Health Outcomes and Urban Form: A Multi-dimensional Study in Canada

by

Amanda Tse

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Abstract

This study is an empirical analysis of the relationship between urban form of residence and health outcomes in Canada using the 2002 and 2004 cycles of the Canadian Community Health Survey. Urban form is defined on 7 levels. From the most central to most peripheral, we had: urban core, urban fringe, rural fringe, secondary urban core, urban area outside the CMA, and rural area outside the CMA. Health outcomes were represented by four measures—body mass index, rating of self-perceived health, incidence of 3 chronic conditions (hypertension, heart disease and diabetes) and a physical activity index — to provide a multidimensional analysis. Using ordinary least squares, linear probability, probit and ordered probit methods, we investigated for evidence that urban forms farther away from the urban core are associated with poorer health, which is defined by higher BMI, higher probability for being overweight and obese, higher risk for a chronic condition and/or lower physical activity level.

Our results indeed provided evidence that urban forms do, in fact, affect the physical activity levels of Canadians as well as their BMI outcomes. The effects vary for males and females, and across socio-demographic factors. However, statistically insignificant were the effects of urban forms on the incidence of heart disease, diabetes and hypertension as well as self-perceived health.

Acknowledgements

Firstly, I would like to thank Charles Beach for advising me on this project. Your openness to advise me on the subject of this paper was very much encouraging. I also appreciated your sage advice, patience and understanding. One day, I will return to New York and once again call to mind the suggestions you shared with me! Many thanks also to Casey Warman whose advice and assistance with STATA was invaluable. Thank you for emailing me regression outputs even after I had moved away, and having endless patience (I'm sure you will have more visitors who take to your doorbell with incessant shamelessness!).

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1 Introduction

When Statistics Canada began collecting information on the health of its citizens in 1978, 13.8% of the total population was obese and another 35.4% was overweight. These figures, compared to the 2004 rates[1] where 23% of the total population is obese and another 59% were overweight, illustrate a drastic increase. The consequences of obesity, including diabetes, heart disease, stroke, several types of cancers and premature death, essentially add unnecessary pressure to an already stretched health care system. Aside from research on medical causes and genetic factors that predispose individuals to a higher risk of obesity, researchers have also turned to research on behavioral, social, economic and environmental factors which can affect excess weight.

Within the literature, many factors have been uncovered. For example, Powell et al. (2005) found that food prices, restaurant and fast food outlet densities had significant impact on body mass indices. Furthermore, Powell et al. (2007) found that chain supermarkets were associated with lower rates of overweight among adolescents, but local convenience stores had a negative influence. However, over the last 30 years, urban residential form shifted toward lower density developments with a predominantly uni-dimensional land use mix. Urban residential form, thereafter simply referred to as 'urban form', was built around the increasing ubiquity of the automobile. Vandergrift and Yoked (2004) noted that this development decreased the opportunity cost of car driving while simultaneously increasing the opportunity cost of healthy modes of travel such as cycling or walking. New Urbanists and Smart Growth proponents often draw on this tradeoff in advocating higher urban development density with greater land use mix and connectivity.

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[1] These 2004 rates come from Cycle 3.1 of the Canadian Community Health Survey, and are the most recent publicly available figures on obesity and overweight figures.

It is the relationship between urban form and physical health that we endeavor to explore in this paper. A number of studies have explored obesity as affected by the contextual factor of urban form in the American environment, yet few studies of the sort have been conducted for Canada. More than simply examine the issue of obesity, we also study physical activity outcomes, self-perceived health and the incidence of chronic conditions to provide a multi-dimensional perspective of the relationship. Not only will our findings possibly verify the claims of New Urbanists and Smart Growth advocates, but they will also have potentially important policy implications for the allocation of health care, land use policies and future urban development within and outside of Canadian cities.

This discussion will proceed after a brief background on the terminology, then a look at recent literature on the subject. Following a discussion of the data employed in this study, I will detail the empirical methods to be employed. A presentation and discussion of findings will conclude the examination.

2 Background Terminology

Before presenting our methodology and analysis, it is useful to first establish common understanding of the terminology. The term “urban sprawl” often appears in the literature of this field. However, “urban sprawl” is only a description of a specific type of urban form. More generally, the *urban form* of a region refers to how an area or region is spatially developed (Tsai, 2005). Form encompasses various zoning and land use mixes, density, the road network and relevant greenspace; thus urban form is to be viewed from a regional perspective[2]. Urban sprawl, then, refers to a type of low density development which typically sustains car dependence (Lopez, 2004). Our dataset delineates urban form

[2] The disaggregate counterpart of urban form is typically built environment (or built form) which focuses more on the spatial form of built structures within a neighbourhoods and disaggregated locales of urban regions.

on 7 levels which we use in our regression analyses: *urban core*, *urban fringe*, *rural fringe*, *urban area outside the CMA*[3] (central metropolitan area), *rural area outside the CMA*, and a *secondary urban core*. As defined by Statistics Canada, the urban core is a large urban area around which a CMA or CA[4] is delineated and must have a population (based on the previous census) of at least 50,000 if the urban area is a CMA, or 10,000 if the urban area is classified as a CA. The urban fringe encompasses small urban areas within a CMA or CA that are not contiguous with the urban core of the CMA or CA. Our data also distinguishes the urban area outside the CMA and so follows a similar definition except being outside

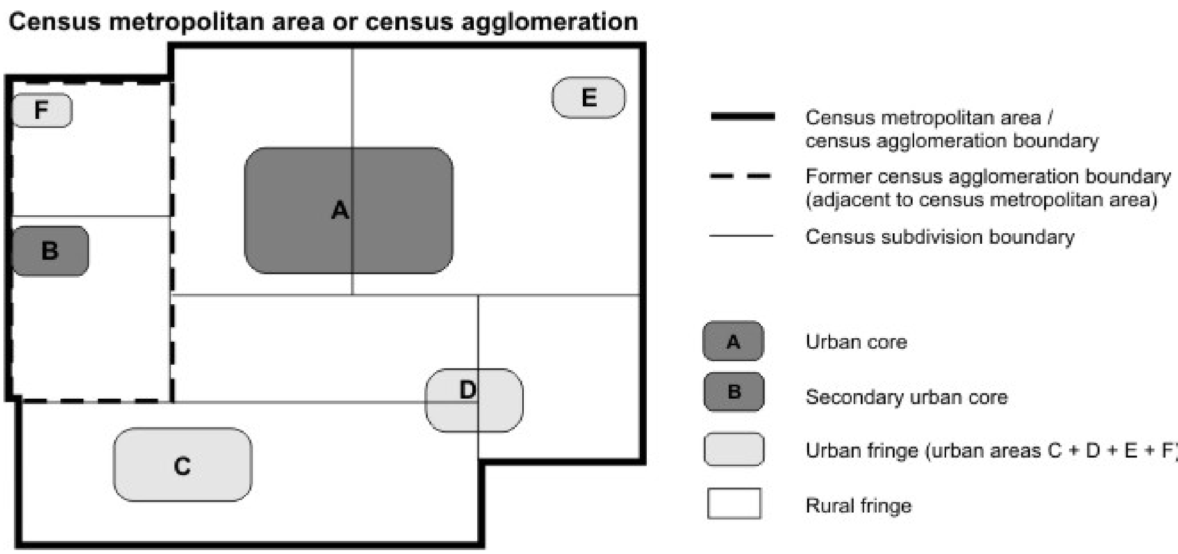

Figure 1: Illustrative Definition of Urban Form

the boundaries of the CMA. The rural fringe is all territory within a CMA or CA not classified as an urban core or an urban fringe. Likewise, the rural area outside of the CMA would be all territory not included in the CMA and not included as the urban area outside the CMA.

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[3] Central Metropolitan Area (CMA) is an area consisting of one or more neighbouring municipalities situated around a major urban core, with a total population of at least 100,000 of which at least 50,000 live in the urban core.
[4] Census Agglomeration (CA) is an area consisting of one or more neighbouring municipalities situated around a major urban core, with a total population of at least 100,000 of which at least 10,000 live in the urban core.

Also needing definition is the term “health outcomes”. Health itself is multi-dimensional. Therefore, our analysis will attempt to model this multi-dimensionality by examining four relevant outcomes:

- Body mass index (BMI), which is the most common health outcome measure used in the literature;
- Incidence of three chronic conditions[5]: hypertension (or high blood pressure), heart disease and diabetes. These will provide an indication of the probability of realized effects since these three conditions are associated to lifestyle, which can be affected by urban form;
- Rating of self-perceived health, which is seldom used, but can provide an indication of self-perceived effects of residing in various urban forms; and
- Physical activity index, which has been regularly used to instrument health outcomes in the literature because of its close link to healthy lifestyles.

These four outcomes will provide a more comprehensive and multidimensional view of the role that urban form plays on health.

3 Literature Review

Discussions on this issue of the effect of urban form on health outcomes, by its nature, have been rooted in the urban planning and public health fields. Recent studies consider this relation by focusing on various measures of urban form and health. Definitions of urban form and methods used by researchers have generated two broad examinations of this relationship. One focuses on neighbourhood effects and another group of studies focus on regional effects which are also deemed metropolitan area effects.

[5] A chronic condition is defined by Statistics Canada as a long-term condition that has lasted, or is expected to last, six months or more. (http://www.statcan.gc.ca/concepts/definitions/health-sante-eng.htm)

3.1 Different types of measures for urban form and health

Handy et al. (2002) attempt to provide appropriate measures to quantify urban form. Distinguishing between local (or neighbourhood) and regional measures, Handy et al. suggest five dimensions of urban form and one regional dimension as well as methods for quantifying these measures. Neighbourhood dimensions include density, land use mix, street connectivity, street scale and aesthetic qualities. Density is often measured by persons per square area and land use by the share of total area for different uses. Street connectivity refers to the availability of transportation routes within an area and is typically estimated by average block length; whereas street scale, estimated by the ratio of building height to street width, refers to the three-dimensional space along a street. The dimension to consider at the regional level is regional structure which can be estimated by the rate of decline in density with distance from the city core or by the degree of centralization or decentralization classified by activity centers[6]. Unfortunately, data on these uni-dimensional measures of urban forms are largely unavailable for Canadian cities. Thus, we rely on Statistics Canada's geographical delineation.

Likewise, Turcotte (2008) defines the divide between urban and suburban regions using four methods. One is to define urban form by administrative borders; another distinguishes the central core from a periphery, which itself is ambiguous. Better, yet, is to define urban form by neighbourhood density, similar to Handy et al. (2002). However, Turcotte's most preferred measure is the distance from city hall, which acts as a proxy to the city center. This definition is attractive partly due to ease of measurement, and because the measure will remain constant over time, whereas the former measures are boundaries which can change over time.

[6] That is, defining degree to which an urban area is monocentric or polycentric.

Different than Handy et al. (2002) and Turcotte (2008), many studies employ a "sprawl index", which measure the degree to which a neighbourhood exhibits urban sprawl. The most popular sprawl index used is that developed by Ewing, Pendall and Chen (2002). Developed for SmartGrowth America, it combines 22 measures on four dimensions of urban form: residential density, land use mix, degree of centering and street accessibility. These measures are totalled then adjusted for the metropolitan size. Other "sprawl indexes" within the literature include a measure used by Ross et al. (2007) of three equally weighted aspects of urban form: the proportion of CMA dwellings that are single or detached units, the dwelling density of the CMA, and the percentage of CMA population living in the urban core as defined by Statistics Canada. However, as Kelly-Schwartz et al. (2004) discusses, uni-dimensional measures of urban form (such as density or street connectivity) provide a more precise and intelligible picture of urban form than a four-dimensional measure such as a sprawl index.

As identified in Section 2, the term "health outcome" is rather ambiguous. The difficulty lies not in identifying how to measure outcomes but in defining what should be deemed a "health outcome". The majority of studies on this relationship have relied on the body mass index and physical activity levels. Discussions of urban form and health have routinely evolved into discussions of whether the urban form of residence bears effect on the propensity to be obese. Within this study, we not only consider this outcome— the propensity to be obese given the urban form one resides in— but also the effect of urban form on BMI where BMI is a continuous value and when grouped into categories.

Aside from the BMI, Ewing et al.(2003) and Sturm and Cohen (2004) broaden the definition of health outcomes to also include the probability of having diabetes, hypertension and heart disease. These three chronic conditions have been shown by Haapanen et al.(1997) to be affected by lifestyle choices which can be influenced by where one lives, and so were viewed in their studies as outcomes to also consider. Rare, but used by Kelly-Schwartz et al.(2004), is self-reported health. This measure acts as a proxy to overall health much like BMI, except that it encompasses all factors in addition to physical health as partly by BMI.

Moreover, examining the physical activity levels of individuals is indicative of overall "health outcomes" of individuals. Theory suggests that, as the urban form becomes increasingly automobile dependent, residents would have a lower propensity to walk or bike. The reduction in physical activity increases the likelihood of becoming overweight or obese. Turcotte (2009), Kelly-Schwartz et al.(2004), Ewing et al.(2003) and Frank, Andresen and Schmid (2004) study the relationship between physical activity as it relates to physical health and urban form. In their likeness, I also study the effect of urban forms in Canada on the physical activity levels of respondents.

3.2 Different methodologies

Aside from variations in the literature regarding definitions and interpretations of urban form and health outcome, there are also varied methods in representing and interpreting the relationship. The principal difference lies in the treatment of urban form — the majority of researchers treat urban form as an exogenous variable, and two particular studies treat urban form as an endogenous factor. In essence, this distinction was born from the issue of self-selection.

Studies that treat urban form as exogenous primarily use cross-sectional data. American studies have used the Behavioural Risk Factors Surveillance Survey (Ewing et al., 2003; Handy et al., 2002; and Kelly-Schwartz et al., 2004), the Healthcare for Communities Survey (Sturm and Cohen, 2004) or the National Health and Nutrition Examination Survey. In Canada, researchers have used the Canadian Community Health Survey (Ross et al., 2007). Controlling for individual socio-demographic and economic characteristics including age, race/ethnicity, income, education attainment, gender and smoking status, the results generally found a positive association between urban form and obesity rates. The strength of this correlation, however, is varied.

For example, Ewing et al. (2003) used an urban sprawl index and modelled BMI as a continuous variable as well as a binary (obese or not) variable. They found that individuals living in areas where the urban form is marked with a high sprawl index are less likely to walk, generally weigh more and have higher prevalence of hypertension than those living in areas where the sprawl index was low. However, it was noted that the effects observed are statistically significant but small in magnitude. Kelly-Schwartz et al. (2004) found, using a similar method, that measures of sprawl are not significantly related to the diagnosis of hypertension, heart disease and diabetes. Unlike Ewing et al. (2003), a sprawl index in addition to uni-dimensional measures of urban form were used. Their findings suggest a more complex relationship—relatively connected areas tended to encourage physical activity, but higher density was related to poorer health[7]. Ross et al. (2007), a Canadian study, distinguished regional effects from local neighbourhood effects. Specifically, the hypothesis was that living in a metropolitan region of a sprawling urban form had an incremental effect on BMI. Using nested modelling, Ross et al. confirmed this finding, but only for men. For women, the association between a sprawling urban form and BMI was positive but hardly significant.

The second group of researchers criticize the above studies for not accounting for the role of self-selection and endogeneity in their studies. Instead of cross-sectional analysis, two studies in particular attempt to endogenize the role of urban form by using longitudinal data. Eid et al. (2007) study the relationship between BMI and urban form, and specifically the possibility that individuals with a propensity to be obese self-select

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[7] Kelly-Schwartz et al.suggested that higher density may be correlated with higher stress which has a negative impact on health thus resulting in findings of poorer health.

into sprawling neighbourhoods. With longitudinal data, Eid et al. used the method of first differences and found results comparable to earlier studies. However, further studying the endogeneity by examining the outcomes of individuals who moved to a different neighbourhood, they found the changes in urban form did not bear an effect on BMI. Thus Eid et al. conclude that urban form does not cause the incidences of excess weight that are observed.

A similar study by Platinga and Bernell (2007) also attempts to address endogeneity by examining the subsample of individuals who moved residences. To determine if the change in urban form has an effect on the BMI of individuals, they first test if an individual's prior BMI affects the choice of urban form during a move controlling for individual characteristics, and then conduct a second test which uses a linear model of the change in BMI post-move again controlling for individual characteristics. Two interesting results emerge. One, BMI is a significant factor in the choice of urban form. Two, individuals who move to denser locations tend to see drops in BMI, with the greater the change in density the greater the weight loss. For that reason, Platinga and Bernell conclude that the relationship is indeed two-way.

Arguments can be made both in support of urban form being an exogenous variable, as well as that being endogenous. In fact, some studies indicate that walking and biking facilities actually encourage people to be more active. In a survey of US adults using a park or walking and jogging trail, almost 30 percent reported an increase in activity since they began using these facilities. A recent poll found that, if given a choice, 55 percent of Americans would rather walk than drive to destinations (McCann and Ewing, 2003). Even so, it is difficult to ignore the role of self-selection embodied in urban form. Nonetheless, we proceed to examine the relationship assuming urban form is exogenous. The present empirical study will only identify if there exists a similar correlation between urban form and health outcomes within Canada as in the American findings.

4 Method

4.1 Data and Method

This section details the dataset used in the present study to examine the relationship between health outcomes and urban form. In describing this relationship, our goal is four-fold. We first will examine how urban form affects the most basic health indicator – body mass index. Doing so, we will treat the body mass index as a continuous variable, as a binary variable for obesity, and also as an ordered health rating in three separate analyses. Second, the reported ratings of self-perceived health will provide an additional dimension. Thirdly, we examine the relationship by examining the incidence rates of heart disease, diabetes and hypertension. We complete our discussion with an examination of the effects of urban form on physical activity levels.

Data

Data used for this study come from the Canadian Community Health Survey (CCHS). The CCHS is a cross-sectional dataset of information on health care utilization, health status and health determinants for Canadians collected in cycles every second year. Our analysis will focus on two cycles[8] in particular—Cycle 2.1 and Cycle 3.1 conducted for 2002 and 2004, respectively. Both followed the same delineation of urban form, as described in Section 2: urban core, urban fringe, rural fringe, urban area and rural area outside the CMA, and secondary urban core. Since the time difference between the two data cycles was two years when the Canadian government and economic environment remained unchanged, we did not control for differences between the cycles using a dummy

[8] Cycle 4.1 has recently been released but was found to have different definition of urban forms than Cycle 2.1 and 3.1, and so was not included in this study.

variable. Most advantageous of combining the two data cycles is the sample size, yielding a large number of observations.

Data within the survey of particular relevance to our analysis include the body mass index, incidence of chronic conditions, self-perceived health ratings and a measure of physical activity levels; the survey includes as well socio-demographic factors. Ensuring analytical integrity, we restricted the dataset in several ways. First, we excluded observations from the three territories, so that our sample reflects the outcomes only of the individuals in the provinces. The reason lies primarily in the different lifestyle due to a harsher climate and their northern latitude. Second, we eliminated all observations where females reported being pregnant, as it would bias body mass index figures. Also, this analysis examined adults only, where an adult is defined by the age range of 18 to 70 inclusive. Finally, we dropped all observations where responses were not stated, unknown or refused. Interpretations of our exogenous and dependent variables follow as described.

Socio-Demographic Covariates

Ethnic background is a significant factor in health outcomes. Different ethnicities have different predispositions for certain health outcomes. We followed a conventional classification of the ethnic backgrounds cited by respondents: *White*, *Black*, *Asian*[9] , *South Asian*[10] , *South East Asian*[11] , *Middle Eastern*[12] , *Latin American*, and *Aboriginal*. The group *Other* captured multi-ethnic individuals and those whose ethnicities are not represented above. In one variable specification of our model, we made use of a general binary classification, *minority*, which grouped together all non-white ethnicities.

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[9] Asian includes the Korean, Chinese and Japanese ethnicities.
[10] South Asian groups together the ethnicities of India and Pakistan.
[11] South East Asian category encompasses Cambodian, Vietnamese, Filipino and Indonesian ethnicities.
[12] Middle Eastern groups together the ethnicities of the Middle East, North Africa and Western Asia.

The highest level of education attained by the respondent is defined on a scale of ten levels with the lowest being attainment of less than grade 8 education and the highest being attainment of a graduate degree. Within the CCHS, these ten levels are further simplified into four levels: *less than secondary school*, *secondary school graduate*, *some post-secondary schooling*, and *post-secondary graduate*. We used both grouping in two separate variable specifications of our model.

Another important factor is the total amount of resources an individual may have for accessing health care. Here, we took total household income as an instrument of total resources. We also included the variable for personal hourly wage as an indicator of one's opportunity cost of time for health care. Personal hourly wage was calculated from the respondent's best estimate of personal annual income adjusted by the number of hours they work in a year as reported in the CCHS.

Dependent Variables (Health Outcomes)

Body mass index is derived within the CCHS using collected measurements on height and weight by the calculation: weight(kg)/[height (m)]^2. This was presented as a continuous value, where the mean BMI was 25.95. We further grouped the data into BMI categories as used in general medicine, following the definition established by the World Health Organization (WHO):

BMI ≤ 18.5	underweight
18.5 < BMI ≤ 25	normal
25 < BMI ≤ 30	overweight
30 < BMI	obese[13].

Doing so, we found that nearly 42 percent of the sample in Canada is classified as *normal*, and 39 percent as *overweight*. At the extremes, less than 2 percent of the sample was

[13] The WHO further defines obesity in three more specific classes: Obese class I (30 < BMI ≤ 35), Obese class II (35 < BMI ≤ 40) and Obese Class III (BMI > 40) but we treat all individuals with a BMI greater than or equal as being obese, all facing the same health risks and consequences.

underweight but nearly 18 percent were *obese*. Besides the continuous and categorical view of BMI, we also created a binary (obese or not) variable.

We contrast BMI with reported self-perceived health ratings. There were five levels reported by respondents: *excellent*, *very good*, *satisfactory*, *fair* and *poor*. Nearly 90 percent reported one of *very good*, *good* or *excellent* health. Only 8 percent reported *fair* health, and even fewer reported *poor* health at 2 percent.

Incidence of heart disease, diabetes and hypertension is each recorded as a binary outcome. The least common affliction reported is heart disease—4 percent of the sample, whereas hypertension, reported by 13 percent, was the most common. Also nearly as frequent is diabetes with about 12 percent of respondents reporting incidence. We recognized that the CCHS does not distinguish between Type I and Type II diabetes. However, we made the assumption that the figures reflect a prevalence of Type II diabetes as this form is currently more prevalent, and moreover is affected by daily lifestyle.

Lastly, the physical activity index is a derived measure within the CCHS, determined by calculating the total daily energy expenditure (kcal/kg/day) as the average of daily energy expended during leisure time activities reported by respondents of the last three months. It is classified on three levels: *inactive*, *moderately active* or *active*. Nearly 50 percent of the sample was found to be *inactive*, and the other half split between being *active* and *moderately active*.

Summary Statistics

Calculating the summary statistics of the relevant variables used in our analysis, we have the following results in Table 1.

