13. OECD. *National Accounts of OECD Countries Main Aggregates Volume I*, table B5, 2005.
14. Esping-Andersen Gosta. *The Three Worlds of Welfare Capitalism*. Polity Press: Cambridge. 1990.
15. OECD Information By Country, <http://stats.oecd.org/wbos/viewhtml.aspx?QueryName=21&QueryType=View&Lang=en> (subject: Public Policies, Social Expenditures).
16. Luxembourg Income Study (LIS). Key Figures, <http://www.lisproject.org/keyfigures.htm>
17. Lin BH, Huang CL, French SA. Factors associated with women's and children's body mass indices by income status. *Int J Obes Relat Metab Disord* 2004; **28**: 536–542.
18. Phipps P, Burton P, Lethbridge L, Osberg L. Measuring obesity in young children. *Can Public Pol* 2004; **30**: 349–364.
19. Jolliffe D. Extent of overweight among US children and adolescents from 1971 to 2000. *Int J Obes Relat Metab Disord* 1971; **28**: 4–9.
20. Cole TK, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000; **320**: 1240–1243.
21. Manson JE, Colditz GA, Stampfer MJ, Willet WC, Rosver B, Monson RR, Speizer FE, Hennekens CH. A prospective study of obesity and risk of coronary heart disease in women. *N Engl J Med* 1990; **322**: 882–889.
22. Zhou BF. Effect of body mass index on all-cause mortality and incidence of cardiovascular diseases' report for meta-analysis of prospective studies open optimal cut-off points of body mass index in Chinese adults. *Biomed Environ Sci* 2002; **15**: 345–352.
23. Calle EE, Thun MJ, Petrelli JM, Rodriguez C, Heath CW Jr. Body mass index and mortality in a prospective cohort of U. S. adults. *N Engl J Med* 1999; **341**: 1097–1105.
24. Kenchaiah S, Evans JC, Levy D, Wilson PWF, Benjamin EJ, Larson M, Kannel WB, Vasan RS. Obesity and the risk of heart failure. *N Engl J Med* 2002; **347**: 305–313.
25. Field AE, Coakley EH, Must A, Spadano JL, Laird N, Dietz WH, Rimm E, Colditz GA. Impact of overweight on the risk of developing common chronic diseases during a 10-year period. *Arch Intern Med* 2001; **161**: 1581–1586.
26. Smeeding T, Rainwater L, Coder J. *Luxembourg Income Study (LIS): Information Guide*. LIS Working Paper no. 7, Maxwell School of Citizenship and Public Affairs, Syracuse. Syracuse University: New York, 1993.
27. Osberg L. Poverty in Canada and the USA: measurement, trends and implications. Presidential address. *Can J Economics* 2000; **33**: 847–877.
28. Rainwater L, Smeeding T. *Poor Kids in a Rich Country: America's Children in Comparative Perspective*. Russell Sage Foundation: New York, 2003.
29. Osberg L, Xu K. International comparisons of poverty intensity: index de-composition bootstrap inference. *J Human Resour* 2000; **35**: 51–81.
30. Storey ML, Forshee RA, Weaver AR, Sansalone WR. Demographic and lifestyle factors associated with body mass index among children and adolescents. *Int J Food Sci Nutr* 2003; **54**: 491–503.
31. Strauss RS, Knight J. Influence of the home environment on the development of obesity in children. *Pediatrics* 1999; **103**: e85.
32. Willms JD, Tremblay MS, Katzmarzyk PT. Geographic and demographic variation in the prevalence of overweight Canadian children. *Obes Res* 2003; **11**: 668–673.
33. Wang Z, Patterson CM, Hills AP. Association between overweight or obesity and household income and parental body mass index in Australian youth: analysis of the Australian National Nutrition Survey, 1995. *Asia Pac J Clin Nutr* 2002; **11**: 200–205.
34. Whitehead M, Burstrom B, Diderichsen F. Social policies and the pathways to inequalities in health: a comparative analysis of lone mothers in Britain and Sweden. *Soc Sci Med* 2000; **50**: 255–270.
35. Drewnowski A. Obesity and the food environment dietary energy and diet costs. *Am J Prev Med* 2004; **27**: 154–162.
36. Morris JE, Coley RL. Maternal, family, and work correlates of role strain in low-income mothers. *J Fam Psychol* 2004; **18**: 424–432.
37. Rosmond R. Role of stress in the pathogenesis of the metabolic syndrome. *Psychoendocrinology* 2005; **30**: 1–10.
38. Wang M. The role of glucocorticoid action in the pathophysiology of the metabolic syndrome. *Nutr Metab* 2005; **2**: 3.
39. Dallman F, la Fleur S, Pecoraro NC, Gomez F, Houshyar H, Akana S. Minireview: glucocorticoids-food intake, abdominal obesity, and wealthy nations in 2004. *Endocrinology* 2004; **145**: 2633–2638.
40. Epel E, Lapidus R, McEwen B, Brownell K. Stress may add bite to appetite in women: a laboratory study of stress-induced cortisol and eating behaviour. *Psychoendocrinology* 2001; **26**: 37–49.
41. Osberg L. Jobs and growth: the missing link. In: Banting K, Battle K (eds). *A New Social Vision for Canada?* School of Policy Studies: Kingston, 1994, pp. 57–69.

42. Kaiser Family Foundation. *The Role of Media in Childhood Obesity*. 2004 Issue Brief <http://www.kaisernetwork.org/health_cast/hcast_index.cfm?display=detail&hc=1087>.
43. Dietz W. Health consequences of obesity in youth: childhood predictors adult disease. *Pediatrics* 1998; **101**: 518–525.
44. Bhargava SK, Sachdev HS, Fall CH, Osmond C, Lakshmy R, Barker DJ, Biswas SK, Ramji S, Prabhakaran D, Reddy KS. Relation of serial changes in childhood body-mass index to impaired glucose tolerance in young adulthood. *N Engl J Med* 2004; **350**: 865–875.
45. Phipps S. The impact of poverty on health: a scan of research literature. *Poverty and Health-Canadian Population Health Initiative Collected Papers*. Canadian Institute for Health Information: Ottawa, 2003, pp. A1–A29.
46. Alter DA, Eny K. The relationship between the supply of fast-food chains and cardiovascular outcomes. *Can J Public Health* 2005; **96**: 173–177.