Table 1: Summary Statistics

VARIABLE	OBS	WEIGHT	MEAN	STD. DEV.	MIN VALUE	MAX VALUE
Independent Variable						
age	132059	28140169.4	42.16198	13.63653	unreleased*	unreleased*
pers_est_inc	132059	28140169.4	36884.27	35965.26	unreleased*	unreleased*
hrwage	116057	25438273.2	18.84542	30.87351	unreleased*	unreleased*
male	132059	28140169.4	0.5009291	0.4999991	0	1
educ	132059	28140169.4	0.6840521	0.4648923	0	1
immigrant	132059	28140169.4	0.2066394	0.4048945	0	1
eth_white	132059	28140169.4	0.8457433	0.3611946	0	1
eth_black	132059	28140169.4	0.0166904	0.1281088	0	1
eth_Asian	132059	28140169.4	0.0367855	0.1882348	0	1
eth_SEAsian	132059	28140169.4	0.0170601	0.1294954	0	1
eth_SAsian	132059	28140169.4	0.0281906	0.165517	0	1
eth_MidEast	132059	28140169.4	0.0091035	0.0949771	0	1
eth_LatAm	132059	28140169.4	0.009458	0.0967914	0	1
eth_Aborig~l	132059	28140169.4	0.0149053	0.1211741	0	1
eth_other	132059	28140169.4	0.0220631	0.1468889	0	1
ur_urbcore	132059	28140169.4	0.7116552	0.4529924	0	1
ur_urbfringe	132059	28140169.4	0.0234726	0.1513991	0	1
ur_rurfringe	132059	28140169.4	0.0685445	0.252678	0	1
ur_urbosCMA	132059	28140169.4	0.0681917	0.2520747	0	1
ur_rurosCMA	132059	28140169.4	0.1141503	0.3179938	0	1
ur_2urbcore	132059	28140169.4	0.0139855	0.1174305	0	1
ed10_g8less	132059	28140169.4	0.0432196	0.2033512	0	1
ed10_g9g10	132059	28140169.4	0.054431	0.2268662	0	1
ed10_g11g13	132059	28140169.4	0.0383048	0.191931	0	1
ed10_hsgrad	132059	28140169.4	0.1799925	0.3841812	0	1
ed10_somep~c	132059	28140169.4	0.0891015	0.2848902	0	1
ed10_trade~p	132059	28140169.4	0.1275004	0.3335327	0	1
ed10_colle~p	132059	28140169.4	0.2055684	0.4041164	0	1
ed10_unicert	132059	28140169.4	0.0355952	0.1852787	0	1
ed10_BAdeg~e	132059	28140169.4	0.1559807	0.362837	0	1
ed10_BAplus	132059	28140169.4	0.0703059	0.2556619	0	1
ed04_hsless	132059	28140169.4	0.1359554	0.3427412	0	1
ed04_hsgrad	132059	28140169.4	0.1799925	0.3841812	0	1
ed04_somep~c	132059	28140169.4	0.0891015	0.2848902	0	1
ed04_posts~d	132059	28140169.4	0.5949506	0.4909016	0	1
prov_nfld	132059	28140169.4	0.0165309	0.1275055	0	1
prov_pei	132059	28140169.4	0.0040389	0.0634235	0	1
prov_ns	132059	28140169.4	0.0283014	0.1658324	0	1
prov_nb	132059	28140169.4	0.0229736	0.1498194	0	1
prov_que	132059	28140169.4	0.2479596	0.4318283	0	1
prov_on	132059	28140169.4	0.3961629	0.489099	0	1
prov_man	132059	28140169.4	0.0323219	0.1768536	0	1
prov_sk	132059	28140169.4	0.0283604	0.1660001	0	1
prov_ab	132059	28140169.4	0.0963159	0.295024	0	1
prov_bc	132059	28140169.4	0.1270345	0.3330116	0	1
mar_never	132059	28140169.4	0.23004	0.4208582	0	1
mar_curren~y	132059	28140169.4	0.6681932	0.470862	0	1
mar_other	132059	28140169.4	0.1017668	0.3023414	0	1
hhinc_5000~s	132059	28140169.4	0.0050614	0.0709634	0	1
hhinc_5000	131198	27914516.3	0.015038	0.1217038	0	1
hhinc_10000	131198	27914516.3	0.0321181	0.1763138	0	1
hhinc_15000	131198	27914516.3	0.0314228	0.1744573	0	1
hhinc_20000	131198	27914516.3	0.0798844	0.2711142	0	1
hhinc_30000	131198	27914516.3	0.0983764	0.2978229	0	1
hhinc_40000	131198	27914516.3	0.1015921	0.3021112	0	1
hhinc_50000	131198	27914516.3	0.1014066	0.3018664	0	1
hhinc_60000	131198	27914516.3	0.1825046	0.3862598	0	1
hhinc_80000	131198	27914516.3	0.3525547	0.4777655	0	1
Dependent Variable						
BMI	132059	28140169.4	25.94638	5.198876	unreleased*	unreleased*
BMIcat_under	132059	28140169.4	0.0167449	0.1283143	0	1
BMIcat_normal	132059	28140169.4	0.4183774	0.4932928	0	1
BMIcat_over	132059	28140169.4	0.3861617	0.4868684	0	1
BMIcat_obese	132059	28140169.4	0.1787159	0.3831142	0	1
hlth_excellent	132059	28140169.4	0.2290317	0.4202097	0	1
hlth_verygood	132031	28134920.1	0.3863952	0.4869229	0	1
hlth_good	132031	28134920.1	0.285994	0.4518865	0	1
hlth_fair	132031	28134920.1	0.0764647	0.2657402	0	1
hlth_poor	132031	28134920.1	0.0220717	0.1469167	0	1
hbp	131952	28120387.9	0.132765	0.3393206	0	1
heartdis	132000	28130153.2	0.0353526	0.1846694	0	1
diabetes	132029	28133510.8	0.1162842	0.3205655	0	1
phys_active	132059	28140169.4	0.2489486	0.432404	0	1
phys_moderate	131366	27971528.8	0.2610275	0.4391949	0	1
phys_inactive	131366	27971528.8	0.488523	0.4998683	0	1

* data was not permitted to be released

4.2 Econometric Model

The analysis focuses on the national experience. Each dimension of our analysis will follow an econometric model of the form:

$$Health_i = \beta_0 + \delta U_i + \beta X_i + \mu_i$$

where $Health_i$ corresponds to an individual *i*'s health outcome variable, be it BMI, an incidence dummy, self-perceived health or physical activity index. In this form, X_i is the vector of the socio-demographic covariates. U_i is the vector of urban form descriptors. Thus δ is the vector of parameters to be estimated which disclose the effect of urban form on $Health_i$. Similarly, β is the vector of parameters which describe the effects on $Health_i$ attributed to socio-demographic characteristics. To avoid the problem of multicollinearity, the reference group consists of individuals living in the urban core, with highest education attainment being high school graduation, household income of over $80000 and of White ethnic background. The constant, β_0, reflects the average outcomes of this reference group.

We conducted this analysis separately for male and female respondents in the case that gender effects were not entirely captured with a single gender dummy variable. Since the literature does not follow a uniform variable specification of their models, we examine three variable specifications. The first is the most detailed including all variables—urban form, age, ethnicity, household income, hourly wage and education as specified in 10 levels. The second specification is a subset of the first, utilizing all the same variables, except that education is specified in the simpler 4 levels. Lastly, the third specification reduces ethnicity simply to a binary White-or-not variable named *minority*, but in all other aspects is similar to the second specification. Each specification will be denoted as specification (1), (2) and (3), respectively.

The analysis starts with the dimension of health outcomes where $Health_i$ is represented by BMI_i. We examined this relationship by first considering BMI as a continuous dependent variable, such that the interpretation would be the marginal change in the BMI of an average male or female due to the urban form of residence, controlling for socio-demographic characteristics. We further explored this relationship between urban form and BMI by examining the likelihood of obesity given the urban form of residence. We treat BMI as a binary outcome of obese (BMI > 30) or not. Thus we employed both a linear probability model as well as a probit model to determine the marginal probability of being obese due to urban form. Thirdly, we analyzed the role of urban form on the categorical definition of BMI as used by medical professionals. Unique to this study, we used an ordered probit model to analyze the probability of being classified as *underweight*, *normal*, *overweight* or *obese*, as well as their marginal probabilities given the urban form of residence, controlling for socio-demographic factors. We expected a positive relationship with urban forms increasingly farther from the urban core.

The second section of our analysis will reveal the effect of urban form on self-perceived health. That is, $Health_i$ is here represented with self-reported health rating. Since self-health was defined as a ranked rating (*excellent*, *very good*, *satisfactory*, *fair* and *poor*), we employed an ordered probit regression. The results from this set of regressions reflected the probability of each self-health rating as well as the marginal effects of urban form on each rating. Where the first part of the analysis looking at BMI outcomes will provide a glimpse of the actual effects of urban form on health, this second part of the analysis will determine the effects of urban form on perceived health. This added dimension also distinguishes our study from previous.

Additionally, $Health_i$ is modeled in terms of the probability of having hypertension, heart disease and diabetes. This dimension will characterize the role of urban form on the incidence of chronic conditions that are affected by lifestyle. Again, we analyzed the marginal probabilities of having each condition with both a linear probability model and a probit model. We expected that both models would generate quantitatively similar results and corroborate each other.

Finally, the last part of our multi-dimensional analysis related the effect of urban form on physical activity. We considered physical activity level as the dependent variable. With an ordered probit model, we determined the probability of each outcome given the urban form, as well as the marginal effect that urban form has on each of these outcomes. Our suspicion was that further urban forms have a negative influence on physical activity levels.

Based on the delineation of urban form by Statistics Canada, where four of the six delineations occur within a CMA and two beyond its boundaries, we made the assumption that further urban forms are associated with greater car dependence. This assumption is comparable with previous studies. In fact, Turcotte (2008) drew on the tendency for urban forms on the periphery to be more dispersed and sprawled than those close to the central urban core. Lopez (2004) described the effect of this pattern of urban form with a flow representation similar to the one we have adapted below:

car-friendly urban form → increased automobile use → decreased physical activity
→ higher BMI → increased cardiovascular disease, diabetes and hypertension

We test for evidence of effects of urban form on health in our multi-dimensional analysis. According to the flow representation, we expect to observe a positive relationship between increasingly spread-out urban forms and health outcomes regardless of the measure used to represent it. Moreover, the magnitude of influence should be greatest in the two urban forms outside of the CMA and it would progressively decrease moving inward toward the urban core, which is expected to have least effect on health outcomes. Since the direction of flow points to decreased physical activity first, the marginal probability estimates for each physical activity level should be found significant, more so than the estimates generated in the analysis of chronic conditions.

5 Discussion of Findings

5.1 Canadian Overview – Outcomes of Body Mass Index

Body Mass Index as a Continuous Variable

Several interesting findings emerged in our first examination of the relationship between BMI and urban form. First, as reported in Table 2, we observed differences in the marginal effects on males and females. Across the three variable specifications, the general marginal effect of living within the CMA of a city was lower for female BMI than for male BMI. Beyond the CMA, the difference was reversed—the marginal effect on female BMI, on average was greater than that for male. In essence, these results suggest that male BMI is more affected by the urban forms within a city's CMA boundaries than females are; and the opposite is true for the urban forms found outside a CMA.

Before going further, noting that we have three specifications for our model, we compare their respective R-squared values. The males' R^2 value decreased across the three specifications as the number of variables decline, from 0.0658 for specification (1) to 0.0608 for specification to 0.0485 for specification (3). We test the males' specifications with F-tests. First, we confirmed that variable specification (2) is statistically preferred than specification (3) by computing a standard F-statistic, where the null hypothesis is that (3) is the preferred model (i.e., the coefficient restrictions implicit in model (3) hold). This calculation can be found in the appendix. This test yielded an F-statistics of 105.387 which is greater than the critical F-statistic value at the 5% level of significance at 7 and

Table 2: Ordinary Least Squares Regression of BMI Results

	MALE			FEMALE		
	-1	-2	-3	-1	-2	-3
	BMI	BMI	BMI	BMI	BMI	BMI
ur_urbfringe	0.55208	0.61154	0.67153	0.30136	0.35536	0.39845
	*(0.174)***	*(0.176)***	*(0.177)***	*(0.202)*	*(0.201)*	*(0.201)**
ur_rurfringe	0.28308	0.36760	0.40641	0.03672	0.08391	0.14576
	*(0.103)***	*(0.104)***	*(0.104)***	*(0.124)*	*(0.125)*	*(0.125)*
ur_urbosCMA	0.22599	0.31785	0.41141	0.61249	0.67782	0.77442
	*(0.090)**	*(0.091)***	*(0.090)***	*(0.110)***	*(0.110)***	*(0.110)***
ur_rurosCMA	0.32302	0.41612	0.50060	0.52787	0.61057	0.69589
	*(0.078)***	*(0.078)***	*(0.078)***	*(0.097)***	*(0.096)***	*(0.096)***
ur_2urbcore	0.31508	0.39798	0.46020	0.19950	0.31159	0.35236
	(0.240)	*(0.240)*	*(0.238)*	*(0.328)*	*(0.330)*	*(0.339)*
age	0.05740	0.05690	0.05599	0.08361	0.08431	0.08342
	*(0.002)***	*(0.002)***	*(0.002)***	*(0.002)***	*(0.002)***	*(0.002)***
eth_Black	-0.42395	-0.44977		1.07566	1.11930	
	(0.253)	*(0.252)*		*(0.307)***	*(0.307)***	
eth_Asian	-2.82649	-3.03290		-3.21120	-3.35058	
	*(0.169)***	*(0.165)***		*(0.146)***	*(0.146)***	
eth_SEAsian	-1.93487	-1.97129		-2.13826	-2.13846	
	*(0.211)***	*(0.211)***		*(0.250)***	*(0.249)***	
eth_SAsian	-1.52954	-1.66526		-1.00760	-1.10879	
	*(0.200)***	*(0.197)***		*(0.257)***	*(0.257)***	
eth_MidEast	-0.47600	-0.70057		-0.92151	-1.02694	
	(0.340)	*(0.328)**		*(0.388)**	*(0.381)***	
eth_LatAm	0.13757	0.01516		0.03741	0.02053	
	(0.340)	*(0.344)*		*(0.358)*	*(0.359)*	
eth_Aboriginal	1.35555	1.38998		1.67365	1.70926	
	*(0.243)***	*(0.244)***		*(0.242)***	*(0.240)***	
eth_other	-0.25655	-0.31203		-0.55650	-0.61612	
	(0.255)	*(0.254)*		*(0.252)**	*(0.252)**	
minority			1.20361			1.09279
			*(0.095)***			*(0.103)***
ed10_g8less	0.33629			0.88907		
	(0.176)			*(0.241)***		
ed10_g9g10	0.42395			0.84737		
	*(0.141)***			*(0.233)***		
ed10_g11g13	-0.21839			0.47172		
	(0.148)			*(0.204)**		
ed10_somepostsec	-0.03669			-0.05314		
	(0.131)			*(0.156)*		
ed10_tradedip	0.27671			0.01193		
	*(0.092)***			*(0.135)*		
ed10_collegedip	0.18915			0.08748		
	*(0.091)**			*(0.109)*		
ed10_unicert	0.11879			-0.54900		
	(0.370)			*(0.171***		
ed10_BAdegree	-0.44157			-0.78655		
	*(0.098)***			*(0.117)***		
ed10_BAplus	-0.87927			-1.12596		
	*(0.123)***			*(0.155)***		
ed04_hsless		0.17517	0.23041		0.70177	0.76536
		(0.104)	*(0.106)**		*(0.152)***	*(0.153)***
ed04_somepostsec		-0.02563	-0.01976		-0.04567	0.05389
		(0.132)	*(0.133)*		*(0.156)*	*(0.157)*
ed04_postsecgrad		-0.06119	-0.08133		-0.30995	-0.30306
		(0.076)	*(0.077)*		*(0.097)***	*(0.098)***
hhinc_5000less	-1.67748	-1.64940	-1.58003	0.67701	0.75522	0.75133
	*(0.343)***	*(0.373)***	*(0.336)***	*(0.388)*	*(0.382)**	*-0.401*
hhinc_5000	-1.79515	-1.69282	-1.63140	0.94370	1.06207	1.09306
	*(0.245)***	*(0.245)***	*(0.245)***	*(0.297)***	*(0.295)***	*(0.304)***
hhinc_10000	-0.85263	-0.77487	-0.68677	0.46786	0.60557	0.73202
	*(0.225)***	*(0.222)***	*(0.227)***	*(0.182)**	*(0.181)***	*(0.184)***
hhinc_15000	-1.36389	-1.25802	-1.23037	0.73002	0.87225	0.97662
	*(0.180)***	*(0.178)***	*(0.182)***	*(0.183)***	*(0.182)***	*(0.185)***
hhinc_20000	-0.99309	-0.89094	-0.88173	0.24372	0.39601	0.49141
	*(0.118)***	*(0.117)***	*(0.119)***	*(0.127)*	*(0.126)***	*(0.127)***
hhinc_30000	-0.77704	-0.66667	-0.66530	0.49190	0.63538	0.69669
	*(0.108)***	*(0.108)***	*(0.109)***	*(0.120)***	*(0.119)***	*(0.121)***
hhinc_40000	-0.53193	-0.40766	-0.43543	0.73022	0.85148	0.88305
	*(0.103)***	*(0.102)***	*(0.104)***	*(0.129)***	*(0.129)***	*(0.131)***
hhinc_50000	-0.40064	-0.30147	-0.31272	0.46824	0.58887	0.62323
	*(0.098)***	*(0.098)***	*(0.099)***	*(0.126)***	*(0.126)***	*(0.127)***
hhinc_60000	-0.04067	0.04148	0.04345	0.50864	0.59635	0.61911
	(0.089)	*(0.089)*	*(0.090)*	*(0.103)***	*(0.102)***	*(0.103)***
hrwage	0.00042	-0.00076	-0.00084	0.00122	0.00042	0.00055
	(0.001)	*(0.001)*	*(0.001)*	*(0.002)*	*(0.002)*	*(0.002)*
Constant	24.76336**	24.72441**	23.54080**	21.43888**	21.32109**	20.18778**
	-0.122	*-0.120*	*-0.140*	*-0.165*	*-0.163*	*-0.173*
Observations	56233	56233	56233	59212	59212	59212
R-squared	0.0658	0.0608	0.0485	0.0837	0.0793	0.0648
RSS	1139167.42	1145216.75	1160247.6	1635020.41	1642766.95	1668664.26
F-stat	58.65	67.22	67.75	93.04	104.37	105.25

Robust standard errors in parentheses

* significant at 5%; ** significant at 1%

an infinite degrees of freedom of 2.01, thus we reject the null hypothesis in favor of specification (2). Second, we performed a similar test between specifications (1) and (2). The result of the hypothesis test favored specification (1), as the F-statistic is of 49.736 is much greater than the critical value at the 5% level of significance with 6 and infinite degrees of freedom of 2.10. Together, these two tests suggested that model (1) was the most preferred of the three specifications for males. We followed the same procedure to compare the three females' specifications and again concluded that specification (1) was most preferred. Thus, we focus on the results of specification (1) in our discussion.

Two patterns emerged in the estimated effects of urban form on BMI. Generally, we observed a positive relationship between BMI and urban forms farther from the urban core irrespective of gender, which is consistent with the findings of many American studies. More specifically, living in the urban fringe appeared to have the greatest effect on male BMI, increasing it by 0.552 units all else equal. Compared to living in the urban core, the marginal effect on male BMI in the rural area outside of a CMA, secondary urban core, rural fringe within the CMA and urban area outside of the CMA were 0.323 units, 0.315 units, 0.283 and 0.226 units, respectively. Still, the marginal effects on BMI of all urban forms further from the core were positive and significant. The only estimate not found to be statistically significant was that associated with the secondary urban core, perhaps due to the small proportion of the sample observed living in this urban form.

While the range in marginal effects was small for males, the range is considerably larger for females. Living in an urban area or rural area outside of the CMA produced the greatest effect on BMI, marginally increasing it by 0.612 and 0.528 units compared to living in the urban core. Living in the urban fringe within the CMA marginally increased BMI by 0.301 units. The secondary urban core marginally increased BMI by 0.200 units, and lesser still was living in the rural fringe which barely increased BMI by 0.037 units.

While the estimates for residing in the urban fringe, rural fringe and secondary urban core were found to be statistically insignificant, the marginal effects for urban area and rural area outside of the CMA were found to be significant at the 5% level of significance. This suggested that a tangible positive effect on female BMI from living in either of these urban forms exists in comparison to living in the urban core.

Our findings revealed that the relationship, for the most part, is significant among males, but not quite for females. At the very least, the positive relationship between urban form and BMI treated as a continuous value still confirms that the correlation found in the American studies apply in Canada as well. These results lend some initial evidence to the flow diagram that Lopez (2004) described.

Body Mass Index in a Binary Variable

Furthermore, generalizing BMI outcome to obese or not, we look at the resulting marginal probability of this outcome given the urban form. Both the linear probability model and probit model generated quantitatively similar results as expected, displayed in Tables 3 and 4. Therefore, we focus on the results of the linear probability model where we have calculated robust standard errors on the regression coefficients. Comparing the three specifications, we again find specification (1) is preferred among the three specifications for both males and females, thus we speak to the estimates of this specification.

Differences between males and females with respect to urban form continued. The marginal probability of being obese was higher for females than males when living outside of the CMA, and reversed for urban forms within a CMA—the urban fringe, rural fringe, and secondary urban core. Males appeared to have a relatively constant positive marginal probability for being obese (of about 1 – 1.5 percentage points compared to living in the urban core) regardless of the urban form they live in. But for females, the range in

Table 3: Linear Probability Model of BMI (Obese or Not) Results

	MALE			FEMALE		
	-1	-2	-3	-1	-2	-3
	BMIcat_obese	BMIcat_obese	BMIcat_obese	BMIcat_obese	BMIcat_obese	BMIcat_obese
ur_urbfringe	0.01080	0.01521	0.01930	0.00384	0.00608	0.00867
	(0.017)	*(0.017)*	*(0.017)*	*(0.014)*	*(0.014)*	*(0.014)*
ur_rurfringe	0.00166	0.00785	0.01026	-0.00570	-0.00364	-0.00060
	(0.010)	*(0.010)*	*(0.010)*	*(0.008)*	*(0.008)*	*(0.008)*
ur_urbosCMA	0.01489	0.02154	0.02763	0.02949	0.03234	0.03750
	(0.008)	*(0.008)***	*(0.008)***	*(0.008)***	*(0.008)***	*(0.008)***
ur_rurosCMA	0.01612	0.02266	0.02812	0.02398	0.02773	0.03227
	*(0.007)**	*(0.007)***	*(0.007)***	*(0.007)***	*(0.007)***	*(0.007)***
ur_2urbcore	-0.00132	0.00473	0.00889	0.00857	0.01373	0.01599
	(0.022)	*(0.022)*	*(0.022)*	*(0.023)*	*(0.024)*	*(0.024)*
age	0.00254	0.00251	0.00246	0.00269	0.00274	0.00270
	*(0.000)***	*(0.000)***	*(0.000)***	*(0.000)***	*(0.000)***	*(0.000)***
eth_Black	-0.01635	-0.01887		0.01618	0.01828	
	(0.023)	*(0.023)*		*(0.023)*	*(0.023)*	
eth_Asian	-0.12230	-0.13676		-0.12305	-0.12895	
	*(0.010)***	*(0.010)***		*(0.008)***	*(0.008)***	
eth_SEAsian	-0.12522	-0.12945		-0.11120	-0.11103	
	*(0.015)***	*(0.015)***		*(0.013)***	*(0.013)***	
eth_SAsian	-0.08940	-0.09881		-0.07232	-0.07685	
	*(0.017)***	*(0.017)***		*(0.014)***	*(0.014)***	
eth_MidEast	-0.01021	-0.02576		-0.02816	-0.03251	
	(0.032)	*(0.032)*		*(0.035)*	*(0.035)*	
eth_LatAm	-0.01799	-0.02640		-0.00160	-0.00207	
	(0.028)	*(0.028)*		*(0.028)*	*(0.028)*	
eth_Aboriginal	0.10427	0.10733		0.09390	0.09545	
	*(0.020)***	*(0.020)***		*(0.017)***	*(0.017)***	
eth_other	0.00486	0.00079		-0.02726	-0.02981	
	(0.020)	*(0.020)*		*(0.019)*	*(0.019)*	
minority			0.05775			0.05150
			*(0.007)***			*(0.007)***
ed10_g8less	0.02384			0.06197		
	(0.015)			*(0.017)***		
ed10_g9g10	0.03330			0.05106		
	*(0.013)***			*(0.015)***		
ed10_g11g13	0.00602			0.02909		
	(0.014)			*(0.013)**		
ed10_somepostsec	-0.00265			0.02113		
	'(0.010)			*(0.010)**		
ed10_tradedip	0.01083			0.01000		
	(0.009)			*(0.009)*		
ed10_collegedip	-0.00242			0.01382		
	(0.008)			*(0.007)**		
ed10_unicert	-0.01865			-0.01084		
	'(0.014)			*(0.012)*		
ed10_BAdegree	-0.04907			-0.02463		
	*(0.008)***			*(0.007)***		
ed10_BAplus	-0.06517			-0.04227		
	*(0.012)***			*(0.009)***		
ed04_hsless		0.02049	0.02360		0.04535	0.04778
		*(0.009)**	*(0.009)**		*(0.010)***	*(0.010)***
ed04_somepostsec		-0.00182	-0.00152		0.02156	0.02532
		(0.010)	*(0.010)*		*(0.010)**	*(0.010)**
ed04_postsecgrad		-0.01770	-0.01880		-0.00377	-0.00390
		*(0.007)***	*(0.007)***		*(0.006)*	*(0.006)*
hhinc_5000less	-0.07979	-0.07714	-0.07586	0.04601	0.04947	0.04970
	*(0.020)***	*(0.020)***	*(0.020)***	*(0.022)**	*(0.022)**	*(0.023)**
hhinc_5000	-0.05895	-0.05267	-0.04836	0.06760	0.07350	0.07666
	*(0.015)***	*(0.016)***	*(0.015)***	*(0.015)***	*(0.015)***	*(0.015)***
hhinc_10000	-0.02590	-0.02125	-0.01595	0.04775	0.05444	0.06009
	(0.015)	*(0.015)*	*(0.015)*	*(0.012)***	*(0.012)***	*(0.012)***
hhinc_15000	-0.03836	-0.03189	-0.02983	0.05779	0.06448	0.06976
	*(0.014)***	*(0.014)**	*(0.014)**	*(0.012)***	*(0.012)***	*(0.012)***
hhinc_20000	-0.03321	-0.02640	-0.02552	0.03160	0.03866	0.04256
	'(0.010)	*(0.009)***	*(0.010)***	*(0.008)***	*(0.008)***	*(0.008)***
hhinc_30000	-0.02829	-0.02063	-0.02059	0.04490	0.05135	0.05376
	*(0.009)***	*(0.009)**	*(0.009)**	*(0.008)***	*(0.008)***	*(0.008)***
hhinc_40000	-0.02971	-0.02108	-0.02276	0.05247	0.05787	0.05893
	*(0.008)***	*(0.008)**	*(0.008)***	*(0.009)***	*(0.009)***	*(0.009)***
hhinc_50000	-0.01591	-0.00890	-0.00979	0.03618	0.04160	0.04251
	(0.009)	*(0.009)*	*(0.009)*	*(0.009)***	*(0.009)***	*(0.009)***
hhinc_60000	0.00691	0.01280	0.01268	0.03260	0.03649	0.03716
	(0.007)	*(0.007)*	*(0.007)*	*(0.007)***	*(0.007)***	*(0.007)***
hrwage	-0.00015	-0.00022	-0.00023	0.00008	0.00004	0.00005
	*(0.000)**	*(0.000)***	*(0.000)***	*(0.000)*	*(0.000)*	*(0.000)*
Constant	0.11543	0.11257	0.05583	0.01876	0.01278	-0.04028
	*(0.010)***	*(0.010)***	*(0.011)***	*(0.010)**	*(0.009)*	*(0.010)***
Observations	56233	56233	56233	59212	59212	59212
R-squared	0.023	0.020	0.015	0.032	0.030	0.024
RSS	8573.88	8600.67	8648.51	7616.95	7633.08	7678.53
F-stat	25.94	28.87	24.27	37.33	41.64	37.03

Robust standard errors in parentheses

* significant at 5%; ** significant at 1%

Table 4: Probit Model of BMI (Obese or Not)

	MALE			FEMALE		
	-1	-2	-3	-1	-2	-3
	BMIcat_obese	BMIcat_obese	BMIcat_obese	BMIcat_obese	BMIcat_obese	BMIcat_obese
ur_urbfringe	0.01056	0.01520	0.02020	0.00274	0.00529	0.00828
	(0.016)	*(0.016)*	*(0.017)*	*(0.014)*	*(0.015)*	*(0.015)*
ur_rurfringe	0.00142	0.00778	0.01049	-0.00529	-0.00316	0.00036
	(0.009)	*(0.009)*	*0.00955*	*(0.008)*	*(0.008)*	*(0.008)*
ur_urbosCMA	0.01414	0.02106**	0.02792**	0.02720**	0.03061**	0.03713**
	(0.008)	*(0.008)*	*(0.008)*	*(0.007)*	*(0.007)*	*(0.007)*
ur_rurosCMA	0.01520*	0.02192**	0.02830**	0.02141**	0.02535**	0.03109**
	(0.007)	*(0.007)*	*(0.007)*	*(0.006)*	*(0.006)*	*(0.006)*
ur_2urbcore	-0.00095	0.00502	0.00954	0.00745	0.01354	0.01658
	(0.020)	*(0.021)*	*(0.021)*	*(0.023)*	*(0.023)*	*(0.024)*
age	0.00256**	0.00253**	0.00248**	0.00264**	0.00267**	0.00265**
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
eth_Black	-0.01583	-0.01828		0.01776	0.01995	
	(0.024)	*(0.023)*		*(0.022)*	*(0.022)*	
eth_Asian	-0.13353**	-0.14001**		-0.12720**	-0.12916**	
	(0.010)	*(0.010)*		*(0.008)*	*(0.008)*	
eth_SEAsian	-0.12544**	-0.12836		-0.10791**	-0.10860**	
	(0.015)	*(0.014)***		*(0.012)*	*(0.012)*	
eth_SAsian	-0.09351	-0.10012**		-0.07191**	-0.07455**	
	*(0.018)***	*(0.017)*		*(0.014)*	*(0.014)*	
eth_MidEast	-0.00992	-0.02674		-0.02633	-0.03116	
	(0.035)	*(0.032)*		*(0.034)*	*(0.033)*	
eth_LatAm	-0.01965	-0.02648		-0.00129	-0.00129	
	(0.029)	*(0.028)*		*(0.027)*	*(0.027)*	
eth_Aboriginal	0.10268**	0.10641**		0.08764**	0.08993**	
	(0.020)	*(0.020)*		*(0.016)*	*(0.016)*	
eth_other	0.00501	0.00067		-0.02602	-0.02903	
	(0.020)	*(0.019)*		*(0.019)*	*(0.019)*	
minority			0.06029**			0.05193**
			(0.008)			*(0.008)*
ed10_g8less	0.02107			0.0506**		
	(0.014)			*(0.015)*		
ed10_g9g10	0.03019*			0.04418**		
	*(0.012)**			*(0.015)*		
ed10_g11g13	0.00418			0.02662*		
	(0.013)			*(0.013)*		
ed10_somepostsec	-0.00452			0.01963		
	(0.010)			*(0.010)*		
ed10_tradedip	0.00962			0.00982		
	(0.008)			*(0.008)*		
ed10_collegedip	-0.00176			0.01394*		
	(0.008)			*(0.007)*		
ed10_unicert	-0.01920			-0.01185		
	(0.013)			*(0.012)*		
ed10_BAdegree	-0.04853**			-0.02791**		
	(0.008)			*(0.007)*		
ed10_BAplus	-0.06238**			-0.04439**		
	(0.011)			*(0.009)*		
ed04_hsless		0.01806*	0.02145*		0.0385**	0.04156**
		(0.009)	*(0.009)*		*(0.010)*	*(0.010)*
ed04_somepostsec		-0.00396	-0.00294		0.02003	0.02492*
		(0.010)	*(0.010)*		*(0.010)*	*(0.011)*
ed04_postsecgrad		-0.01720*	-0.01842**		-0.00385	-0.00373
		(0.007)	*(0.007)*		*(0.006)*	*(0.006)*
hhinc_5000less	-0.08181**	-0.08010*	-0.07834**	0.04581	0.05081	0.05408
	(0.019)	*(0.019)*	*(0.020)*	*(0.026)*	*(0.026)*	*(0.028)**
hhinc_5000	-0.05669**	-0.05148**	-0.04858**	0.07095**	0.07962**	0.08385**
	(0.014)	*(0.015)*	*(0.015)*	*(0.016)*	*(0.017)*	*(0.017)*
hhinc_10000	-0.02677	-0.02268	-0.01781	0.04875**	0.05772**	0.06655**
	(0.014)	*(0.015)*	*(0.015)*	*(0.013)*	*(0.013)*	*(0.013)*
hhinc_15000	-0.04018**	-0.03515**	-0.03222*	0.05965**	0.06909**	0.07718**
	(0.013)	*(0.013)*	*(0.013)*	*(0.013)*	*(0.013)*	*(0.014)*
hhinc_20000	-0.03484**	-0.02903**	-0.02802**	0.03256**	0.04157**	0.04656**
	(0.009)	*(0.009)*	*(0.009)*	*(0.009)*	*(0.009)*	*(0.009)*
hhinc_30000	-0.02834**	-0.02166**	-0.02149*	0.04755**	0.05632**	0.06010**
	(0.008)	*(0.008)*	*(0.008)*	*(0.009)*	*(0.009)*	*(0.010)*
hhinc_40000	-0.02966**	-0.02217**	-0.02362**	0.05558**	0.06303**	0.06531**
	(0.008)	*(0.008)*	*(0.008)*	*(0.010)*	*(0.010)*	*(0.010)*
hhinc_50000	-0.01668*	-0.01002	-0.01060	0.04024**	0.04707**	0.04828**
	(0.008)	*(0.008)*	*(0.008)*	*(0.010)*	*(0.010)*	*(0.010)*
hhinc_60000	0.00651	0.01233	0.01227	0.03536**	0.04033**	0.04190**
	(0.007)	*(0.007)*	*(0.007)*	*(0.007)*	*(0.008)*	*(0.008)*
hrwage	-0.00019*	-0.00029**	-0.00029**	0.00008	0.00005	0.00005
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Observations	56233	56233	56233	59212	59212	59212
LogLike	-26905.890	-26996.940	-27202.330	-24784.720	-24855.770	-25103.110

Robust standard errors in parentheses
* significant at 5%; ** significant at 1%

marginal effects is again greater, from -0.57 percentage points if living in the rural fringe to almost 3 percentage points if in the urban area outside of the CMA. Not only were the largest marginal probabilities of being obese due to urban forms outside of the CMA, increasing the likelihood by an average of 2.7 percentage points, but the two estimates were also statistically significant at the 5 percentage points level. The results of this model indeed confirm a finding from the analysis of BMI as a continuous variable, that female health outcomes are more susceptible to urban forms. More specifically, female outcomes tended to slightly better their counterparts for urban forms within of the CMA, but they are drastically worse off in urban forms outside of the CMA.

Body Mass Index in an Ordered Ranking

The ordered probit model results where BMI is an ordered rating of health forms the final perspective on the effect that urban form has on BMI. Based on the cut point derived from the ordered probit regression of BMI regressed on urban form along with socio-demographic controls, we calculated the associated probabilities (in Table 5) as the probit model is based on the normal distribution, as described by Woodridge (2002). These are the base probabilities from which we interpreted the marginal probabilities of each category as affected by urban form.

Table 5: Computed Probabilities from Ordered Probit of BMI (Categories)

	MALE			FEMALE		
BMI_cat	-1	-2	-3	-1	-2	-3
cut1	-2.13911***	-2.124164***	-1.81822***	-1.24851***	-1.22040***	-0.96778***
	(0.042)	*(0.042)*	*(0.047)*	*(0.035)*	*(0.035)*	*(0.040)*
cut2	0.03919	0.0479	0.31824***	0.97666***	0.99853***	1.21627***
	(0.031)	*(0.031)*	*(0.037)*	*(0.033)*	*(0.033)*	*(0.039)*
cut3	1.42440***	1.428173***	1.68769***	1.88163***	1.90089***	2.10963***
	(0.032)	*(0.032)*	*(0.038)*	*(0.035)*	*(0.035)*	*(0.040)*
	Probabilities					
Underweight	0.0162	0.0168	0.0345	0.1059	0.1112	0.1666
Normal	0.4994	0.5023	0.5903	0.7297	0.7298	0.7215
Overweight	0.4072	0.4043	0.3294	0.1344	0.1304	0.0945
Obese	0.0772	0.0766	0.0457	0.0299	0.0287	0.0174
Observations	56233	56233	56233	59212	59212	59212
LogLike	-57697	-57853	-58264	-61203	-61332	-61874

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Similar to the earlier two models of BMI, we compare the explanatory power between the three specifications. Noting that the ordered probit estimates are arrived by the maximum likelihood method, we employ two likelihood ratio chi-squared tests to test the specifications. Looking at the male half of our analysis, the first test compares male specification (2) to (3) with the null hypothesis being that (3) is preferred. According to the calculations found in the appendix, the test statistic is 822, which is considerably greater than the chi-squared critical value at the 5% level of significance with 7 degrees of freedom of 14.07. Therefore, we reject that (3) is preferred. Testing that (2) is preferred to (1) yields the test statistic of 312, and so we conclude that specification (1) is most preferred among the three male specifications, as it is greater than the chi-squared critical value at the 5% level of significance with 6 degrees of freedom of 12.59. Testing the same three specifications for females, the test statistic comparing (2) to (3) was 1084 and that comparing (1) and (2) was 258. Both test statistics indicate that specification (1) is the preferred specification for females too. Therefore, we focus on the marginal probability estimates generated by specification (1).

Most concerning are the figures associated with *normal*, *overweight* and *obese* categories. For males, increasingly dispersed urban forms bear greatest effect on the *normal* and *obese* category. The marginal effect of living in the urban fringe or rural fringe, secondary urban core or in either urban form outside of the CMA on the probability of being *underweight* is very slight. Ceteris paribus, except for living in the urban core, the marginal effect on the probability of *normal* is nearly -4.7 percentage points, - 2.4 percentage points, -2.3 percentage points, -3.1 percentage points and -2.4 percentage points for living in the urban fringe, rural fringe, urban area outside of the CMA, rural area outside of the CMA and the secondary urban core, respectively. Meanwhile, the marginal probability of obesity increased by about 4 percentage points, 1.9 percentage points, 1.8 percentage points, 2.5 percentage points and 2 percentage points for each

Table 6: Marginal Effects for Ordered Probit of BMI (Categories) - Male Results

	MALE											
	-1				-2				-3			
COEFFICIENT	underweight	normal	overweight	obese	underweight	normal	overweight	obese	underweight	normal	overweight	obese
ur_urbfringe	-0.00139***	-0.04716***	0.00902***	0.03953***	-0.00155***	-0.05232***	0.00946***	0.04440***	-0.00183***	(-0.05617)***	(0.00951)***	(0.04849)***
	(0.000)	*(0.0139)*	*(0.002)*	*(0.0127)*	*(0.000)*	*(0.0137)*	*(0.001)*	*(0.013)*	*(0.000)*	*(0.014)*	*(0.001)*	*(0.013)*
ur_rurfringe	-0.00076***	-0.02373***	0.00555***	0.01894***	-0.00100	-0.03135***	0.00694***	0.02541***	-0.00120***	-0.03394***	0.00723***	0.02790***
	(0.000)	*(0.009)*	*(0.002)*	*(0.007)*	*(0.000)*	*(0.008)*	*(0.002)*	*(0.007)*	*(0.000)*	*(0.008)*	*(0.001)*	*(0.007)*
ur_urbosCMA	-0.00073***	-0.02281***	0.00536***	0.01818***	-0.00099	-0.03100***	0.00687***	0.02511***	-0.00131***	-0.03760***	0.00780***	0.03111***
	(0.000)	*(0.007)*	*(0.002)*	*(0.006)*	*(0.000)*	*(0.007)*	*(0.001)*	*(0.006)*	*(0.000)*	*(0.007)*	*(0.001)*	*(0.006)*
ur_rurosCMA	-0.00099	-0.03146***	0.00715***	0.02530***	-0.00124***	-0.03932***	0.00848***	0.03209***	-0.00156***	-0.04520***	0.00918***	0.03757***
	(0.000)	*(0.006)*	*(0.001)*	*(0.005)*	*(0.000)*	*(0.006)*	*(0.001)*	*(0.005)*	*(0.000)*	*(0.006)*	*(0.001)*	*(0.006)*
ur_2urbcore	-0.00076	-0.02397	0.00549	0.01924	-0.00099	-0.03147*	0.00677**	0.02569	-0.00123**	-0.03560**	0.00725***	0.02958*
	(0.001)	*(0.019)*	*(0.004)*	*(0.016)*	*(0.000)*	*(0.019)*	*(0.003)*	*(0.016)*	*(0.001)*	*(0.018)*	*(0.003)*	*(0.016)*
age	-0.00018***	-0.00536***	0.00143***	0.00411***	-0.00018***	-0.00528***	0.00140***	0.00406***	-0.00020***	-0.00515***	0.00134***	0.00400***
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
eth_Black	0.00025	0.00728	-0.00202	-0.00551	0.00037	0.01016	-0.00285	-0.00767				
	(0.001)	*(0.024)*	*(0.007)*	*(0.018)*	*(0.001)*	*(0.024)*	*(0.007)*	*(0.018)*				
eth_Asian	0.02384***	0.27099***	-0.15607***	-0.13875***	0.02760***	0.28677***	-0.16971***	-0.14466***				
	(0.004)	*(0.017)*	*(0.015)*	*(0.006)*	*(0.004)*	*(0.016)*	*(0.015)*	*(0.005)*				
eth_SEAsian	0.00966***	0.16340***	-0.07730***	-0.09576***	0.01021***	0.16705***	-0.07950***	-0.09777***				
	(0.002)	*(0.024)*	*(0.016)*	*(0.011)*	*(0.002)*	*(0.024)*	*(0.016)*	*(0.010)*				
eth_SAsian	0.00613***	0.12163***	-0.05128***	-0.07647***	0.00721***	0.13430***	-0.05833***	-0.08317***				
	(0.002)	*(0.021)*	*(0.012)*	*-0.011*	*(0.002)*	*(0.021)*	*(0.012)*	*(0.010)*				
eth_MidEast	0.00023	0.00648	-0.00179	-0.00491	0.00103	0.02719	-0.00832	-0.01991				
	(0.001)	*(0.032)*	*(0.009)*	*(0.024)*	*(0.001)*	*(0.032)*	*(0.011)*	*(0.022)*				
eth_LatAm	-0.00080	-0.02559	0.00578	0.02061	-0.00047	-0.01425	0.00347	0.01126				
	(0.001)	*(0.029)*	*(0.005)*	*(0.024)*	*(0.001)*	*(0.030)*	*(0.007)*	*(0.024)*				
eth_Aboriginal	-0.00245***	-0.09727***	0.00887***	0.09085***	-0.00256***	-0.10004***	0.00841***	0.09419***				
	(0.000)	*(0.016)*	*(0.002)*	*(0.018)*	*(0.000)*	*(0.016)*	*(0.002)*	*(0.018)*				
eth_other	0.00065	0.01800	-0.00528	-0.01337	0.00087	0.02320	-0.00695	-0.01713				
	(0.001)	*(0.020)*	*(0.007)*	*(0.015)*	*(0.001)*	*(0.020)*	*(0.007)*	*(0.014)*				
minority									-0.00476***	-0.09775***	0.03502***	0.06749***
									(0.001)	*(0.009)*	*(0.004)*	*(0.005)*
ed10_g8less	-0.00038	-0.01158	0.00289	0.00907								
	(0.000)	*(0.014)*	*(0.003)*	*(0.012)*								
ed10_g9g10	-0.00095***	-0.03046***	0.00677***	0.02464**								
	(0.000)	*(0.011)*	*(0.002)*	*(0.010)*								
ed10_g11g13	0.00070	0.01943	-0.00572	-0.01441								
	(0.001)	*(0.014)*	*(0.004)*	*(0.010)*								
ed10_somepostsec	0.00052	0.01461	-0.00417	-0.01096								
	(0.000)	*(0.011)*	*(0.003)*	*(0.008)*								
ed10_tradedip	-0.00070***	-0.02153***	0.00524***	0.01698***								
	(0.000)	*(0.008)*	*(0.002)*	*(0.006)*								
ed10_collegedip	-0.00035	-0.01039	0.00266	0.00807								
	(0.000)	*(0.008)*	*(0.002)*	*(0.006)*								
ed10_unicert	0.00060	0.01676	-0.00488	-0.01248								
	(0.000)	*(0.014)*	*(0.004)*	*(0.010)*								
ed10_BAdegree	0.00179***	0.04704***	-0.01486***	-0.03397***								
	(0.000)	*(0.009)*	*(0.003)*	*(0.006)*								
ed10_BAplus	0.00358***	0.08286***	-0.03032***	-0.05611***								
	(0.001)	*(0.013)*	*(0.006)*	*(0.007)*								
ed04_hsless					-0.00028	-0.00806	0.00207	0.00627	-0.00047	-0.01259	0.00310	0.00996
					0.00030086	*(0.009)*	*(0.002)*	*(0.007)*	*(0.000)*	*(0.009)*	*(0.002)*	*(0.007)*
ed04_somepostsec					0.00049	0.01363	-0.00386	-0.01027	0.00050	0.01252	-0.00347	-0.00955
					0.000404	*(0.011)*	*(0.003)*	*(0.008)*	*(0.000)*	*(0.011)*	*(0.003)*	*(0.008)*
ed04_postsecgrad					0.00039*	0.01142*	-0.00299*	-0.00882*	0.00049*	0.01288*	-0.00331*	-0.01006*
					0.00022968	*(0.007)*	*(0.002)*	*(0.005)*	*(0.000)*	*(0.007)*	*(0.002)*	*(0.005)*
hhinc_5000less	0.00923***	0.15766***	-0.07422***	-0.09266***	0.00899**	0.15315***	-0.07114***	-0.09100***	0.00900***	0.14378***	-0.06497***	-0.08781***
	(0.003)	*(0.036)*	*(0.023)*	*(0.016)*	*(0.004)*	*(0.039)*	*(0.025)*	*(0.018)*	*(0.003)*	*(0.035)*	*(0.022)*	*(0.017)*
hhinc_5000	0.01143***	0.18018***	-0.08906***	-0.10255***	0.01066***	0.17071***	-0.08243***	-0.09895***	0.01091***	0.16297***	-0.07703***	-0.09685***
	(0.002)	*(0.020)*	*(0.014)*	*(0.009)*	*(0.002)*	*(0.020)*	*(0.014)*	*(0.009)*	*(0.002)*	*(0.020)*	*(0.013)*	*(0.009)*
hhinc_10000	0.00565***	0.11407***	-0.04751***	-0.07221***	0.00529***	0.10715***	-0.04362***	-0.06881***	0.00513***	0.09740***	-0.03824**	-0.06430***
	(0.001)	*(0.020)*	*(0.011)*	*(0.010)*	*(0.001)*	*(0.019)*	*(0.010)*	*(0.010)*	*(0.001)*	*0.01908109*	*0.00976911*	*(0.011)*
hhinc_15000	0.00709***	0.13381***	-0.05874***	-0.08216***	0.00650***	0.12429***	-0.05307***	-0.07773***	0.00674***	0.11892***	-0.04973***	-0.07594***
	(0.001)	*(0.017)*	*(0.010)*	*(0.008)*	*(0.001)*	*(0.017)*	*(0.009)*	*(0.008)*	*(0.001)*	*(0.017)*	*(0.009)*	*(0.009)*
hhinc_20000	0.00479***	0.10318***	-0.04052***	-0.06745***	0.00431***	0.09359***	-0.03564***	-0.06226***	0.00457***	0.09073***	-0.03397***	-0.06133***
	(0.001)	*(0.011)*	*(0.006)*	*(0.006)*	*(0.001)*	*(0.011)*	*(0.005)*	*(0.006)*	*(0.001)*	*(0.011)*	*(0.005)*	*(0.007)*
hhinc_30000	0.00334***	0.07849***	-0.02825***	-0.05357***	0.00286***	0.06792***	-0.02356***	-0.04721***	0.00309***	0.06660***	0.02277***	-0.04692***
	(0.001)	*(0.010)*	*(0.004)*	*(0.006)*	*0.00053661*	*(0.009)*	*(0.004)*	*(0.006)*	*(0.001)*	*(0.009)*	*(0.004)*	*(0.006)*
hhinc_40000	0.00256***	0.06318***	-0.02156***	-0.04418***	0.00206***	0.05149***	-0.01683***	-0.03672***	0.00235***	0.05285***	-0.01716***	-0.03804***
	(0.000)	*(0.009)*	*(0.004)*	*(0.006)*	*(0.000)*	*(0.009)*	*(0.003)*	*(0.006)*	*(0.001)*	*(0.009)*	*(0.004)*	*(0.006)*
hhinc_50000	0.00150***	0.03960***	-0.01245***	-0.02866***	0.00114***	0.030300***	-0.00916***	-0.02228***	0.00129***	0.03088***	-0.00923***	-0.02294***
	(0.000)	*0.00890204*	*0.00320803*	*(0.006)*	*(0.000)*	*(0.009)*	*(0.003)*	*(0.006)*	*(0.000)*	*(0.009)*	*(0.003)*	*(0.006)*
hhinc_60000	0.00031	0.00884	-0.00243	-0.00671	0.00004	0.00128	-0.00034	-0.00098	0.00004	0.00096	-0.00025	-0.00075
	(0.000)	*(0.007)*	*(0.002)*	*(0.005)*	*0.00024824*	*(0.007)*	*(0.002)*	*(0.005)*	*(0.000)*	*(0.007)*	*(0.002)*	*(0.006)*
hrwage	0.00000	-0.00008	0.00002	0.00006	0.00000	0.00003	-0.00001	-0.00002	0.00000	0.00003	-0.00001	-0.00003
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Observations	56233				56233				56233			
LogLike	-57697				-57853				-58264			

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Marginal Effects for Ordered Probit of BMI (Categories) - Female Results

	FEMALE											
	-1				-2				-3			
COEFFICIENT	underweight	normal	overweight	obese	underweight	normal	overweight	obese	underweight	normal	overweight	obese
ur_urbfringe	-0.00189	-0.01453	0.00683	0.00960	-0.00243	-0.01864	0.00866	0.01241	-0.00299	-0.02161	0.00987	0.01474
	(0.002)	*(0.016)*	*(0.007)*	*(0.011)*	*(0.002)*	*(0.016)*	*(0.007)*	*(0.011)*	*(0.002)*	*(0.016)*	*(0.007)*	*(0.011)*
ur_rurfringe	-0.00075	-0.00556	0.00267	0.00364	-0.00120	-0.00892	0.00424	0.00588	-0.00193	-0.01350	0.00629	0.00914
	(0.001)	*(0.009)*	*(0.004)*	*(0.006)*	*(0.001)*	*(0.009)*	*(0.004)*	*(0.006)*	*(0.001)*	*(0.009)*	*(0.004)*	*(0.006)*
ur_urbosCMA	-0.00498***	-0.04112***	0.01841***	0.02769***	-0.00554***	-0.04578***	0.02023***	0.03109***	-0.00668***	-0.05234***	0.02252***	0.03649***
	(0.001)	*(0.008)*	*(0.003)*	*(0.006)*	*(0.001)*	*(0.008)*	*(0.003)*	*(0.006)*	*(0.001)*	*(0.008)*	*(0.003)*	*(0.006)*
ur_rurosCMA	-0.00557***	-0.04608***	0.02059***	0.03106***	-0.00628***	-0.05203***	0.02292***	0.03539***	-0.00735***	-0.05755***	0.02476***	0.04014***
	(0.001)	*(0.007)*	*(0.003)*	*(0.005)*	*(0.001)*	*(0.007)*	*(0.003)*	*(0.005)*	*(0.001)*	*(0.007)*	*(0.003)*	*(0.005)*
ur_2urbcore	-0.00301	-0.02385	0.01098	0.01588	-0.00400	-0.03213	0.01448	0.02165	-0.00460*	-0.03476	0.01539	0.02398
	(0.003)	*(0.023)*	*(0.010)*	*(0.016)*	*(0.003)*	*(0.023)*	*(0.010)*	*(0.016)*	*(0.003)*	*(0.024)*	*(0.010)*	*(0.017)*
age	-0.00091***	-0.00662***	0.00321***	0.00432***	-0.00092***	-0.00664***	0.00321***	0.00435***	-0.00096***	-0.00645***	0.00309***	0.00432***
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
eth_black	-0.00938***	-0.09154***	0.03609***	0.06483***	-0.00977***	-0.09507***	0.03699***	0.06785***				
	(0.002)	*(0.024)*	*(0.007)*	*(0.018)*	*(0.002)*	*(0.024)*	*(0.007)*	*(0.019)*				
eth_Asian	0.07554***	0.18955***	-0.15033***	-0.11476***	0.08082***	0.19167***	-0.15498***	-0.11750***				
	(0.008)	*(0.006)*	*(0.009)*	*(0.004)*	*(0.008)*	*(0.005)*	*(0.009)*	*(0.004)*				
eth_SEAsian	0.03655***	0.13952***	-0.09291***	-0.08317***	0.03692***	0.13918***	-0.09260***	-0.08350***				
	(0.008)	*(0.015)*	*(0.014)*	*(0.009)*	*(0.008)*	*(0.015)*	*(0.014)*	*(0.009)*				
eth_SAsian	0.01043**	0.06048***	-0.03326***	-0.03766***	0.01200***	0.06682***	-0.03718***	-0.04165***				
	(0.004)	*(0.019)*	*(0.012)*	*(0.012)*	*(0.004)*	*(0.019)*	*(0.012)*	*(0.011)*				
eth_MidEast	0.00551	0.03518	-0.01840	-0.02229	0.00690	0.04225	-0.02238	-0.02676				
	(0.006)	*(0.035)*	*(0.020)*	*(0.022)*	*(0.007)*	*(0.034)*	*(0.020)*	*(0.021)*				
eth_LatAm	-0.00182	-0.01396	0.00657	0.00922	-0.00172	-0.01295	0.00608	0.00858				
	(0.004)	*(0.031)*	*(0.014)*	*(0.021)*	*(0.004)*	*(0.031)*	*(0.014)*	*(0.021)*				
eth_Aboriginal	-0.01201***	-0.13102***	0.04653***	0.09650***	-0.01230***	-0.13319***	0.04677***	0.09872***				
	(0.001)	*(0.016)*	*(0.004)*	*(0.014)*	*(0.001)*	*(0.016)*	*(0.004)*	*(0.014)*				
eth_other	0.00427	0.02810	-0.01445	-0.01792	0.00498	0.03192	-0.01651	-0.02040				
	(0.004)	*(0.021)*	*(0.011)*	*(0.013)*	*(0.004)*	*(0.021)*	*(0.011)*	*(0.013)*				
white									-0.01307***	-0.07168***	0.03844***	0.04630***
									0.00180002	*0.00765262*	*0.00464967*	*0.00477456*
ed10_g8less	-0.00635***	-0.05532***	0.02384***	0.03783***								
	(0.002)	*(0.017)*	*(0.006)*	*(0.012)*								
ed10_g9g10	-0.00552***	-0.04666***	0.02055***	0.03163***								
	(0.002)	*(0.015)*	*(0.006)*	*(0.011)*								
ed10_g11g13	-0.00383**	-0.03096**	0.01407**	0.02072*								
	(0.002)	*(0.016)*	*(0.007)*	*(0.011)*								
ed10_somepostsec	0.00033	0.00242	-0.00118	-0.00158								
	(0.002)	*(0.011)*	*(0.005)*	*(0.007)*								
ed10_tradedip	-0.00081	-0.00602	0.00289	0.00394								
	(0.001)	*(0.009)*	*(0.004)*	*(0.006)*								
ed10_collegedip	-0.00117	-0.00865	0.00415	0.00567								
	(0.001)	*(0.007)*	*(0.004)*	*(0.005)*								
ed10_unicert	0.00443**	0.02917**	-0.01500**	-0.01860**								
	(0.002)	*(0.013)*	*(0.007)*	*(0.008)*								
ed10_BAdegree	0.00814***	0.05202***	-0.02714***	-0.03302***								
	(0.002)	*(0.008)*	*(0.005)*	*(0.005)*								
ed10_BAplus	0.01356***	0.07560***	-0.04233***	-0.04683***								
	(0.002)	*(0.010)*	*(0.006)*	*(0.006)*								
ed04_hsless					-0.00510***	-0.04114***	0.01848***	0.02776***	-0.00595***	-0.04519***	0.01990***	0.03125***
					0.00116265	*0.01056924*	*0.00437342*	*0.00735223*	*0.00121148*	*0.01045892*	*0.00419546*	*0.00746751*
ed04_somepostsec					0.00027	0.00190	-0.00092	-0.00124	-0.00083	-0.00563	0.00267	0.00379
					0.0015483	*0.01102446*	*0.00536715*	*0.0072056*	*0.00158656*	*0.0110131*	*0.005158*	*0.00744154*
ed04_postsecgrad					0.00253***	0.01849***	-0.00885***	-0.01217***	0.00259***	0.01765***	-0.00836***	-0.01187***
					0.0008824	*0.00649139*	*0.00308075*	*0.00429089*	*0.00094489*	*0.00647209*	*0.00304309*	*0.00437194*
hhinc_5000less	-0.00370	-0.02999	0.01360	0.02008	-0.00434	-0.03533	0.01578	0.02389	-0.00454	-0.03428	0.01516	0.02366
	(0.003)	*(0.031)*	*(0.013)*	*(0.021)*	*(0.003)*	*(0.031)*	*(0.013)*	*(0.022)*	*(0.004)*	*(0.032)*	*(0.013)*	*(0.023)*
hhinc_5000	-0.00284	-0.02236	0.01033	0.01487	-0.00389*	-0.03117	0.01408	0.02099	-0.00439	-0.03300	0.01466	0.02273
	(0.002)	*(0.021)*	*(0.009)*	*(0.014)*	*(0.002)*	*(0.021)*	*(0.009)*	*(0.015)*	*(0.003)*	*(0.023)*	*(0.001)*	*(0.016)*
hhinc_10000	-0.00180	-0.01379	0.00649	0.00909	-0.00307*	-0.02394*	0.01101*	0.01600*	-0.00446***	-0.03343**	0.01488***	0.02301**
	(0.002)	*(0.013)*	*(0.006)*	*(0.009)*	*(0.002)*	*(0.013)*	*(0.006)*	*(0.009)*	*(0.002)*	*(0.014)*	*(0.006)*	*(0.010)*
hhinc_15000	-0.00474***	-0.03931***	0.01755***	0.02650***	-0.00589***	-0.04980***	0.02166***	0.03404***	-0.00716***	-0.05769***	0.024318***	0.04053***
	(0.001)	*(0.014)*	*(0.006)*	*(0.009)*	*(0.001)*	*(0.013)*	*(0.005)*	*(0.010)*	*(0.001)*	*(0.014)*	*(0.005)*	*(0.010)*
hhinc_20000	-0.00207*	-0.01587*	0.00747*	0.01047*	-0.00348***	-0.02717***	0.01248***	0.01817***	-0.00462***	-0.03426***	0.01534***	0.02354***
	(0.001)	*(0.010)*	*(0.004)*	*(0.006)*	*(0.001)*	*(0.010)*	*(0.004)*	*(0.006)*	*(0.001)*	*(0.010)*	*(0.004)*	*(0.007)*
hhinc_30000	-0.00450***	-0.03635***	0.01651***	0.02434***	-0.00574***	-0.04705***	0.02088***	0.03190***	-0.00663***	-0.05122***	0.02227***	0.03558***
	(0.001)	*(0.010)*	*(0.004)*	*(0.007)*	*(0.001)*	*(0.010)*	*(0.004)*	*0.00666409*	*0.00108247*	*(0.010)*	*(0.004)*	*(0.007)*
hhinc_40000	-0.00622***	-0.05231***	0.02309***	0.03543***	-0.00722***	-0.06137***	0.02654***	0.04205***	-0.00799***	-0.06363***	0.02703***	0.04459***
	(0.001)	*(0.010)*	*(0.004)*	*(0.007)*	*(0.001)*	*(0.010)*	*(0.004)*	*(0.007)*	*(0.001)*	*(0.010)*	*(0.004)*	*(0.008)*
hhinc_50000	-0.00386***	-0.03073***	0.01411***	0.02048***	-0.00492***	-0.03953***	0.01780***	0.02664***	-0.00558***	-0.04201***	0.01861***	0.02898***
	(0.001)	*(0.010)*	*(0.004)*	*(0.007)*	*0.00110411*	*0.00981304*	*0.00411018*	*0.00680078*	*0.00115736*	*(0.010)*	*0.00396615*	*(0.007)*
hhinc_60000	-0.00451***	-0.03563***	0.01643***	0.02372***	-0.00533***	-0.04209***	0.01916***	0.02826***	-0.00590***	-0.04355***	0.01955***	0.02989***
	(0.001)	*(0.008)*	*(0.003)*	*(0.005)*	*(0.001)*	*(0.008)*	*(0.003)*	*(0.005)*	*(0.001)*	*(0.008)*	*(0.003)*	*(0.005)*
hrwage	-0.00001	-0.00008	0.00004	0.00006	0.00000	-0.00002	0.00001	0.00002	0.00000	-0.00003	0.00002	0.00002
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Observations	59212				59212				59212			
LogLike	-61203				-61332				-61874			

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

respective form. The marginal probability of being *overweight* was estimated to be less than 1 percentage points for the five forms. All the above marginal probabilities for each BMI category given the urban form were found to be statistically significant at the 1% level, except for that of living in the secondary urban core.

The results for the female half of the analysis found that fewer marginal probabilities to be statistically significant. However, the estimates for the effect associated with two urban forms were found to be very significant at the 1% level. Living in the urban area outside of the CMA was found to decrease the probability of being *underweight* or *normal* by 0.5 percentage points and 4.1 percentage points respectively, but increased the probability of being *overweight* or *obese* by nearly 1.8 percentage points and 2.8 percentage points, compared with females living in the urban core. Similarly, the marginal probability of being *underweight* and *normal* associated with living in the rural area outside of the CMA was estimated to be about -0.6 percentage points and 4.6 percentage points, but that of being *overweight* and *obese* was 2.1 percentage points and 3.1 percentage points, respectively. This suggests that the relationship between urban form and BMI categories is less pronounced in females than in males, as in the two previous models. Nonetheless, between both genders, urban forms farther from the urban core tended to decrease the probability of being *underweight* or *normal*, but increase the probability of being *overweight* or *obese*. This is consistent with our hypothesis and flow representation.

***

Over all three models of BMI, several factors remained relatively constant throughout. For example, regardless whether the highest grade of education attained was defined on 10 levels or on 4 levels, the more education attained, the lower is the expected BMI value; or conversely, lower education attainment is associated with higher

BMI values and a greater likelihood of *overweight* and *obese*. This finding accords with previous studies. Additionally, there exists a positive relationship between BMI and household income for males, yet an inverse relationship between these two variables for females. Compared to the reference group which has a household income greater than $80,000, male BMI, and the probability of a higher BMI generally increased with higher income. However, the opposite appears for females – BMI and the probability of a higher BMI tend to increase with lower incomes. This finding is also consistent with the results from studies by Kelly-Schwartz (2004), Tjepkema (2005), and Chang and Lauderdale (2005). Coefficients on the household income variables were also found to be statistically significant. On the other hand, hourly wage, representing the opportunity cost of time, had a very negligible marginal effect in all three models and was statistically insignificant. This suggests that total household resources were a more significant determinant of BMI. Since socio-demographic characteristics controlled in part for the unobserved effects of urban form on body mass index outcomes, it was reassuring that the marginal effects of these characteristics remained consistent through the set of results and also were consistent with previous research.

5.2 Canadian Overview – Outcomes of Self-Perceived Rating of Health

Turning to the dimension of self-perceived health, we review the results of this ordered probit model. Since the probit model is based on the normal distribution, we use the cut points to find the associated probabilities and are reported in Table 8. The probabilities of *excellent* or *very good* health ratings were highest—at about 43 percent and 39 percent for males across the three specifications, and about 39 percent and 40 percent for females over the three specifications. It is noted that the range in calculated probabilities is much lower for males than for females.

Table 8: Computed Probabilities from Ordered Probit of Self-Perceived Health

	MALE			FEMALE		
self_health	-1	-2	-3	-1	-2	-3
cut1	-0.17432***	-0.16287***	-0.19246***	-0.23278***	-0.19069***	-0.38930***
	(0.029)	*(0.029)*	*(0.036)*	*(0.032)*	*(0.032)*	*(0.037)*
cut2	0.92117***	0.92650***	0.89553***	0.87301***	0.91132***	0.71214***
	(0.030)	*(0.030)*	*(0.036)*	*(0.032)*	*(0.032)*	*(0.037)*
cut3	2.06276***	2.06216***	2.03017***	1.93056***	1.96515***	1.76563***
	(0.031)	*(0.031)*	*(0.037)*	*(0.033)*	*(0.033)*	*(0.038)*
cut4	2.9019***	2.89802***	2.86564***	2.73578***	2.76783***	2.56840***
	(0.035)	*(0.035)*	*(0.041)*	*(0.038)*	*(0.038)*	*(0.042)*
Probabilities						
Excellent	0.4308	0.4353	0.4237	0.4080	0.4244	0.3485
Very good	0.3907	0.3876	0.3911	0.4007	0.3946	0.4133
Satisfactory	0.1589	0.1575	0.1641	0.1646	0.1564	0.1995
Fair	0.0177	0.0177	0.0191	0.0237	0.0219	0.0336
Poor	0.0019	0.0019	0.0021	0.0031	0.0028	0.0051
Observations	56222	56222	56222	59209	59209	59209
LogLike	-71213	-71478	-71535	-75773	-75948	-75969

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The log-likelihood value is highest for specification (1) for both male and female, suggesting that variable specification (1) has more explanatory power. We formally tested the variables specifications using two likelihood ratio tests[14] following a similar procedure as explained in Section 5.1, we again found that specification (1) is preferred to the two other specifications for both male and female and therefore we primarily discuss the estimates of specification (1).

The marginal effects of urban form on male self-perceived ratings of health, as reported in Table 9, showed an inconsistency between the three specifications. In particular, variable specification (1) revealed that residing in the rural fringe, urban area outside of a CMA, rural area outside of CMA or a secondary urban core had a negative marginal influence on *satisfactory*, *fair* and *poor* ratings. However, this pattern was inconsistent with variable specifications (2) and (3), which both show that residing in the urban or rural fringe within the CMA or that outside the CMA has a negative marginal effect on *excellent* and *very good* health.

14 Calculations can be found in the appendix.

Table 9: Marginal Effects for Ordered Probit of Self-Perceived Rating - Male Results

	MALE														
			-1					-2					-3		
COEFFICIENT	excellent	very_good	good	fair	poor	excellent	very_good	good	fair	poor	excellent	very_good	good	fair	poor
ur_urbfringe	-0.02285*	-0.00715	0.01888*	0.00878	0.00234	-0.02855**	-0.00923*	0.02346**	0.01124**	0.00308*	-0.02956**	-0.00960*	0.02427**	0.01169**	0.00321**
	(0.013)	*(0.005)*	*(0.011)*	*(0.005)*	*(0.001)*	*(0.013)*	*(0.005)*	*(0.011)*	*(0.006)*	*(0.002)*	*(0.013)*	*(0.005)*	*(0.011)*	*(0.006)*	*(0.001)*
ur_rurfringe	0.00468	0.00118	-0.00379	-0.00165	-0.00042	-0.00386	-0.00102	0.00312	0.00140	0.00037	-0.00451	-0.00120	0.00364	0.00164	0.00043
	(0.007)	*(0.002)*	*(0.006)*	*(0.003)*	*(0.001)*	*(0.007)*	*(0.002)*	*(0.006)*	*(0.003)*	*(0.001)*	*(0.007)*	*(0.002)*	*(0.006)*	*(0.003)*	*(0.001)*
ur_urbosCMA	0.00491	0.00123	-0.00398	-0.00173	-0.00044	-0.00419	-0.00111	0.00339	0.00152	0.00040	-0.00603	-0.00162	0.00487	0.00220	0.00058
	(0.007)	*(0.002)*	*(0.005)*	*(0.002)*	*(0.001)*	*(0.006)*	*(0.002)*	*(0.005)*	*(0.002)*	*(0.001)*	*(0.006)*	*(0.002)*	*(0.005)*	*(0.002)*	*(0.001)*
ur_rurosCMA	0.00733	0.00182	-0.00593	-0.00256	-0.00065	-0.00149	-0.00039	0.00120	0.00053	0.00014	-0.00311	-0.00082	0.00251	0.00112	0.00029
	(0.006)	*(0.001)*	*(0.005)*	*(0.002)*	*(0.000)*	*(0.006)*	*(0.001)*	*(0.004)*	*(0.002)*	*(0.001)*	*(0.006)*	*(0.001)*	*(0.004)*	*(0.002)*	*(0.001)*
ur_2urbcore	0.01329	0.00308	-0.01069	-0.00454	-0.00113	0.00455	0.00113	-0.00366	-0.00161	-0.00041	0.00331	0.00083	-0.00265	-0.00117	-0.00030
	(0.019)	*(0.004)*	*(0.015)*	*(0.006)*	*(0.002)*	*(0.018)*	*(0.004)*	*(0.014)*	*(0.006)*	*(0.002)*	*(0.018)*	*(0.004)*	*(0.014)*	*(0.006)*	*(0.002)*
age	-0.00417***	-0.00109***	0.00339***	0.00148***	0.00038***	-0.00409***	-0.00105***	0.00330***	0.00146***	0.00038***	-0.00410***	-0.00105***	0.00330***	0.00147***	0.00038***
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
eth_Black	0.06042**	0.00845***	-0.04677**	-0.01791***	-0.00418***	0.06474**	0.00844***	-0.04957**	-0.01909***	-0.00451***					
	(0.027)	*(0.001)*	*(0.020)*	*(0.007)*	*(0.001)*	*(0.028)*	*(0.001)*	*(0.020)*	*(0.007)*	*(0.001)*					
eth_Asian	-0.06364***	-0.02655***	0.05381***	0.02822***	0.00816***	-0.04645***	-0.01701***	0.03855***	0.01941***	0.00550***					
	(0.012)	*(0.007)*	*(0.010)*	*(0.006)*	*(0.002)*	*(0.013)*	*(0.006)*	*(0.011)*	*(0.006)*	*(0.002)*					
eth_SEAsian	-0.01147	-0.00329	0.00941	0.00425	0.00111	-0.00504	-0.00135	0.00408	0.00184	0.00048					
	(0.018)	*(0.006)*	*(0.015)*	*(0.007)*	*(0.002)*	*(0.018)*	*(0.005)*	*(0.015)*	*(0.007)*	*(0.006)*					
eth_SAsian	-0.00435	-0.00117	0.00355	0.00157	0.00040	0.00918	0.00219	-0.00735	-0.00320	-0.00082					
	(0.016)	*(0.004)*	*(0.013)*	*(0.006)*	*(0.002)*	*(0.017)*	*(0.004)*	*(0.013)*	*(0.006)*	*(0.001)*					
eth_MidEast	0.01788	0.00396	-0.01433	-0.00601	-0.00149	0.04145	0.00712**	-0.03235	-0.01305	-0.00318					
	(0.034)	*(0.006)*	*(0.027)*	*(0.011)*	*(0.003)*	*(0.035)*	*(0.003)*	*(0.026)*	*(0.010)*	*(0.002)*					
eth_LatAm	-0.02263	-0.00711	0.01871	0.00872	0.00232	-0.01164	-0.00331	0.00946	0.00434	0.00115					
	(0.027)	*(0.010)*	*(0.023)*	*(0.011)*	*(0.003)*	*(0.028)*	*(0.009)*	*(0.023)*	*(0.011)*	*(0.003)*					
eth_Aboriginal	-0.05129***	-0.01996***	0.04316***	0.021903***	0.00619***	-0.05519***	-0.02183***	0.04607***	0.02399***	0.00696***					
	(0.013)	*(0.007)*	*(0.011)*	*(0.006)*	*(0.002)*	*(0.012)*	*(0.007)*	*(0.011)*	*(0.006)*	*(0.002)*					
eth_other	-0.01781	-0.00536	0.01467	0.00673	0.00177	-0.01328	-0.00381	0.01080	0.00497	0.00132					
	(0.016)	*(0.005)*	*(0.013)*	*(0.006)*	*(0.002)*	*(0.016)*	*(0.005)*	*(0.013)*	*(0.006)*	*(0.002)*					
minority											0.00920	0.00250	-0.00744	-0.00337	-0.00089
											(0.007)	*(0.002)*	*(0.006)*	*(0.003)*	*(0.001)*
ed10_g8less	-0.06697***	-0.02856***	0.05671***	0.03007***	0.00876***										
	(0.010)	*(0.006)*	*(0.009)*	*(0.006)*	*(0.002)*										
ed10_g9g10	-0.03698***	-0.01266***	0.03079***	0.01481***	0.00403***										
	(0.009)	*(0.004)*	*(0.008)*	*(0.004)*	*(0.001)*										
ed10_g11g13	-0.05994***	-0.02427***	0.05057***	0.02615***	0.00749***										
	(0.010)	*(0.006)*	*(0.008)*	*(0.005)*	*(0.002)*										
ed10_somepostsec	0.00744	0.00183	-0.00602	-0.00260	-0.00066										
	(0.009)	*(0.002)*	*(0.007)*	*(0.003)*	*(0.001)*										
ed10_tradedip	-0.00252	-0.00067	0.00205	0.00090	0.00023										
	(0.007)	*(0.002)*	*(0.006)*	*(0.002)*	*(0.001)*										
ed10_collegedip	0.02403***	0.00542***	-0.01929***	-0.00814***	-0.00203***										
	(0.007)	*(0.001)*	*(0.006)*	*(0.002)*	*(0.001)*										
ed10_unicert	0.05436***	0.00838***	-0.04236***	-0.01649***	-0.00389***										
	(0.014)	*(0.001)*	*(0.011)*	*(0.004)*	*(0.001)*										
ed10_BAdegree	0.08899***	0.01183***	-0.06853***	-0.02616***	-0.00612***										
	(0.009)	*(0.001)*	*(0.006)*	*(0.002)*	*(0.001)*										
ed10_BAplus	0.12425***	0.00754***	-0.09213***	-0.03245***	-0.00722***										
	(0.012)	*(0.002)*	*(0.008)*	*(0.002)*	*(0.001)*										
ed04_hsless						-0.05103***	-0.01793***	0.04218***	0.02091***	0.00587***	-0.05136***	-0.01804***	0.04239***	0.02108***	0.00593***
						(0.007)	*(0.003)*	*(0.006)*	*(0.003)*	*(0.001)*	*(0.007)*	*(0.003)*	*(0.006)*	*(0.003)*	*(0.001)*
ed04_somepostsec						0.00643	0.00158	-0.00516	-0.00226	-0.00058	0.00765	0.00186	-0.00613	-0.00269	-0.00069
						(0.009)	*(0.002)*	*(0.007)*	*(0.003)*	*(0.001)*	*(0.009)*	*(0.002)*	*(0.007)*	*(0.003)*	*(0.001)*
ed04_postsecgrad						0.04088***	0.01133***	-0.03313***	-0.01509***	-0.00400***	0.04125***	0.01141***	-0.03337***	-0.01524***	-0.00405***
						(0.005)	*(0.002)*	*(0.004)*	*(0.002)*	*(0.001)*	*(0.005)*	*(0.002)*	*(0.004)*	*(0.002)*	*(0.001)*
hhinc_5000less	-0.06363**	-0.02728*	0.05392**	0.02864**	0.00835*	-0.06553***	-0.02815*	0.05501***	0.02979**	0.00888*	-0.06540***	-0.02800*	0.05479***	0.02973**	0.00888*
	(0.025)	*(0.016)*	*(0.022)*	*(0.014)*	*(0.005)*	*(0.024)*	*(0.015)*	*(0.021)*	*(0.014)*	*(0.005)*	*(0.024)*	*(0.015)*	*(0.021)*	*(0.014)*	*(0.004)*
hhinc_5000	-0.15413***	-0.12379***	0.12690***	0.10758***	0.04345***	-0.15840***	-0.12934***	0.12747***	0.11291***	0.04737***	-0.15902***	-0.13001***	0.12743***	0.11366***	0.04794***
	(0.009)	*(0.014)*	*(0.005)*	*(0.012)*	*(0.007)*	*(0.009)*	*(0.015)*	*(0.005)*	*(0.012)*	*(0.007)*	*(0.009)*	*(0.015)*	*(0.005)*	*(0.012)*	*(0.007)*
hhinc_10000	-0.11909***	-0.07324***	0.10168***	0.06756***	0.02308***	-0.12314***	-0.07679***	0.10371***	0.07116***	0.02507***	-0.12308***	-0.07651***	0.10341***	0.07108)***	0.02510***
	(0.008)	*(0.009)*	*(0.007)*	*(0.007)*	*(0.003)*	*(0.008)*	*(0.009)*	*(0.007)*	*(0.008)*	*(0.003)*	*(0.008)*	*(0.009)*	*(0.007)*	*(0.008)*	*(0.004)*
hhinc_15000	-0.09759***	-0.05198***	0.08347***	0.05015***	0.01596***	-0.10382***	-0.05694***	0.08781***	0.05486***	0.01810***	-0.10258***	-0.05564***	0.08656***	0.05390***	0.01776***
	(0.010)	*(0.009)*	*(0.009)*	*(0.008)*	*(0.003)*	*(0.010)*	*(0.009)*	*(0.009)*	*(0.008)*	*(0.003)*	*(0.010)*	*(0.009)*	*(0.009)*	*(0.008)*	*(0.003)*
hhinc_20000	-0.06870***	-0.02881***	0.05807***	0.03057***	0.00887***	-0.07611***	-0.03305***	0.06384***	0.03485***	0.01046***	-0.07485***	-0.03217***	0.06263***	0.03414***	0.01025***
	(0.008)	*(0.005)*	*(0.007)*	*(0.004)*	*(0.001)*	*(0.008)*	*(0.005)*	*(0.007)*	*(0.004)*	*(0.002)*	*(0.008)*	*(0.005)*	*(0.007)*	*(0.004)*	*(0.002)*
hhinc_30000	-0.05335***	-0.01986***	0.04470***	0.02228***	0.00622***	-0.06251***	-0.02433***	0.05207***	0.02696***	0.00780***	-0.06185***	-0.02392***	0.05141***	0.02664***	0.00772***
	(0.007)	*(0.003)*	*(0.006)*	*(0.003)*	*(0.001)*	*(0.007)*	*(0.004)*	*(0.006)*	*(0.004)*	*(0.001)*	*(0.007)*	*(0.003)*	*(0.006)*	*(0.004)*	*(0.001)*
hhinc_40000	-0.03244***	-0.01052***	0.02688***	0.01267***	0.00340***	-0.04290***	-0.01468***	0.03541***	0.01735***	0.00483***	-0.04231***	-0.01439***	0.03484***	0.01709***	0.00476***
	(0.007)	*(0.003)*	*(0.006)*	*(0.003)*	*(0.001)*	*(0.007)*	*(0.003)*	*(0.006)*	*(0.003)*	*(0.001)*	*(0.007)*	*(0.003)*	*(0.006)*	*(0.003)*	*(0.001)*
hhinc_50000	-0.03428***	-0.01122***	0.02843***	0.01345***	0.00362***	-0.04327***	-0.01481***	0.03571***	0.01750***	0.00487***	-0.04317***	-0.01473***	0.03557***	0.01747***	0.00487***
	(0.007)	*(0.003)*	*(0.006)*	*(0.003)*	*(0.001)*	*(0.007)*	*(0.003)*	*(0.006)*	*(0.003)*	*(0.001)*	*(0.007)*	*(0.003)*	*(0.006)*	*(0.003)*	*(0.001)*
hhinc_60000	-0.02739***	-0.00823***	0.02255***	0.01035***	0.00273***	-0.03507***	-0.01082***	0.02870***	0.01353***	0.00367***	-0.03467***	-0.01065***	0.02832***	0.01338***	0.00363***
	(0.006)	*(0.002)*	*(0.005)*	*(0.002)*	*(0.001)*	*(0.006)*	*(0.002)*	*(0.005)*	*(0.002)*	*(0.001)*	*(0.006)*	*(0.002)*	*(0.005)*	*(0.002)*	*(0.001)*
hrwage	0.00036***	0.00010***	-0.00030***	-0.00013***	-0.00003***	0.00048***	0.00012***	-0.00039***	-0.00017***	-0.00004***	0.00048***	0.00012***	-0.00038***	-0.00017***	-0.00004***
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Observations			56222					56222					56222		
LogLike			-71213					-71478					-71535		

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The marginal probabilities were very small in magnitude and in many cases statistically insignificant, suggesting that the urban form in which one lives may not be a significant factor in self-perceived health. Where the estimate of marginal probability was found to be significant was in the effect of living in the urban fringe. Variable specification (1) lead us to believe at a 90% level of confidence that living in this form decreases the probability that one would give an *excellent* self-perceived health rating by about 2.29 percentage points, but increases the probability that one would rate their health as *satisfactory* by nearly 1.89 percentage points, compared to a similar male living in the urban core.

Among the females, the marginal effect of the urban forms on each rating, too, appeared minimal. However, as found in Table 10, the results of all three specifications are comparable. The marginal probability of living in the urban fringe, rural fringe, secondary urban core or rural area outside of CMA on health ratings of *satisfactory*, *fair* and *poor* was generally negative compared to similar females living in the urban core. Marginal probabilities were positive for *excellent* and *very good* ratings. On the other hand, the signs are reversed for the urban area outside of the CMA — marginal probabilities for *excellent* and *very good* ratings was negative, but positive for *satisfactory*, *fair* and *poor* ratings.

Again, the marginal probabilities were small in levels. In spite of this, estimates were found to be statistically significant, and in fact, significant at the 1% or 10% levels. As specification (1) suggests, compared to females in the urban core, living in the rural fringe increases the marginal probability that a female would report a self-perceived health rating of *excellent* or *very good* by 2.6 percentage points and 0.45 percentage points, respectively. Conversely, females were about 1.9 percentage points, 0.88 percentage points and 0.25 percentage points less likely to rate their health as *satisfactory*, *fair* and *poor*, respectively. These estimates were significant at the 1% level, as is the marginal

Table 10: Marginal Effects for Ordered Probit of Self-Perceived Rating - Female Results

	FEMALE														
	-1					-2					-3				
COEFFICIENT	excellent	very_good	good	fair	poor	excellent	very_good	good	fair	poor	excellent	very_good	good	fair	poor
ur_urbfringe	0.01749	0.00325	-0.01296	-0.00604	-0.00174	0.01430	0.00273	-0.01057	-0.00500	-0.00147	0.01347	0.00259	-0.00995	-0.00472	-0.00139
	(0.014)	*(0.002)*	*(0.001)*	*(0.005)*	*(0.001)*	*(0.014)*	*(0.002)*	*(0.010)*	*(0.005)*	*(0.001)*	*(0.014)*	*(0.002)*	*(0.010)*	*(0.005)*	*(0.001)*
ur_rurfringe	0.02594***	0.00451***	-0.01914***	-0.00880***	-0.00252***	0.02290***	0.00407***	-0.01683***	-0.00785***	-0.00228***	0.02233***	0.00399***	-0.01641***	-0.00767***	-0.00223***
	(0.009)	*(0.001)*	*(0.006)*	*(0.003)*	*(0.001)*	*(0.009)*	*(0.001)*	*(0.006)*	*(0.003)*	*(0.001)*	*(0.009)*	*(0.001)*	*(0.006)*	*(0.003)*	*(0.001)*
ur_urbosCMA	-0.00839	-0.00199	0.00633	0.00312	0.00094	-0.01261*	-0.00308*	0.00948*	0.00475*	0.00146*	-0.01388**	-0.00342*	0.01044**	0.00526**	0.00161*
	(0.007)	*(0.002)*	*(0.005)*	*(0.003)*	*(0.001)*	*(0.007)*	*(0.002)*	*(0.005)*	*(0.003)*	*(0.001)*	*(0.007)*	*(0.001)*	*(0.005)*	*(0.003)*	*(0.001)*
ur_rurosCMA	0.01511**	0.00296***	-0.01124***	-0.00529***	-0.00154***	0.00907	0.00185*	-0.00673	-0.00323	-0.00096	0.00792	0.00163	-0.00588	-0.00283	-0.00084
	(0.006)	*(0.001)*	*(0.004)*	*(0.002)*	*(0.001)*	*(0.006)*	*(0.001)*	*(0.004)*	*(0.002)*	*(0.001)*	*(0.006)*	*(0.001)*	*(0.004)*	*(0.002)*	*(0.001)*
ur_2urbcore	0.01547	0.00293	-0.01148	-0.00536	-0.00155	0.00766	0.00156	-0.00568	-0.00273	-0.00081	0.00676	0.00139	-0.00502	-0.00242	-0.00072
	(0.017)	*(0.003)*	*(0.013)*	*(0.006)*	*(0.001)*	*(0.017)*	*(0.003)*	*(0.013)*	*(0.006)*	*(0.002)*	*(0.017)*	*(0.003)*	*(0.013)*	*(0.006)*	*(0.002)*
age	-0.00294***	-0.00065***	0.00220***	0.00107***	0.00032***	-0.00308***	-0.00068***	0.00230***	0.00112***	0.00034***	-0.00309***	-0.00068***	0.00230***	0.00112***	0.00034***
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
eth_black	-0.03615*	-0.01101	0.02776*	0.01474*	0.00467	-0.03908**	-0.01210	0.02988**	0.01611*	0.00520*					
	(0.019)	*(0.008)*	*(0.015)*	*(0.009)*	*(0.003)*	*(0.019)*	*(0.008)*	*(0.015)*	*(0.009)*	*(0.003)*					
eth_Asian	-0.08410***	-0.03593**	0.06581***	0.04016***	).01407197**	-0.07716***	-0.03117***	0.05985***	0.03595***	0.01253***					
	(0.010)	*(0.007)*	*(0.008)*	*(0.006)*	*(0.003)*	*(0.011)*	*(0.007)*	*(0.008)*	*(0.006)*	*(0.003)*					
eth_SEAsian	-0.03880**	-0.01206	0.02983347*	0.01595*	0.00507	-0.03848**	-0.01184	0.02940*	0.01582*	0.00509					
	(0.020)	*(0.008)*	*(0.015)*	*(0.009)*	*(0.003)*	*(0.020)*	*(0.008)*	*(0.015)*	*(0.009)*	*(0.003)*					
eth_SAsian	-0.05329***	-0.01848**	0.04127***	0.02298***	0.00752***	-0.04739***	-0.01560**	0.03637***	0.02005***	0.00657**					
	(0.015)	*(0.008)*	*(0.012)*	*(0.008)*	*(0.003)*	*(0.015)*	*(0.007)*	*(0.012)*	*(0.008)*	*(0.003)*					
eth_MidEast	-0.04280	-0.01386	0.03300	0.01790	0.00575	-0.03660	-0.01118	0.02795	0.01500	0.00482					
	(0.027)	*(0.012)*	*(0.021)*	*(0.013)*	*(0.004)*	*(0.027)*	*(0.011)*	*(0.021)*	*(0.012)*	*(0.004)*					
eth_LatAm	-0.02370	-0.00653	0.01807	0.00929	0.00287	-0.02258	-0.00611	0.01710	0.00883	0.00276					
	(0.027)	*(0.009)*	*(0.021)*	*(0.011)*	*(0.004)*	*(0.027)*	*(0.009)*	*(0.021)*	*(0.011)*	*(0.004)*					
eth_Aboriginal	-0.08209***	-0.03554***	0.06430***	0.03946***	0.01387***	-0.08368***	-0.03637***	0.06512***	0.04047***	0.01446***					
	(0.010)	*(0.007)*	*(0.008)*	*(0.006)*	*(0.003)*	*(0.010)*	*(0.007)*	*(0.008)*	*(0.006)*	*(0.003)*					
eth_other	-0.06179***	-0.02295***	0.04805***	0.02750***	0.00919***	-0.05829***	-0.02092***	0.04497***	0.02564***	0.00860***					
	(0.015)	*(0.008)*	*(0.012)*	*(0.008)*	*(0.003)*	*(0.015)*	*(0.008)*	*(0.012)*	*(0.008)*	*(0.003)*					
white											0.05775***	0.01819***	-0.04411***	-0.02402***	-0.00781***
											(0.006)	*(0.003)*	*(0.005)*	*(0.003)*	*(0.001)*
ed10_g8less	-0.10667***	-0.05376***	0.08370***	0.05584***	0.02088***										
	(0.009)	*(0.008)*	*(0.008)*	*(0.007)*	*(0.003)*										
ed10_g9g10	-0.07750***	-0.03146***	0.06051***	0.03604***	0.01241***										
	(0.009)	*(0.006)*	*(0.007)*	*(0.005)*	*(0.002)*										
ed10_g11g13	-0.05145***	-0.01748***	0.03979***	0.02198***	0.00716***										
	(0.012)	*(0.005)*	*(0.009)*	*(0.006)*	*(0.002)*										
ed10_somepostsec	-0.00480	-0.00111	0.00361	0.00177	0.00053										
	(0.009)	*(0.002)*	*(0.006)*	*(0.003)*	*(0.001)*										
ed10_tradedip	-0.00502	-0.00116	0.00377	0.00185	0.00055										
	(0.008)	*(0.002)*	*(0.006)*	*(0.003)*	*(0.001)*										
ed10_collegedip	0.02018***	0.00402***	-0.01502***	-0.00711***	-0.00207***										
	(0.007)	*(0.001)*	*(0.005)*	*(0.002)*	*(0.001)*										
ed10_unicert	0.05125**	0.00644***	-0.03706***	-0.01617***	-0.004467***										
	(0.012)	*(0.001)*	*(0.009)*	*(0.003)*	*(0.001)*										
ed10_BAdegree	0.07294***	0.00910***	-0.052659***	-0.02302***	-0.00637***										
	(0.008)	*(0.001)*	*(0.006)*	*(0.002)*	*(0.001)*										
ed10_BAplus	0.09565***	0.00600***	-0.06705***	-0.02736***	-0.00723***										
	(0.012)	*(0.001)*	*(0.008)*	*(0.003)*	*(0.001)*										
ed04_hsless						-0.07690***	-0.02862***	0.05933***	0.03445***	0.01174***	-0.07682***	-0.02855***	0.05923***	0.03441***	0.011730***
						(0.007)	*(0.004)*	*(0.006)*	*(0.004)*	*(0.002)*	*(0.007)*	*(0.004)*	*(0.006)*	*(0.004)*	*(0.002)*
ed04_somepostsec						-0.00589	-0.00136	0.00441	0.00218	0.00066	-0.00534	-0.00122	0.00400	0.00197	0.00060
						(0.009)	*(0.002)*	*(0.006)*	*(0.003)*	*(0.001)*	*(0.009)*	*(0.002)*	*(0.006)*	*(0.003)*	*(0.001)*
ed04_postsecgrad						0.03611***	0.00866***	-0.02709***	-0.01354***	-0.00414***	0.03657***	0.008773***	-0.02741***	-0.01372***	-0.00420***
						(0.006)	*(0.002)*	*(0.004)*	*(0.002)*	*(0.001)*	*(0.006)*	*(0.002)*	*(0.004)*	*(0.002)*	*(0.001)*
hhinc_5000less	-0.06273***	-0.02382*	0.04886***	0.02821**	0.00949*	-0.06703***	-0.02611*	0.05195***	0.03065**	0.01054**	-0.06733***	-0.02626*	0.05214***	0.03083**	0.01061**
	(0.024)	*(0.013)*	*(0.019)*	*(0.013)*	*(0.005)*	*(0.023)*	*(0.014)*	*(0.018)*	*(0.013)*	*(0.005)*	*(0.023)*	*(0.014)*	*(0.018)*	*(0.013)*	*(0.005)*
hhinc_5000	-0.15761***	-0.11687***	0.11883***	0.10648***	0.04916***	-0.16297***	-0.12452***	0.12044***	0.11289***	0.05415***	-0.16364***	-0.12549***	0.12062***	0.11375***	0.05477***
	(0.009)	*(0.014)*	*(0.005)*	*(0.011)*	*(0.007)*	*(0.008)*	*(0.014)*	*(0.004)*	*(0.011)*	*(0.008)*	*(0.008)*	*(0.014)*	*(0.004)*	*(0.011)*	*(0.008)*
hhinc_10000	-0.13905***	-0.08682***	0.10780***	0.08334***	0.03473***	-0.14595***	-0.09464***	0.11152***	0.09006***	0.03900***	-0.14585***	-0.09440***	0.11135***	0.08996***	0.03894***
	(0.007)	*(0.008)*	*(0.005)*	*(0.007)*	*(0.004)*	*(0.007)*	*(0.008)*	*(0.005)*	*(0.007)*	*(0.004)*	*(0.007)*	*(0.008)*	*(0.005)*	*(0.007)*	*(0.004)*
hhinc_15000	-0.10896***	-0.05544***	0.08547***	0.05737***	0.02156***	-0.11679***	-0.06212***	0.09081***	0.06341***	0.02469***	-0.11679***	-0.06206***	0.09073***	0.06341***	0.02470***
	(0.008)	*(0.007)*	*(0.007)*	*(0.006)*	*(0.003)*	*(0.008)*	*(0.007)*	*(0.006)*	*(0.006)*	*(0.003)*	*(0.008)*	*(0.008)*	*(0.006)*	*(0.006)*	*(0.003)*
hhinc_20000	-0.08564***	-0.03496***	0.06680***	0.03997***	0.01383***	-0.09509***	-0.04085***	0.07378***	0.04578***	0.01638***	-0.09500***	-0.04075***	0.07366***	0.04573***	0.01637***
	(0.007)	*(0.004)*	*(0.005)*	*(0.004)*	*(0.002)*	*(0.006)*	*(0.004)*	*(0.005)*	*(0.004)*	*(0.002)*	*(0.006)*	*(0.004)*	*(0.005)*	*(0.004)*	*(0.002)*
hhinc_30000	-0.06405***	-0.02228***	0.04957***	0.02767***	0.00910***	-0.07281***	-0.026556***	0.05614***	0.03230***	0.01093***	-0.07230***	-0.02626***	0.05570***	0.03204***	0.01084***
	(0.006)	*(0.003)*	*(0.005)*	*(0.003)*	*(0.001)*	*(0.006)*	*(0.003)*	*(0.005)*	*(0.003)*	*(0.001)*	*(0.006)*	*(0.003)*	*(0.005)*	*(0.003)*	*(0.001)*
hhinc_40000	-0.06223***	-0.02133***	0.04811***	0.02671***	0.00874***	-0.06987***	-0.02493***	0.05380***	0.03068***	0.01031***	-0.06929***	-0.02460***	0.05331***	0.03038***	0.01021***
	(0.007)	*(0.003)*	*(0.006)*	*(0.004)*	*(0.001)*	*(0.007)*	*(0.004)*	*(0.005)*	*(0.004)*	*(0.001)*	*(0.007)*	*(0.004)*	*(0.005)*	*(0.004)*	*(0.001)*
hhinc_50000	-0.04162***	-0.01247***	0.03191***	0.01686***	0.00532***	-0.04938***	-0.01547***	0.03775***	0.02047***	0.00663***	-0.04883***	-0.01522***	0.03729***	0.02022***	0.00654***
	(0.007)	*(0.003)*	*(0.006)*	*(0.003)*	*(0.001)*	*(0.007)*	*(0.003)*	*(0.006)*	*(0.003)*	*(0.001)*	*(0.007)*	*(0.003)*	*(0.006)*	*(0.003)*	*(0.001)*
hhinc_60000	-0.03866***	-0.01075***	0.02948***	0.01521***	0.00472***	-0.04423***	-0.01259***	0.03359***	0.01764***	0.00559***	-0.04391***	-0.01246***	0.03332***	0.01751***	0.00555***
	(0.006)	*(0.002)*	*(0.005)*	*(0.003)*	*(0.000)*	*(0.006)*	*(0.002)*	*(0.005)*	*(0.003)*	*(0.001)*	*(0.006)*	*(0.002)*	*(0.005)*	*(0.003)*	*(0.001)*
hrwage	0.00035***	0.00008***	-0.00027***	-0.00013***	-0.00004***	0.00042***	0.00009***	-0.00031***	-0.00015***	-0.00005***	0.00041***	0.00009***	-0.00031***	-0.00015***	-0.00005***
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Observations			59209					59209					59209		
LogLike			-75773					-75948					-75969		

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

probability of self-health attributed to living in the rural area outside of the CMA. Chances of reporting *excellent* and *very good* health increased by 1.5 percentage points and 0.29 percentage points, and that of reporting *satisfactory*, *fair* or *poor* health fell by 1.1 percentage points, 0.5 percentage points and 0.15 percentage points. Specifications (2) and (3) suggest, instead, that it is the urban area outside of the CMA, not the rural area, which bears statistical significance for the marginal probabilities of each reported rating.

Self-perceived health added a different perspective to our study of health outcomes. It appeared that people generally do not associated their health with the urban form they live in, which is reflected in results opposite to what we found looking at the actual effects of urban form on BMI. Males, consciously or not, do find self-perceived health to improve the closer to the urban core they are, but for females, urban forms which are closer to the urban core were generally associated with higher ratings of *satisfactory*, *fair* or *poor* self-perceived health. This finding largely opposes the finding from studying the health outcome of BMI.

***

The marginal probabilities of age, education, hourly wage and household income were found to be statistically significant and of expected directions. Aging an extra year decreased the probability that *excellent* and *very good* self-perceived health was reported, and increased that for *satisfactory*, *fair* or *poor*. A unit increase in the hourly wage increased the likelihood of an *excellent* and *very good* health while decreasing the probability of the bottom three ratings. Keeping in mind the reference group which had a household income of over $80000, we generally found between male and female, the higher the household income, the higher the marginal probability of rating their health in the top two ratings and the lower the marginal probabilities of one of the bottom three ratings. Education had a similar effect. More education generally reflected higher marginal likelihoods for *excellent* and *very good* ratings. Compared with the reference ethnic White group, we found that Blacks had positive marginal probabilities for *excellent* and *very good* health and negative marginal probabilities for the bottom three ratings, but Asians had the opposite. The estimates for the other ethnicities were largely insignificant.

5.3 Canadian Overview – Outcomes of Chronic Conditions

High Blood Pressure

Both a linear probability model and a probit for high blood pressure were used to determine the likelihood of this chronic condition given the urban form of residence. While the results were close overall, as found in Tables 11 and 12, in some aspects the two models diverged. Both models estimated that living in the urban and rural fringe within a CMA as opposed to the urban core tended to very slightly increase the probability of having hypertension for males, as well as increase the probability for females living in the urban fringe, but decrease for those living in the rural fringe. Where the two differed is in the magnitudes of their estimates. The linear probability model estimated the magnitudes for the female probabilities of living in the urban fringe to be lower than that for the male, but the probit model finds the opposite.

Living in the urban and rural areas outside the CMA tended to decrease probability for having hypertension in males; but for females, only living in the rural area outside of the CMA decreased the probability of having high blood pressure. Both models estimated the probability of having hypertension if living in the urban fringe to be higher for females

Table 11: Linear Probability Model of Hypertension

	MALE			FEMALE		
	-1	-2	-3	-1	-2	-3
	hbp	hbp	hbp	hbp	hbp	hbp
ur_urbfringe	0.00513	0.00697	0.00704	0.01256	0.01383	0.01378
	[0.012]	*[0.012]*	*[0.012]*	*[0.012]*	*[0.012]*	*[0.012]*
ur_rurfringe	0.00025	0.00276	0.00283	-0.00804	-0.00665	-0.00628
	[0.008]	*[0.008]*	*[0.008]*	*[0.007]*	*[0.007]*	*[0.007]*
ur_urbosCMA	-0.00314	-0.00041	-0.00011	0.00779	0.00987	0.01011
	[0.006]	*[0.006]*	*[0.006]*	*[0.006]*	*[0.006]*	*[0.006]*
ur_rurosCMA	-0.01245	-0.00968	-0.00937	-0.00011	0.00287	0.00312
	*[0.005]**	*[0.005]*	*[0.005]*	*[0.005]*	*[0.005]*	*[0.005]*
ur_2urbcore	-0.01466	-0.01223	-0.01222	-0.01977	-0.01563	-0.01517
	[0.015]	*[0.014]*	*[0.015]*	*[0.012]*	*[0.012]*	*[0.013]*
age	0.00800	0.00799	0.00798	0.00765	0.00772	0.00772
	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***
eth_Black	0.04940	0.04875		0.05859	0.06075	
	*[0.019]**	*[0.019]**		*[0.022]***	*[0.022]***	
eth_Asian	-0.00935	-0.01586		-0.02790	-0.03124	
	[0.012]	*[0.012]*		*[0.011]**	*[0.011]***	
eth_SEAsian	0.01437	0.01265		0.01713	0.01787	
	[0.019]	*[0.019]*		*[0.016]*	*[0.016]*	
eth_SAsian	0.02457	0.02077		-0.00432	-0.00761	
	[0.017]	*[0.017]*		*[0.014]*	*[0.014]*	
eth_MidEast	-0.01807	-0.02477		-0.03421	-0.03636	
	[0.023]	*[0.023]*		*[0.026]*	*[0.026]*	
eth_LatAm	-0.01688	-0.02025		-0.01132	-0.01088	
	[0.023]	*[0.023]*		*[0.016]*	*[0.016]*	
eth_Aboriginal	0.02294	0.02423		0.00919	0.01001	
	[0.015]	*[0.015]*		*[0.012]*	*[0.012]*	
eth_other	-0.01411	-0.01613		-0.01590	-0.01737	
	[0.013]	*[0.013]*		*[0.010]*	*[0.010]*	
minority			-0.00441			0.00326
			[0.007]			*[0.006]*
ed10_g8less	0.00909			0.08144		
	[0.013]			*[0.016]***		
ed10_g9g10	0.02793			0.03980		
	*[0.011]**			*[0.012]***		
ed10_g11g13	-0.00006			0.02929		
	[0.010]			*[0.012]**		
ed10_somepostsec	0.00768			0.00492		
	[0.008]			*[0.007]*		
ed10_tradedip	-0.00446			-0.00330		
	[0.007]			*[0.007]*		
ed10_collegedip	-0.00626			-0.01107		
	[0.007]			*[0.006]*		
ed10_unicert	-0.00088			-0.00913		
	[0.012]			*[0.009]*		
ed10_BAdegree	-0.03046			-0.03090		
	*[0.007]***			*[0.006]***		
ed10_BAplus	-0.03384			-0.05750		
	*[0.010]***			*[0.008]***		
ed04_hsless		0.01343	0.01392		0.04650	0.04740
		[0.008]	*[0.008]*		*[0.008]*	*[0.008]*
ed04_somepostsec		0.00803	0.00887		0.00542	0.00708
		[0.008]	*[0.008]*		*[0.007]*	*[0.007]*
ed04_postsecgrad		-0.01435	-0.01438		-0.01918	-0.01846
		*[0.005]***	*[0.005]***		*[0.005]***	*[0.005]***
hhinc_5000less	-0.01182	-0.01076	-0.01302	0.03783	0.04029	0.04048
	[0.026]	*[0.026]*	*[0.027]*	*[0.018]**	*[0.018]**	*[0.018]**
hhinc_5000	0.02601	0.02835	0.02793	0.04006	0.04661	0.04535
	[0.017]	*[0.017]*	*[0.017]*	*[0.013]***	*[0.013]***	*[0.013]***
hhinc_10000	0.00711	0.00901	0.00726	0.03701	0.04386	0.04484
	[0.012]	*[0.012]*	*[0.012]*	*[0.010]***	*[0.010]***	*[0.010]***
hhinc_15000	-0.01675	-0.01399	-0.01360	0.03477	0.04083	0.04125
	[0.011]	*[0.011]*	*[0.011]*	*[0.009]***	*[0.009]***	*[0.009]***
hhinc_20000	0.00832	0.01123	0.01189	0.03802	0.04426	0.04545
	[0.008]	*[0.008]*	*[0.008]*	*[0.007]***	*[0.007]***	*[0.007]***
hhinc_30000	0.00594	0.00913	0.00948	0.03366	0.03890	0.03952
	[0.008]	*[0.008]*	*[0.008]*	*[0.007]***	*[0.007]***	*[0.007]***
hhinc_40000	-0.00727	-0.00347	-0.00356	0.03686	0.04122	0.04205
	[0.007]	*[0.007]*	*[0.007]*	*[0.008]***	*[0.007]***	*[0.007]***
hhinc_50000	-0.00610	-0.00313	-0.00328	0.01038	0.01470	0.01505
	[0.007]	*[0.007]*	*[0.007]*	*[0.006]*	*[0.006]**	*[0.006]**
hhinc_60000	0.00776	0.01029	0.01049	0.01198	0.01505	0.01554
	[0.006]	*[0.006]*	*[0.006]*	*[0.005]**	*[0.005]***	*[0.005]***
hrwage	-0.00020	-0.00023	-0.00023	-0.00021	-0.00024	-0.00025
	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***
Constant	-0.19408	-0.19533	-0.19094	-0.20870	-0.21478	-0.21940
	*[0.007]***	*[0.007]***	*[0.008]***	*[0.008]***	*[0.008]***	*[0.008]***
Observations	56180	56180	56180	59192	59192	59192
R-squared	0.1007	0.0996	0.0989	0.123	0.121	0.1197
RSS	5583.84	5590.26	5595.1	5099.06	5110.99	5118.49
F-stat	87.38	105.49	138	112.56	134.07	178.92

Robust standard errors in brackets

* significant at 5%; ** significant at 1%

Table 12: Probit Model of Hypertension

	MALE			FEMALE		
	-1	-2	-3	-1	-2	-3
	hbp	hbp	hbp	hbp	hbp	hbp
ur_urbfringe	0.00751	0.00972	0.00984	0.01017	0.012	0.01139
	[0.011]	*[0.011]*	*[0.011]*	*[0.011]*	*[0.011]*	*[0.011]*
ur_rurfringe	0.00138	0.00361	0.00377	-0.00321	-0.002	-0.00147
	[0.007]	*[0.007]*	*[0.007]*	*[0.006]*	*[0.006]*	*[0.006]*
ur_urbosCMA	-0.00039	0.00190	0.00221	0.00929	0.011	0.01177
	[0.006]	*[0.006]*	*[0.006]*	*[0.005]*	*[0.005]**	*[0.005]**
ur_rurosCMA	-0.00794	-0.00609	-0.00573	0.00308	0.005	0.00568
	[0.005]	*[0.005]*	*[0.005]*	*[0.004]*	*[0.004]*	*[0.004]*
ur_2urbcore	-0.01223	-0.01010	-0.00980	-0.01577	-0.013	-0.01343
	[0.013]	*[0.013]*	*[0.013]*	*[0.009]*	*[0.010]*	*[0.010]*
age	0.00721	0.00720	0.00720	0.00634	0.006	0.00644
	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***
eth_Black	0.05227	0.05137		0.06554	0.068	
	*[0.021]**	*[0.021]**		*[0.024]***	*[0.024]***	
eth_Asian	-0.01022	-0.01512		-0.02192	-0.025	
	[0.012]	*[0.011]*		*[0.010]**	*[0.010]**	
eth_SEAsian	0.02138	0.01869		0.02015	0.020	
	[0.020]	*[0.020]*		*[0.016]*	*[0.016]*	
eth_SAsian	0.02868	0.02404		0.00086	-0.002	
	[0.018]	*[0.018]*		*[0.014]*	*[0.014]*	
eth_MidEast	-0.02680	-0.03290		-0.02967	-0.032	
	[0.023]	*[0.022]*		*[0.030]*	*[0.029]*	
eth_LatAm	-0.00877	-0.01202		-0.00866	-0.009	
	[0.024]	*[0.023]*		*[0.017]*	*[0.017]*	
eth_Aboriginal	0.02952	0.03148		0.01756	0.019	
	[0.018]	*[0.018]*		*[0.011]*	*[0.011]*	
eth_other	-0.01436	-0.01623		-0.01871	-0.020	
	[0.014]	*[0.013]*		*[0.009]**	*[0.009]**	
minority			-0.00632			-0.00141
			[0.007]			*[0.006]*
ed10_g8less	-0.00274			0.02443		
	[0.009]			*[0.009]***		
ed10_g9g10	0.02229			0.01740		
	*[0.010]**			*[0.008]**		
ed10_g11g13	-0.00358			0.01690		
	[0.009]			*'[0.011]*		
ed10_somepostsec	-0.00074			-0.00878		
	[0.009]			*[0.006]*		
ed10_tradedip	0.00112			-0.00112		
	[0.006]			*[0.005]*		
ed10_collegedip	0.00083			-0.00562		
	[0.007]			*[0.005]*		
ed10_unicert	-0.00285			-0.00890		
	[0.010]			*[0.007]*		
ed10_BAdegree	-0.02166			-0.02590		
	*[0.006]***			*[0.005]***		
ed10_BAplus	-0.02097			-0.03801		
	*[0.008]***			*[0.005]***		
ed04_hsless		0.00697	0.00753		0.018	0.01946
		[0.007]	*[0.007]*		*[0.006]***	*[0.006]***
ed04_somepostsec		-0.00061	0.00001		-0.009	-0.00708
		[0.009]	*[0.009]*		*[0.006]*	*[0.007]*
ed04_postsecgrad		-0.00751	-0.00757		-0.014	-0.01307
		[0.005]	*[0.005]*		*[0.004]***	*[0.004]***
hhinc_5000less	-0.00442	-0.00392	-0.00576	0.02452	0.028	0.03000
	[0.030]	*[0.030]*	*[0.030]*	*[0.022]*	*[0.023]*	*[0.030]*
hhinc_5000	0.01948	0.02175	0.02180	0.02414	0.030	0.03026
	[0.015]	*[0.015]*	*[0.015]*	*[0.013]*	*[0.013]**	*[0.013]**
hhinc_10000	-0.00172	-0.00049	-0.00219	0.01578	0.022	0.02292
	[0.010]	*[0.010]*	*[0.010]*	*[0.009]*	*[0.009]**	*[0.009]**
hhinc_15000	-0.02344	-0.02175	-0.02150	0.01222	0.018	0.01834
	*[0.009]**	*[0.010]**	*[0.010]**	*[0.008]*	*[0.008]**	*[0.008]**
hhinc_20000	-0.00390	-0.00128	-0.00073	0.01811	0.025	0.02575
	[0.007]	*[0.007]*	*[0.007]*	*[0.007]***	*[0.007]***	*[0.007]***
hhinc_30000	-0.00077	0.00230	0.00265	0.01848	0.025	0.02505
	[0.007]	*[0.007]*	*[0.007]*	*[0.006]***	*[0.006]***	*[0.007]***
hhinc_40000	-0.00929	-0.00591	-0.00607	0.02727	0.032	0.03343
	[0.007]	*[0.007]*	*[0.007]*	*[0.008]***	*[0.008]***	*[0.008]***
hhinc_50000	-0.00764	-0.00485	-0.00496	0.00443	0.009	0.00902
	[0.007]	*[0.007]*	*[0.007]*	*[0.006]*	*[0.006]*	*[0.006]*
hhinc_60000	0.00747	0.01003	0.01042	0.00929	0.013	0.01320
	[0.006]	*[0.006]*	*[0.006]*	*[0.005]*	*[0.005]**	*[0.006]**
hrwage	-0.00008	-0.00010	-0.00011	-0.00009	0.000	-0.00012
	[0.000]	*[0.000]*	*[0.000]*	*[0.000]*	*[0.000]*	*[0.000]*
Observations	56180	56180	56180	59192	59192	59192
LogLike	-18376.13	-18408.01	-18435.92	-16883.11	-16902.79	-16991.05

Robust standard errors in brackets

* significant at 5%; ** significant at 1%

than males. However, there again lies the discrepancy for marginal probability if living in the rural fringe—the linear probability model predicted that the probability is higher for males than females, but the probit model predicted the relative magnitudes to be the opposite.

The discrepancy may be partly due to the fact that the only estimates found to be statistically significant are the marginal probabilities associated with living in the rural area outside the CMA for males in the linear probability model in variable specification (1), and that associated with living in the urban area outside of the CMA for females in variable specifications (2) and (3). Statistical insignificance may in fact result in these differences in the estimated probabilities between models. As expected, the estimates of these two models are largely insignificant. Nonetheless, if we focus solely on the signs of the estimated probabilities, we find some consistency. Compared to urban core residence, marginal probability decreased when residing in the rural or urban fringe beyond the CMA or the secondary urban core, but increased when residing within the CMA for males. For females, the marginal probabilities of incidence were negative for living in the secondary urban core and rural fringe within or outside of the CMA, but positive for residence in the urban fringe within or outside the CMA.

Heart Disease

The results of the linear probability and probit models for heart disease, found in Tables 13 and 14, were very similar and yielded consistent results between the two models, so we focus on the results of the linear probability model. Much like the effect of urban form on the incidence of hypertension, the marginal probability of living in the urban fringe and rural fringe is positive, and negative if living in the forms beyond the CMA and in the secondary urban core in comparison to residence in the urban core for males. Not only were the estimates for both male and female found to be very small, at less

Table 13: Linear Probability Model of Heart Disease

	MALE			FEMALE		
	-1	-2	-3	-1	-2	-3
	heartdis	heartdis	heartdis	heartdis	heartdis	heartdis
ur_urbfringe	0.00267	0.00323	0.00403	-0.00459	-0.00430	-0.00416
	[0.007]	*[0.007]*	*[0.007]*	*[0.004]*	*[0.004]*	*[0.004]*
ur_rurfringe	0.00094	0.00175	0.00223	-0.00178	-0.00155	-0.00146
	[0.004]	*[0.004]*	*[0.004]*	*[0.003]*	*[0.003]*	*[0.003]*
ur_urbosCMA	-0.00537	-0.00446	-0.00341	-0.00344	-0.00307	-0.00286
	[0.004]	*[0.003]*	*[0.003]*	*[0.002]*	*[0.002]*	*[0.002]*
ur_rurosCMA	-0.00180	-0.00070	0.00022	-0.00107	-0.00038	-0.00021
	[0.003]	*[0.003]*	*[0.003]*	*[0.003]*	*[0.003]*	*[0.003]*
ur_2urbcore	-0.01279	-0.01203	-0.01132	-0.00924*	-0.00820	-0.00803
	*[0.006]**	*[0.006]**	*[0.006]*	*[0.005]*	*[0.005]*	*[0.005]*
age	0.00285	0.00285	0.00284	0.00147	0.00150	0.00150
	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***
eth_Black	-0.02048	-0.02077		-0.00870	-0.00804	
	*[0.006]***	*[0.006]***		*[0.008]*	*[0.008]*	
eth_Asian	-0.02048	-0.02304		-0.00002	-0.00079	
	*[0.004]***	*[0.004]***		*[0.007]*	*[0.007]*	
eth_SEAsian	-0.01084	-0.01183		-0.01432	-0.01426	
	[0.010]	*[0.010]*		*[0.002]***	*[0.002]***	
eth_SAsian	-0.01285	-0.01438		-0.00812	-0.00879	
	*[0.006]**	*[0.006]***		*[0.006]*	*[0.006]*	
eth_MidEast	-0.01220	-0.01482		0.00465	0.00423	
	[0.008]	*[0.008]**		*[0.002]*	*[0.002]*	
eth_LatAm	-0.02684	-0.02776		-0.01446	-0.01436	
	*[0.006]***	*[0.006]***		*[0.004]***	*[0.004]***	
eth_Aboriginal	0.01019	0.01052		-0.00128	-0.00116	
	[0.007]	*[0.007]*		*[0.005]*	*[0.005]*	
eth_other	0.01404	0.01387		-0.00087	-0.00130	
	[0.010]	*[0.010]*		*[0.008]*	*[0.009]*	
minority			0.01083			0.00537
			*[0.003]***			*[0.003]*
ed10_g8less	0.02050			0.02915		
	*[0.009]**			*[0.009]***		
ed10_g9g10	-0.00267			0.01071		
	[0.005]			*[0.006]*		
ed10_g11g13	0.00756			0.01009		
	[0.006]			*[0.005]**		
ed10_somepostsec	0.00272			0.00596		
	[0.004]			*[0.003]**		
ed10_tradedip	0.00045			0.00437		
	[0.004]			*[0.004]*		
ed10_collegedip	0.00095			0.00254		
	[0.004]			*[0.003]*		
ed10_unicert	0.00001			0.00000		
	[0.007]			*[0.004]*		
ed10_BAdegree	-0.01072			-0.00386		
	*[0.003]***			*[0.003]*		
ed10_BAplus	-0.01021			-0.00488		
	*[0.005]**			*[0.004]*		
ed04_hsless		0.00632	0.00684		0.01523	0.01507
		[0.004]	*[0.004]*		*[0.004]***	*[0.004]***
ed04_somepostsec		0.00288	0.00288		0.00617	0.00603
		[0.004]	*[0.004]*		*[0.003]**	*[0.003]**
ed04_postsecgrad		-0.00331	-0.00351		0.00033	0.00020
		[0.003]	*[0.003]*		*[0.002]*	*[0.002]*
hhinc_5000less	-0.00362	-0.00351	-0.00504	0.02471	0.02516	0.02544
	[0.006]	*[0.007]*	*[0.007]*	*[0.002]*	*[0.002]*	*[0.002]*
hhinc_5000	0.04307	0.04494	0.04556	0.04282	0.04461	0.04505
	*[0.010]***	*[0.010]***	*[0.010]***	*[0.009]***	*[0.009]***	*[0.009]***
hhinc_10000	0.02848	0.02990	0.02951	0.01816	0.01996	0.02004
	*[0.007]***	*[0.007]***	*[0.007]***	*[0.005]***	*[0.005]***	*[0.005]***
hhinc_15000	0.02090	0.02280	0.02242	0.01514	0.01669	0.01690
	*[0.007]***	*[0.007]***	*[0.007]***	*[0.005]***	*[0.005]***	*[0.005]***
hhinc_20000	0.03190	0.03334	0.03261	0.01298	0.01442	0.01446
	*[0.005]***	*[0.005]***	*[0.005]***	*[0.004]***	*[0.004]***	*[0.004]***
hhinc_30000	0.01255	0.01393	0.01357	0.01049	0.01163	0.01158
	*[0.004]***	*[0.004]***	*[0.004]***	*[0.004]***	*[0.004]***	*[0.004]***
hhinc_40000	0.00918	0.01061	0.00993	0.00199	0.00295	0.00291
	*[0.004]**	*[0.004]***	*[0.004]***	*[0.003]*	*[0.003]*	*[0.003]*
hhinc_50000	0.00346	0.00473	0.00441	0.00100	0.00191	0.00182
	[0.004]	*[0.004]*	*[0.004]*	*[0.003]*	*[0.003]*	*[0.003]*
hhinc_60000	0.00746	0.00837	0.00826	0.00005	0.00071	0.00063
	*[0.003]**	*[0.003]***	*[0.003]***	*[0.002]*	*[0.002]*	*[0.002]*
hrwage	-0.00008	-0.00010	-0.00010	-0.00007	-0.00008	-0.00008
	*[0.000]**	*[0.000]**	*[0.000]**	*[0.000]***	*[0.000]***	*[0.000]***
Constant	-0.08454	-0.08543	-0.09605	-0.04184	-0.04384	-0.04918
	*[0.005]***	*[0.005]***	*[0.005]***	*[0.004]***	*[0.004]***	*[0.004]***
Observations	56218	56218	56218	59192	59192	59192
R-squared	0.0476	0.0468	0.0459	0.0253	0.0247	0.0244
RSS	1818.54	1820.12	1821.81	1243.13	1243.98	1244.27
F-stat	29.36	35.08	46.33	17.69	20.81	26.63

Robust standard errors in brackets

* significant at 5%; ** significant at 1%

Table 14: Probit Model of Heart Disease

	MALE			FEMALE		
	-1	-2	-3	-1	-2	-3
	heartdis	heartdis	heartdis	heartdis	heartdis	heartdis
ur_urbfringe	0.00074	0.00111	0.00170	-0.00384	-0.00379	-0.00371
	[0.004]	*[0.004]*	*[0.004]*	*[0.003]*	*[0.003]*	*[0.003]*
ur_rurfringe	0.00044	0.00091	0.00128	-0.00087	-0.00070	-0.00062
	[0.002]	*[0.002]*	*[0.002]*	*[0.002]*	*[0.002]*	*[0.002]*
ur_urbosCMA	-0.00264	-0.00226	-0.00153	-0.00190	-0.00164	-0.00151
	[0.002]	*[0.002]*	*[0.002]*	*[0.002]*	*[0.002]*	*[0.002]*
ur_rurosCMA	-0.00087	-0.00048	0.00015	-0.00004	0.00035	0.00052
	[0.002]	*[0.002]*	*[0.002]*	*[0.002]*	*[0.002]*	*[0.002]*
ur_2urbcore	-0.00759	-0.00730	-0.00719	-0.00609	-0.00588	-0.00590
	*[0.003]**	*[0.003]**	*[0.003]**	*[0.003]**	*[0.003]**	*[0.003]**
age	0.00183	0.00184	0.00188	0.00103	0.00104	0.00106
	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***
eth_Black	-0.01257	-0.01274		-0.00508	-0.00501	
	*[0.003]***	*[0.003]***		*[0.006]*	*[0.006]*	
eth_Asian	-0.01234	-0.01295		0.00135	0.00057	
	*[0.003]***	*[0.002]***		*[0.005]*	*[0.005]*	
eth_SEAsian	-0.00499	-0.00534		-0.01096	-0.01112	
	[0.008]	*[0.008]*		*[0.002]***	*[0.002]***	
eth_SAsian	-0.00866	-0.00938		-0.00617	-0.00661	
	*[0.004]**	*[0.003]***		*[0.005]*	*[0.004]*	
eth_MidEast	-0.00682	-0.00843		0.00809	0.00778	
	[0.005]	*[0.005]*		*[0.024]*	*[0.024]*	
eth_LatAm	-0.01480	-0.01502		-0.01006	-0.01018	
	*[0.003]***	*[0.003]***		*[0.003]***	*[0.003]***	
eth_Aboriginal	0.01079	0.01144		0.00123	0.00152	
	[0.006]	*[0.006]*		*[0.003]*	*[0.003]*	
eth_other	0.01012	0.01015		-0.00042	-0.00118	
	[0.007]	*[0.007]*		*[0.007]*	*[0.007]*	
minority			0.00635			0.00329
			*[0.002]***			*[0.002]*
ed10_g8less	0.00133			0.00904		
	[0.003]			*[0.004]**		
ed10_g9g10	-0.00155			0.00438		
	[0.003]			*[0.003]*		
ed10_g11g13	0.00347			0.00557		
	[0.004]			*[0.003]*		
ed10_somepostsec	-0.00271			0.00322		
	[0.003]			*[0.003]*		
ed10_tradedip	0.00069			0.00330		
	[0.003]			*[0.003]*		
ed10_collegedip	0.00252			0.00289		
	[0.003]			*[0.002]*		
ed10_unicert	-0.00105			-0.00024		
	[0.004]			*[0.003]*		
ed10_BAdegree	-0.00629			-0.00386		
	*[0.002]***			*[0.002]*		
ed10_BAplus	-0.00433			-0.00232		
	[0.003]			*[0.003]*		
ed04_hsless		0.00042	0.00074		0.00590	0.00587
		[0.002]	*[0.002]*		*[0.003]**	*[0.003]**
ed04_somepostsec		-0.00273	-0.00263		0.00330	0.00329
		[0.003]	*[0.003]*		*[0.003]*	*[0.003]*
ed04_postsecgrad		-0.00110	-0.00125		0.00082	0.00068
		[0.002]	*[0.002]*		*[0.002]*	*[0.002]*
hhinc_5000less	-0.00677	-0.00670	-0.00756	0.02220	0.02373	0.02478
	[0.005]	*[0.005]*	*[0.005]*	*[0.002]*	*[0.002]*	*[0.002]*
hhinc_5000	0.03151	0.03345	0.03456	0.03044	0.03299	0.03410
	*[0.008]***	*[0.008]***	*[0.009]***	*[0.008]***	*[0.009]***	*[0.009]***
hhinc_10000	0.01804	0.01897	0.01849	0.01009	0.01165	0.01205
	*[0.006]***	*[0.006]***	*[0.006]***	*[0.004]**	*[0.004]***	*[0.004]***
hhinc_15000	0.01015	0.01149	0.01133	0.00814	0.00961	0.01020
	[0.005]	*[0.006]**	*[0.006]**	*[0.004]**	*[0.004]**	*[0.004]**
hhinc_20000	0.01684	0.01838	0.01803	0.00658	0.00797	0.00826
	*[0.005]***	*[0.005]***	*[0.005]***	*[0.003]**	*[0.003]**	*[0.003]**
hhinc_30000	0.00559	0.00680	0.00676	0.00615	0.00738	0.00759
	*[0.003]**	*[0.003]**	*[0.003]**	*[0.003]**	*[0.003]**	*[0.003]**
hhinc_40000	0.00447	0.00555	0.00516	0.00046	0.00129	0.00151
	[0.003]	*[0.003]*	*[0.003]*	*[0.002]*	*[0.003]*	*[0.003]*
hhinc_50000	0.00196	0.00285	0.00251	0.00037	0.00102	0.00094
	[0.003]	*[0.003]*	*[0.003]*	*[0.002]*	*[0.002]*	*[0.003]*
hhinc_60000	0.00573	0.00653	0.00647	-0.00015	0.00041	0.00037
	*[0.003]**	*[0.003]**	*[0.003]**	*[0.002]*	*[0.002]*	*[0.002]*
hrwage	-0.00001	-0.00002	-0.00002	-0.00006	-0.00008	-0.00008
	[0.000]	*[0.000]*	*[0.000]*	*[0.000]*	*[0.000]**	*[0.000]**
Observations	56218	56218	56218	59192	59192	59192
LogLike	-7221.69	-7239.23	-7273.6	-5582.87	-5596.79	-5610.05

Robust standard errors in brackets
* significant at 5%; ** significant at 1%

than 1 percentage point, the marginal probabilities were also largely insignificant. However, simply looking at the sign or the direction of the relationship in the female analysis, the coefficients were interestingly all negative. That is, living in the urban core is associated with the greatest marginal probability for having heart disease, though very marginally greater and statistically not significant. The estimated marginal effects of urban form on the probability of having heart disease may only be due to a spurious relationship.

Diabetes

Examining the effects of urban form on the incidence of diabetes using a linear probability model and a probit model, as found in Tables 15 and 16, yields similar results. Therefore, we find it sufficient to focus on the results of the linear probability model. The estimates of the marginal effect of urban form on the probability of diabetes suggest that living in the urban fringe or secondary urban core increased the probability of having diabetes for females, but living in the rural area outside of the CMA would decrease the probability of having diabetes very slightly as compared to living in the urban core. For males, the marginal effect of living in the rural fringe was positive. However, living in the urban and rural area outside the CMA and the secondary urban core was associated with decreased probability for having diabetes.

The marginal effects of living in the rural fringe and the urban area outside of the CMA were unclear across the three variable specifications for females, as was the marginal probability of living in the urban fringe for males. Again the ambiguity in the findings may be the result of statistical insignificance. The only estimates found to be statistically significant at the 10% level were, interestingly, the marginal effect of living in the secondary urban core. Therefore, in terms of the effect of urban form on the health outcome defined by the incidence of diabetes, we find a poor relationship.

Table 15: Linear Probability Model of Diabetes

	MALE			FEMALE		
	-1	-2	-3	-1	-2	-3
	diabetes	diabetes	diabetes	diabetes	diabetes	diabetes
ur_urbfringe	-0.00063	0.00050	0.00125	0.01804	0.01942	0.02082
	[0.010]	*[0.010]*	*[0.010]*	*[0.015]*	*[0.015]*	*[0.015]*
ur_rurfringe	0.00321	0.00442	0.00498	-0.00048	-0.00001	0.00173
	[0.006]	*[0.006]*	*[0.006]*	*[0.010]*	*[0.010]*	*[0.010]*
ur_urbosCMA	-0.00536	-0.00420	-0.00296	-0.00216	-0.00131	0.00152
	[0.005]	*[0.005]*	*[0.005]*	*[0.007]*	*[0.007]*	*[0.007]*
ur_rurosCMA	-0.00512	-0.00440	-0.00330	-0.00716	-0.00588	-0.00338
	[0.004]	*[0.004]*	*[0.004]*	*[0.007]*	*[0.007]*	*[0.007]*
ur_2urbcore	-0.02324	-0.02182	-0.02105	0.04333	0.04504	0.04558
	*[0.010]**	*[0.010]**	*[0.010]**	*[0.021]**	*[0.021]**	*[0.021]**
age	-0.00059	-0.00063	-0.00064	-0.00130	-0.00126	-0.00128
	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***
eth_Black	-0.00720	-0.00780		-0.01272	-0.01175	
	[0.016]	*[0.016]*		*[0.025]*	*[0.025]*	
eth_Asian	-0.03268	-0.03517		-0.09177	-0.09508	
	*[0.008]***	*[0.008]***		*[0.013]***	*[0.013]***	
eth_SEAsian	0.00961	0.00792		-0.01474	-0.01585	
	[0.015]	*[0.015]*		*[0.023]*	*[0.023]*	
eth_SAsian	-0.02199	-0.02360		-0.01460	-0.01582	
	*[0.009]**	*[0.009]***		*[0.023]*	*[0.023]*	
eth_MidEast	-0.02177	-0.02442		0.00424	0.00175	
	[0.015]	*[0.015]*		*[0.004]*	*[0.004]*	
eth_LatAm	0.02466	0.02301		-0.05736	-0.05856	
	[0.028]	*[0.028]*		*[0.024]**	*[0.024]**	
eth_Aboriginal	0.02055	0.02190		0.05222	0.05260	
	[0.015]	*[0.015]*		*[0.017]***	*[0.017]***	
eth_other	0.00814	0.00710		-0.03222	-0.03393	
	[0.018]	*[0.018]*		*[0.018]*	*[0.018]*	
minority			0.00955			0.03176
			[0.006]			*[0.008]***
ed10_g8less	-0.00730			0.01867		
	[0.008]			*[0.016]*		
ed10_g9g10	0.01780			0.00408		
	*[0.009]**			*[0.013]*		
ed10_g11g13	0.02468			0.02433		
	*[0.012]**			*[0.015]*		
ed10_somepostsec	0.00217			0.01016		
	[0.007]			*[0.010]*		
ed10_tradedip	0.00618			0.02647		
	[0.005]			*[0.010]***		
ed10_collegedip	-0.00013			0.01978		
	[0.005]			*[0.007]***		
ed10_unicert	-0.00469			-0.01045		
	[0.008]			*[0.013]*		
ed10_BAdegree	-0.00819			-0.00193		
	[0.006]			*[0.008]*		
ed10_BAplus	-0.00541			0.02221		
	[0.007]			*[0.012]*		
ed04_hsless		0.01321	0.01378		0.01381	0.01540
		*[0.006]**	*[0.006]**		*[0.010]*	*[0.010]*
ed04_somepostsec		0.00219	0.00202		0.01042	0.01293
		[0.007]	*[0.007]*		*[0.010]*	*[0.010]*
ed04_postsecgrad		-0.00104	-0.00146		0.01349	0.01393
		[0.004]	*[0.004]*		*[0.006]**	*[0.006]**
hhinc_5000less	0.00509	0.00568	0.00739	-0.01916	-0.01820	-0.01801
	[0.022]	*[0.022]*	*[0.022]*	*[0.027]*	*[0.027]*	*[0.027]*
hhinc_5000	0.03565	0.03471	0.03548	0.03275	0.03441	0.03385
	*[0.012]***	*[0.012]*	*[0.013]***	*[0.018]*	*[0.018]*	*[0.018]*
hhinc_10000	0.02706	0.02633	0.02718	0.03487	0.03670	0.03938
	*[0.012]**	*[0.012]**	*[0.012]**	*[0.012]***	*[0.012]***	*[0.012]***
hhinc_15000	0.03449	0.03381	0.03323	0.02624	0.02841	0.03154
	*[0.013]***	*[0.013]**	*[0.013]**	*[0.014]*	*[0.014]**	*[0.014]**
hhinc_20000	0.01164	0.01183	0.01134	0.01005	0.01207	0.01347
	[0.007]	*[0.007]*	*[0.007]*	*[0.009]*	*[0.009]*	*[0.009]*
hhinc_30000	0.00783	0.00875	0.00840	0.00246	0.00459	0.00577
	[0.006]	*[0.006]*	*[0.006]*	*[0.008]*	*[0.008]*	*[0.008]*
hhinc_40000	-0.00819	-0.00701	-0.00768	-0.00129	0.00075	0.00148
	[0.005]	*[0.005]*	*[0.005]*	*[0.009]*	*[0.009]*	*[0.009]*
hhinc_50000	0.00009	0.00116	0.00109	0.00090	0.00252	0.00343
	[0.005]	*[0.005]*	*[0.005]*	*[0.009]*	*[0.009]*	*[0.009]*
hhinc_60000	0.00498	0.00605	0.00605	-0.01010	-0.00872	-0.00791
	[0.005]	*[0.005]*	*[0.005]*	*[0.007]*	*[0.007]*	*[0.007]*
hrwage	0.00000	-0.00001	-0.00001	-0.00012	-0.00013	-0.00013
	[0.000]	*[0.000]*	*[0.000]*	*[0.000]**	*[0.000]**	*[0.000]**
Constant	0.08737	0.08840	0.07909	0.21474	0.21203	0.17886
	*[0.007]***	*[0.007]***	*[0.008]***	*[0.010]***	*[0.010]***	*[0.012]***
Observations	56225	56225	56225	59200	59200	59200
R-squared	0.0045	0.0039	0.0028	0.0067	0.006	0.0039
RSS	3376.43	3378.54	3382.23	8185.56	8191.54	8209
F-stat	3.34	3.49	3.59	5.57	6.08	5.48

Robust standard errors in brackets
* significant at 5%; ** significant at 1%

Table 16: Probit Model of Diabetes

	MALE			FEMALE		
	-1	-2	-3	-1	-2	-3
	diabetes	diabetes	diabetes	diabetes	diabetes	diabetes
ur_urbfringe	-0.00019	0.001	0.00143	0.01739	0.01884	0.02066
	[0.009]	*[0.010]*	*[0.010]*	*[0.015]*	*[0.015]*	*[0.015]*
ur_rurfringe	0.00359	0.005	0.00530	-0.00026	0.00007	0.00194
	[0.006]	*[0.006]*	*[0.006]*	*[0.010]*	*[0.010]*	*[0.010]*
ur_urbosCMA	-0.00492	-0.004	-0.00270	-0.00220	-0.00146	0.00148
	[0.005]	*[0.005]*	*[0.005]*	*[0.007]*	*[0.007]*	*[0.007]*
ur_rurosCMA	-0.00465	-0.004	-0.00295	-0.00688	-0.00573	-0.00332
	[0.004]	*[0.004]*	*[0.004]*	*[0.007]*	*[0.007]*	*[0.007]*
ur_2urbcore	-0.02147	-0.021*	-0.02023	0.04263*	0.04433*	0.0453*
	[0.009]	*[0.009]*	*[0.009]*	*[0.021]*	*[0.021]*	*[0.021]*
age	-0.00059	-0.001	-0.00064	-0.00132	-0.00128	-0.00130
	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***	*[0.000]***
eth_Black	-0.00690	-0.007		-0.01258	-0.01185	
	[0.014]	*[0.014]*		*[0.024]*	*[0.024]*	
eth_Asian	-0.03135	-0.033		-0.09046	-0.09250	
	*[0.008]***	*[0.008]***		*[0.013]***	*[0.013]***	
eth_SEAsian	0.01018	0.008		-0.01469	-0.01562	
	[0.015]	*[0.014]*		*[0.022]*	*[0.022]*	
eth_SAsian	-0.02098	-0.022		-0.01414	-0.01522	
	*[0.008]**	*[0.008]***		*[0.022]*	*[0.021]*	
eth_MidEast	-0.02021	-0.022		0.00425	0.00186	
	[0.014]	*[(0.014]*		*[0.034]*	*[0.034]*	
eth_LatAm	0.02326	0.021		-0.05351	-0.05433	
	[0.026]	*[0.026]*		*[0.022]**	*[0.022]**	
eth_Aboriginal	0.01788	0.019		0.04983	0.05013	
	[0.013]	*[0.013]*		*[0.0167]***	*[0.016]***	
eth_other	0.00823	0.007		-0.03032	-0.03182	
	[0.017]	*[0.017]*		*[0.018]*	*[0.017]*	
minority			0.00896			0.03108
			[0.005]			*[0.008]***
ed10_g8less	-0.00725			0.02070		
	[0.008]			*[0.017]*		
ed10_g9g10	0.01725			0.00380		
	[0.009]			*[0.0137]*		
ed10_g11g13	0.02344			0.02487		
	*[0.011]**			*[0.015]*		
ed10_somepostsec	0.00202			0.01071		
	[0.007]			*[0.010]*		
ed10_tradedip	0.00639			0.02721		
	[0.005]			*[0.010]***		
ed10_collegedip	0.00003			0.02020		
	[0.005]			*[0.008]***		
ed10_unicert	-0.00450			-0.01149		
	[0.008]			*[0.013]*		
ed10_BAdegree	-0.00824			-0.00137		
	[0.005]			*[0.009]*		
ed10_BAplus	-0.00493			0.02448		
	[0.007]			*[0.013]*		
ed04_hsless		0.013	0.01339		0.01444	0.01577
		*[0.006]**	*[0.007]**		*[0.010]*	*[0.010]*
ed04_somepostsec		0.002	0.00199		0.01102	0.01335
		[0.007]	*[0.007]*		*[0.010]*	*[0.010]*
ed04_postsecgrad		-0.001	-0.00145		0.01389	0.01416
		[0.004]	*[0.004]*		*[0.006]**	*[0.007]**
hhinc_5000less	0.00494	0.005	0.00626	-0.02070	-0.01997	-0.01912
	[0.022]	*[0.022]*	*[0.022]*	*[0.026]*	*[0.026]*	*[0.026]*
hhinc_5000	0.03621	0.035	0.03647	0.03249	0.03417	0.03402
	*[0.013]***	*[0.013]***	*[0.013]***	*[0.019]*	*[0.019]*	*[0.019]*
hhinc_10000	0.02727	0.027	0.02753	0.03401	0.03594	0.03905
	*[0.013]**	*[0.013]**	*[0.013]**	*[0.013]***	*[0.013]***	*[0.013]***
hhinc_15000	0.03475	0.034	0.03317	0.02489	0.02711	0.03168
	*[0.014]**	*[0.014]**	*[0.013]**	*[0.014]*	*[0.014]*	*[0.015]**
hhinc_20000	0.01162	0.012	0.01153	0.00928	0.01114	0.01295
	[0.007]	*[0.008]*	*[0.008]*	*[0.009]*	*[0.009]*	*[0.009]*
hhinc_30000	0.00783	0.009	0.00852	0.00153	0.00340	0.00504
	[0.006]	*[0.006]*	*[0.006]*	*[0.009]*	*[0.008]*	*[0.009]*
hhinc_40000	-0.00867	-0.008	-0.00814	-0.00173	0.00008	0.00099
	[0.005]	*[0.005]*	*[0.005]*	*[0.009]*	*[0.009]*	*[0.009]*
hhinc_50000	0.00029	0.001	0.00103	0.00036	0.00175	0.00290
	[0.006]	*[0.006]*	*[0.006]*	*[0.009]*	*[0.009]*	*[0.009]*
hhinc_60000	0.00502	0.006	0.00604	-0.01061	-0.00940	-0.00851
	[0.005]	*[0.005]*	*[0.005]*	*[0.007]*	*[0.007]*	*[0.007]*
hrwage	0.00000	0.000	-0.00001	-0.00015	-0.00017	-0.00016
	[0.000]	*[0.000]*	*[0.000]*	*[0.000]*	*[0.000]*	*[0.000]*
Observations	56225	56225	56225	59200	59200	59200
LogLike	-13318.23	-13352.43	-13367.56	-26508.52	-26530.03	-26602.65

Robust standard errors in brackets
* significant at 5%; ** significant at 1%

***

Across the three chronic conditions, and looking at the results of the linear probability model, there were several interesting findings with respect to socio-demographic factors. Firstly, regardless of gender, age raised the marginal probability for hypertension and heart disease, as expected; but aging lowered the likelihood of having diabetes. The marginal probabilities were found in all three chronic conditions to be statistically significant at the 5% level.

Compared to the White reference group, Black males and females have a higher marginal probability for hypertension of about 6 percentage points, whereas it was negative for Asian women of about the same magnitude. Surprisingly, however, both Black and Asian males had a lower marginal likelihood for having heart disease. Latin Americans, South Asian males and South East Asian women seem also to share the lower marginal probability of heart disease, compared to their White counterparts. Also, the comparative marginal probability for having diabetes was about 6 percentage points lower for Latin American women, but was, on average, 5 percentage points higher if the respondent was an Aboriginal woman.

Noteworthy is the effect of education attainment on each chronic condition – lower marginal probability for having each condition was associated with higher educational attainment, but the estimates were generally statistically not significant. On the other hand, estimates of the marginal probabilities from a one-dollar increase in hourly wage were statistically significant at the 5% level for all three conditions. While hourly wage decreased the marginal likelihood of having each chronic condition, the magnitudes were very minute—less than 0.1 percentage points. Higher household income was found, for the most part, to decrease the marginal likelihood of having each of the three conditions. Yet, household income neither bore a statistically significant effect on the marginal probability for hypertension of males, nor on the marginal probabilities of having diabetes. The marginal benefit of higher household income on the marginal probability of having diabetes also appeared to have a statistically insignificant effect beyond an income level of about $40,000 - $60,000. These findings on household income were not surprising since affliction with one of the chronic conditions is non-discriminating.

5.4 Canadian Overview – Outcomes of Physical Activity Index

The results of an ordered probit model revealed the effects of urban form on a ranking of physical activity levels. Table 17 reports the probabilities associated with each physical activity level calculated from the based on the normal distribution using the cut points computed by the ordered probit. On average, across the three specifications, the probability of being *active*, *moderately active* and *inactive* among the males was nearly 43.6 percentage points, 26.4 percentage points and 30 percentage points, respectively. Among the females, these probabilities were reversed at approximately 29 percentage points, 29 percentage points and 42 percentage points, respectively.

Table 17: Calculated Probabilities from Ordered Probit Model of Physical Activity Index

	MALE			FEMALE		
phys_index	-1	-2	-3	-1	-2	-3
cut 1	-0.12601***	-0.10350***	-0.25277***	-0.49759***	-0.47159***	-0.67994***
	(0.033)	*(0.033)*	*(0.040)*	*(0.035)*	*(0.034)*	*(0.040)*
cut 2	0.56251***	0.58322***	0.43300***	0.26330***	0.28802***	0.07887**
	(0.033)	*(0.033)*	*(0.040)*	*(0.035)*	*(0.034)*	*(0.040)*
Probabilities						
active	0.4499	0.4588	0.4002	0.3094	0.3186	0.2483
moderate	0.2633	0.2613	0.2673	0.2945	0.2947	0.2832
inactive	0.2869	0.2799	0.3325	0.3962	0.3867	0.4686
Observations	55916	55916	55916	59164	59164	59164
LogLike	-57979	-58090	-58148	-60679	-60753	-60799

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 18: Marginal Effects for Ordered Probit of Physical Activity Index – Male Results

	MALE								
	-1			-2			-3		
COEFFICIENT	active	moderate	inactive	active	moderate	inactive	active	moderate	inactive
ur_urbfringe	0.03385*	0.00569**	-0.03954*	0.02936	0.00504**	-0.03441*	0.03208*	0.00539**	-0.03747*
	(0.018)	*(0.002)*	*(0.020)*	*(0.018)*	*(0.003)*	*(0.020)*	*(0.018)*	*(0.002)*	*(0.020)*
ur_rurfringe	0.01005	0.00197	-0.01202	0.00294	0.00059	-0.00353	0.00433	0.00087	-0.00520
	(0.010)	*(0.002)*	*(0.011)*	*(0.009)*	*(0.002)*	*(0.011)*	*(0.009)*	*(0.002)*	*(0.011)*
ur_urbosCMA	0.01139	0.00222	-0.01360	0.00350	0.00071	-0.00421	0.00730	0.00144	-0.00873
	(0.007)	*(0.001)*	*(0.009)*	*(0.008)*	*(0.002)*	*(0.009)*	*(0.008)*	*(0.001)*	*(0.009)*
ur_rurosCMA	-0.01970***	-0.00446***	0.02416***	-0.02770***	-0.00646***	0.03416***	-0.02450***	-0.00561***	0.03011***
	(0.007)	*(0.002)*	*(0.008)*	*(0.007)*	*(0.002)*	*(0.008)*	*(0.007)*	*(0.002)*	*(0.008)*
ur_2urbcore	-0.03823**	-0.00980*	0.04803*	-0.04395**	-0.01153*	0.05548**	-0.04147**	-0.01070*	0.05217**
	(0.019)	*(0.006)*	*(0.025)*	*(0.019)*	*(0.006)*	*(0.025)*	*(0.019)*	*(0.006)*	*(0.025)*
age	-0.00305***	-0.00063***	0.00368***	-0.00311***	-0.00064***	0.00375***	-0.00313***	-0.00064***	0.00378***
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
eth_Black	0.03508	-0.00883	0.04391	-0.03140	-0.00770	0.03910			
	(0.023)	*(0.007)*	*(0.030)*	*(0.023)*	*(0.007)*	*(0.030)*			
eth_Asian	-0.08971***	-0.02926***	0.11897***	-0.07807***	-0.02396***	0.10203***			
	(0.015)	*(0.007)*	*(0.021)*	*(0.015)*	*(0.006)*	*(0.021)*			
eth_SEAsian	-0.10313***	-0.03647***	0.13961***	-0.10027***	-0.03476***	0.13503***			
	(0.019)	*(0.010)*	*(0.029)*	*(0.019)*	*(0.010)*	*(0.029)*			
eth_SAsian	-0.07767***	-0.02398***	0.10166***	-0.06958***	-0.02054***	0.09011***			
	(0.016)	*(0.007)*	*(0.023)*	*(0.016)*	*(0.007)*	*(0.0231)*			
eth_MidEast	-0.06249**	-0.01820	0.08069**	-0.04897	-0.01322	0.06219			
	(0.029)	*(0.011)*	*(0.041)*	*(0.030)*	*(0.010)*	*(0.040)*			
eth_LatAm	-0.05011	-0.01370	0.06381	-0.04309	-0.01128	0.05437			
	(0.032)	*(0.011)*	*(0.04)*	*(0.032)*	*(0.010)*	*(0.043)*			
eth_Aboriginal	0.05260***	0.00771***	-0.06031***	0.05018**	0.00743***	-0.05760***			
	(0.020)	*(0.002)*	*(0.022)*	*(0.020)*	*(0.002)*	*(0.022)*			
eth_other	-0.00942	-0.00206	0.01148	-0.00504	-0.00107	0.00610			
	(0.019)	*(0.004)*	*(0.024)*	*(0.019)*	*(0.004)*	*(0.024)*			
minority							0.04833***	0.01200***	-0.06033***
							(0.008)	*(0.002)*	*(0.010)*
ed10_g8less	-0.06997***	-0.02079***	0.09076***						
	(0.013)	*(0.005)*	*(0.018)*						
ed10_g9g10	-0.05661***	-0.01559***	0.07220***						
	(0.011)	*(0.004)*	*(0.014)*						
ed10_g11g13	-0.00522	-0.00111	0.00633						
	(0.014)	*(0.003)*	*(0.017)*						
ed10_somepostsec	0.03693***	0.00629***	-0.04322***						
	(0.011)	*(0.002)*	*(0.013)*						
ed10_tradedip	-0.01564*	-0.00345*	0.01909*						
	(0.008)	*(0.002)*	*(0.010)*						
ed10_collegedip	0.01238	0.00244	-0.01482						
	(0.008)	*(0.002)*	*(0.010)*						
ed10_unicert	0.04128***	0.00663***	-0.04792***						
	(0.015)	*(0.002)*	*(0.017)*						
ed10_BAdegree		0.00803***	-0.05630***						
	(0.010)	*(0.001)*	*(0.011)*						
ed10_BAplus	0.07083***	0.00972***	-0.08055***						
	(0.012)	*(0.001)*	*(0.013)*						
ed04_hsless				-0.04220***	-0.01041***	0.05261***	-0.04060***	-0.00991***	0.05051***
				(0.009)	*(0.003)*	*(0.011)*	*(0.009)*	*(0.003)*	*(0.011)*
ed04_somepostsec				0.03552***	0.00605***	-0.04158***	0.03553***	0.00603***	-0.04156***
				(0.011)	*(0.002)*	*(0.013)*	*(0.011)*	*(0.002)*	*(0.013)*
ed04_postsecgrad				0.02050***	0.00433***	-0.02482***	0.01978***	0.00415***	-0.02393***
				(0.007)	*(0.001)*	*(0.008)*	*(0.007)*	*(0.001)*	*(0.008)*
hhinc_5000less	-0.01960	-0.00455	0.02414	-0.02502	-0.00595	0.03097	-0.02569	-0.00611	0.03179
	(0.036)	*(0.009)*	*(0.046)*	*(0.035)*	*(0.009)*	*(0.044)*	*(0.035)*	*(0.009)*	*(0.044)*
hhinc_5000	-0.05522***	-0.01551**	0.07073***	-0.06378**	-0.01861***	0.08239***	-0.06141***	-0.01764***	0.07905***
	(0.017)	*(0.006)*	*(0.024)*	*(0.017)*	*(0.006)*	*(0.023)*	*(0.017)*	*(0.006)*	*(0.024)*
hhinc_10000		-0.00911**	0.04516**	-0.04250***	-0.01104**	0.05353***	-0.04012***	-0.01026**	0.05039**
	(0.015)	*(0.005)*	*(0.020)*	*(0.015)*	*(0.005)*	*(0.020)*	*(0.015)*	*(0.005)*	*(0.020)*
hhinc_15000	-0.07944***	-0.02498***	0.10442***	-0.08656***	-0.02799***	0.11455***	-0.08574***	-0.02753***	0.11326***
	(0.014)	*(0.006)*	*(0.020)*	*(0.014)*	*(0.006)*	*(0.020)*	*(0.014)*	*(0.006)*	*(0.020)*
hhinc_20000		-0.02198***	0.09611***	-0.08164***	-0.02487***	0.10652***	-0.08136***	-0.02468***	0.10604***
	(0.009)	*(0.004)*	*(0.013)*	*(0.009)*	*(0.004)*	*(0.013)*	*(0.009)*	*(0.004)*	*(0.013)*
hhinc_30000	-0.08195***	-0.02463***	0.10657***	-0.08938***	-0.02753***	0.11691***	-0.08959***	-0.02752***	0.11711***
	(0.008)	*(0.003)*	*(0.011)*	*(0.008)*	*(0.003)*	*(0.011)*	*(0.008)*	*(0.003)*	*(0.011)*
hhinc_40000	-0.07924***	-0.02334***	0.10257***	-0.08729***	-0.02640***	0.11369***	-0.08819***	-0.0267***	0.11486***
	(0.008)	*(0.003)*	*(0.011)*	*(0.008)*	*(0.003)*	*(0.011)*	*(0.008)*	*(0.003)*	*(0.011)*
hhinc_50000	-0.05695***	-0.01525***	(0.011)	-0.06364***	-0.01741***	0.08105***	-0.06437***	-0.01761***	0.08198***
	(0.008)	*(0.003)*	*(0.011)*	*(0.008)*	*(0.003)*	*(0.011)*	*(0.008)*	*(0.003)*	*(0.011)*
hhinc_60000	-0.05514***	-0.01384***	0.06898***	-0.06094***	-0.01549***	0.07643***	-0.06108***	-0.01548***	0.07656***
	(0.007)	*(0.002)*	*(0.008)*	*(0.006)*	*(0.002)*	*(0.008)*	*(0.006)*	*(0.002)*	*(0.008)*
hrwage	0.00020**	0.00004**	-0.00024**	0.000278***	0.00006***	-0.00033***	0.00027***	0.00006***	-0.00033***
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Observations		55916			55916			55916	
LogLike		-57979			-58090			-58148	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 19: Marginal Effects for the Ordered Probit of Physical Activity Index - Female Results

	FEMALE								
	-1			-2			-3		
COEFFICIENT	active	moderate	inactive	active	moderate	inactive	active	moderate	inactive
ur_urbfringe	0.04752***	0.01220***	-0.05971***	0.04520***	0.01170***	-0.05690***	0.04678***	0.01198***	-0.05875***
	(0.014)	*(0.003)*	*(0.017)*	*(0.014)*	*(0.003)*	*(0.017)*	*(0.014)*	*(0.003)*	*(0.017)*
ur_rurfringe	0.01704*	0.00517**	-0.02221**	0.01472*	0.00450*	-0.01922*	0.01634*	0.00494**	-0.02128*
	(0.009)	*(0.003)*	*(0.011)*	*(0.009)*	*(0.003)*	*(0.011)*	*(0.009)*	*(0.002)*	*(0.011)*
ur_urbosCMA	0.02356***	0.00694***	-0.03050***	0.01996***	0.00596***	-0.02591***	0.02286***	0.00671***	-0.02957***
	(0.007)	*(0.003)*	*(0.009)*	*(0.007)*	*(0.002)*	*(0.009)*	*(0.007)*	*(0.002)*	*(0.009)*
ur_rurosCMA	0.00620	0.00198	-0.00818	0.00189	0.00061	-0.00250	0.00431	(0.002)	-0.00569
	(0.006)	*(0.002)*	*(0.008)*	*(0.006)*	*(0.002)*	*(0.008)*	*(0.006)*	*(0.002)*	*(0.008)*
ur_2urbcore	-0.02038	-0.00738	0.02777	-0.02526	-0.00933	0.03459	-0.02438	-0.00894	0.03332
	(0.018)	*(0.007)*	*(0.025)*	*(0.018)*	*(0.007)*	*(0.025)*	*(0.018)*	*(0.007)*	*(0.025)*
age	-0.00138***	-0.00045***	0.00183***	-0.00146***	-0.00048***	0.00193***	-0.00147***	-0.00048***	0.00195***
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
eth_black	-0.05016**	-0.02089**	0.07105**	-0.05140**	-0.02145**	0.07285**			
	(0.020)	*(0.010)*	*(0.031)*	*(0.020)*	*(0.011)*	*(0.031)*			
eth_Asian	-0.09398***	-0.04702***	0.14100***	-0.08991***	-0.04402***	0.13393***			
	(0.011)	*(0.008)*	*(0.019)*	*(0.011)*	*(0.008)*	*(0.019)*			
eth_SEAsian	-0.07192***	-0.03308***	0.10499***	-0.07210***	-0.03306***	0.10516***			
	(0.018)	*(0.010)*	*(0.029)*	*(0.018)*	*(0.011)*	*(0.029)*			
eth_SAsian	-0.06060***	-0.02639***	0.08699***	-0.05651***	-0.02406**	0.08056***			
	(0.018)	*(0.010)*	*(0.028)*	*(0.018)*	*(0.010)*	*(0.027)*			
eth_MidEast	-0.10176***	-0.05436***	0.15612***	-0.09850***	-0.05160***	0.15009***			
	(0.025)	*(0.020)*	*(0.044)*	*(0.025)*	*(0.019)*	*(0.044)*			
eth_LatAm	-0.05279**	-0.02235*	0.07515**	-0.05208**	-0.02189*	0.07397589**			
	(0.022)	*(0.012)*	*(0.034)*	*(0.023)*	*(0.012)*	*(0.034)*			
eth_Aboriginal	0.01040	0.00324	-0.01364	0.00851	0.00266	-0.01117			
	(0.015)	*(0.005)*	*(0.020)*	*(0.015)*	*(0.005)*	*(0.020)*			
eth_other	-0.02332	-0.00855	0.03187	-0.02118	-0.00766	0.02884			
	(0.017)	*(0.007)*	*(0.024)*	*(0.017)*	*(0.007)*	*(0.024)*			
white							0.05873***	0.02338***	-0.08211***
							(0.007)	*(0.003)*	*(0.010)*
ed10_g8less	-0.07169***	-0.03270***	0.10439***						
	(0.012)	*(0.007)*	*(0.018)*						
ed10_g9g10	-0.07256***	-0.03294***	0.10551***						
	(0.010)	*(0.006)*	*(0.015)*						
ed10_g11g13	-0.03516***	-0.01358***	0.04874***						
	(0.012)	*(0.005)*	*(0.017)*						
ed10_somepostsec	0.02195**	0.00655**	-0.02850**						
	(0.010)	*(0.003)*	*(0.013)*						
ed10_tradedip	0.00196	0.00064	-0.00260						
	(0.009)	*(0.003)*	*(0.012)*						
ed10_collegedip	0.02169***	0.00672***	-0.02841***						
	(0.007)	*(0.002)*	*(0.009)*						
ed10_unicert	0.03557***	0.00980***	-0.04537***						
	(0.013)	*(0.003)*	*(0.016)*						
ed10_BAdegree	0.05030***	0.01384***	-0.06414***						
	(0.008)	*(0.002)*	*(0.010)*						
ed10_BAplus	0.07963***	0.01773***	-0.09736***						
	(0.012)	*(0.002)*	*(0.014)*						
ed04_hsless				-0.05931***	-0.02441***	0.08371***	-0.05824***	-0.02381***	0.08204***
				(0.008)	*(0.004)*	*(0.011)*	*(0.008)*	*(0.004)*	*(0.011)*
ed04_somepostsec				0.02131**	0.00635**	-0.02766**	0.02264**	0.00669**	-0.02933**
				(0.010)	*(0.003)*	*(0.013)*	*(0.010)*	*(0.003)*	*(0.013)*
ed04_postsecgrad				0.03085***	0.01047***	-0.04132***	0.03086***	0.01045***	-0.04131***
				(0.006)	*(0.002)*	*(0.008)*	*(0.006)*	*(0.002)*	*(0.008)*
hhinc_5000less	-0.03705	-0.01458	0.05163	-0.04039	-0.01610	0.05648	-0.04137	-0.01653	0.05790
	(0.026)	*(0.012)*	*(0.038)*	*(0.026)*	*(0.012)*	*(0.038)*	*(0.026)*	*(0.012)*	*(0.038)*
hhinc_5000	-0.03578**	-0.01396*	0.04974*	-0.04254**	-0.01706**	0.05960**	-0.04169**	-0.01661**	0.05830**
	(0.018)	*(0.008)*	*(0.027)*	*(0.018)*	*(0.009)*	*(0.026)*	*(0.017)*	*(0.008)*	*(0.026)*
hhinc_10000	-0.05590***	-0.02373***	0.07963***	-0.06278***	-0.02738***	0.09016***	-0.06126***	-0.02647***	0.08773***
	(0.010)	*(0.005)*	*(0.015)*	*(0.010)*	*(0.005)*	*(0.015)*	*(0.010)*	*(0.005)*	*(0.015)*
hhinc_15000	(0.010)	-0.02035***	0.06975***	-0.05611**	-0.02373***	0.07984***	-0.05524***	-0.02320***	0.07844***
	(0.010)	*(0.005)*	*(0.016)*	*(0.010)*	*(0.006)*	*(0.016)*	*(0.010)*	*(0.005)*	*(0.016)*
hhinc_20000	-0.05709***	-0.02371***	0.08080***	-0.06446***	-0.02746***	0.09192***	-0.06347***	-0.02687***	0.09034***
	(0.007)	*(0.004)*	*(0.011)*	*(0.007)*	*(0.004)*	*(0.011)*	*(0.007)*	*(0.004)*	*(0.011)*
hhinc_30000	-0.05035***	-0.02014***	0.07049***	-0.05682***	-0.02322***	0.08003***	-0.05631***	-0.02290***	0.07921***
	(0.007)	*(0.003)*	*(0.010)*	*(0.007)*	*(0.003)*	*(0.010)*	*(0.007)*	*(0.003)*	*(0.011)*
hhinc_40000	-0.04652***	-0.01831***	0.06483***	-0.052056***	-0.02085***	0.07291***	-0.05226***	-0.02090***	0.07316***
	(0.008)	*(0.004)*	*(0.011)*	*(0.008)*	*(0.004)*	*(0.011)*	*(0.008)*	*(0.004)*	*(0.011)*
hhinc_50000	-0.04678***	-0.01843***	0.06522***	-0.05229***	-0.02096***	0.07325***	-0.05196***	-0.02075***	0.07271***
	(0.007)	*(0.003)*	*(0.011)*	*(0.007)*	*(0.004)*	*(0.011)*	*(0.007)*	*(0.003)*	*(0.011)*
hhinc_60000	-0.03359***	-0.01224***	0.04583***	-0.03750***	-0.01378***	0.05128***	-0.03727***	-0.01365***	0.05092***
	(0.006)	*(0.003)*	*(0.008)*	*(0.006)*	*(0.003)*	*(0.009)*	*(0.006)*	*(0.003)*	*(0.009)*
hrwage	0.00010	0.00003	-0.00014	0.00014*	0.00005*	-0.00019*	0.00015**	0.00005**	-0.00020**
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Observations		59164			59164			59164	
LogLike		-60679			-60753			-60799	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The marginal effect of urban form on these above probabilities for being *active*, *moderately active* and *inactive* compared to those living in the urban core, all else held equal, are all reported in Tables 18 and 19. We, again, tested which specification is most preferred among the three for males and females. Using two sets of two likelihood ratio tests which tested the preferred specifications between (2) and (3), and between (1) and (2), we found specification (1) to be undoubtedly preferred, so we speak to these estimates.

Males living in the urban fringe or rural fringe as well as the urban area outside the CMA had a positive marginal probability of being active and moderately active, and negative marginal likelihood of inactive. Moreover, the marginal probabilities associated with living in the urban fringe are significant at the 10% level in the three specifications, increasing the probability of being *active* and *moderately active* by 3.4 percentage points and 0.57 percentage points, while decreasing that of being *inactive* by nearly 4 percentage points. By contrast, living in the rural area beyond the CMA or the secondary urban core increased the probability of being *inactive* by 2.4 percentage points and 4.8 percentage points, while both decreased that of *active* or *moderately active* lifestyles by as total of nearly 6 percentage points and 1.3 percentage points. These estimates were statistically significant.

For females, the results in four of the five urban forms were associated with increasing the marginal likelihood for being *active* and *moderately active*, while decreasing that of inactivity, compared to living in the urban core. The only form for which the marginal effects were reversed is that of the secondary urban core. The estimates associated with living in the urban fringe and rural fringe within the CMA and the urban area outside the CMA were found to be statistically significant. Most significant is the effect due to the urban area within the CMA. The probability of being *active* and *moderately active* was estimated to increase by 4.8 percentage points and 1.2 percentage points, while being *inactive* was estimated to decrease by almost 6 percentage points. The results of this dimension of health outcomes finds that living in an urban form closer to the urban core generally improves health outcomes, as we had initially hypothesized. Higher rates of activity are associated with urban forms closer to the urban core for males and females.

***

Consistent with observed effects in society, aging decreases the marginal probability of being physically active or moderately active, while raising the marginal probability of being inactive. Asians, South East Asians, South Asians, Aboriginals and Middle Eastern peoples were all more likely to be less active compared to their White counterparts. The estimates of the difference are statistically significant at the 1% level.

Being more educated is also associated with inactivity at the 1% statistical significance level. This is not surprising since employment for higher educated individuals are less likely to involve manual labour, which has implications on daily energy expenditure and thus on physical activity index. Similarly, a higher wage or a higher opportunity cost of time is associated with an increased marginal probability of inactivity and decreased marginal probability for an active lifestyle, though the magnitudes of the effects are small. As expected, higher household incomes afford greater recreation and leisure opportunities, which is reflected in the lower marginal probability for inactivity, while higher for that of active or moderately active levels. Socio-demographic factors were statistically significant in the analysis of physical activity as were the geographic urban form factors, providing strong evidence of the relationship between urban form and physical activity levels.

6 Conclusion

Pooling together the 2003 and 2005 cycles of the Canadian Community Health Survey, we explored the relationship between urban forms and health outcomes in Canada. Urban forms were defined by the urban core, urban fringe and rural fringe within the CMA, urban and rural areas outside the CMA and a secondary urban core. Closest to the urban core are the urban forms within the CMA — the urban and rural fringes, and the secondary urban core. Farthest were the two forms beyond the CMA. Health outcome was characterized in four ways – body mass index; rating of self-perceived health; incidences of diabetes, heart disease and hypertension; and a physical activity index. These four measures were considered to provide a multidimensional view of health effects of where we live. Using the standard econometric model but adapting it for each dimension we examined, we used ordinary least square regressions, linear probability models, probit regressions and ordered probit regressions to investigate the relationships. We examined results for evidence that urban forms farther away from the urban core are associated with poorer health, defined by higher BMI, higher probability for being overweight and obese, higher risk for a chronic condition and/or lower physical activity level.

Based on our findings, there was evidence that urban form does indeed affect health outcomes. However, our results suggested that the effects vary for several dimensions of health outcomes, and vary with gender. Generally, between the two genders, we found that the relationship found in American studies also appears in the Canadian context: urban forms farther away from the urban core are associated with slightly higher BMI and increased probability of being overweight or obese. Interestingly, between the genders, we found more statistical significance in the estimates of the effects on males. Male BMI and their probability for higher BMI are greatest for the urban forms within the CMA, but this pattern is reversed for females. The greatest marginal effects on BMI and the probability of being overweight and obese are associated with urban forms outside of the CMA, as theory would suggest. However, the estimates were often found to be statistically insignificant.

Estimates which were also found to be predominantly significant were the results of the analysis on physical activity levels. As expected, urban forms closer to the urban core were associated with greater positive marginal probabilities of being active and moderately active of greater magnitudes, as well as a decreased chance of being inactive. However, all forms, except for the living in the rural area outside of the CMA and in the secondary urban core, had positive marginal probabilities. This would imply living in the urban core is associated with having a lower probability of being active and moderately active compared to living in, say, the urban fringe. The results for male and female were similar.

Where our results were not consistent with to our hypothesis is with the analysis of self-perceived health and incidence of chronic conditions. The effects of urban form on self-perceived health are not particularly evident to the individual. Estimates were both minimal in magnitude and usually insignificant. Our analysis also suggested that the probabilities of having hypertension, heart disease and diabetes are not significantly affected by urban form, perhaps because the link is too weak or indirect.

The estimated effects of our socio-demographic variables were also consistent with expected effects and similar to that found in previous studies. Age was a significant factor for health outcomes; it tended to have a negative influence on health outcomes of both male and females. Also, as we suspected, household income and the opportunity cost of time were most directly positive influences on the marginal probability of physical activity. For chronic conditions, not only was household income found to not significantly affect the marginal probabilities of having hypertension in males or diabetes, there also appeared to be a threshold effect beyond which higher household income did not significantly change the likelihood of having heart disease. While hourly wage was statistically significant at the 5% levels, the magnitudes were negligible.

While the marginal effects attributed to various ethnicities were largely insignificant in the analysis of BMI and self-rated health, more estimates were statistically significant in the analysis on physical activity levels and incidence of the chronic conditions. Compared to ethnic Whites, Blacks had higher marginal probability for hypertension, while the reverse was found for Asian females. The marginal likelihood for having heart disease for Latin Americans was negative, as was that for Asian, Black and South Asian males as well as Southeast Asian females. Aboriginal females also faced a higher marginal probability for diabetes.

Overall, our findings do indeed lend evidence to support the flow representation we described earlier in the study. Urban forms most directly affect physical activity levels as we had predicted. More indirect are the estimated effects of urban form on changes to BMI and the effects on the incidence of chronic conditions and to self-perceived health, in this order.

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Appendix

These test statistics were compared to the following critical values:

$F(7, \infty) = 2.01$ $F(6, \infty) = 2.10$

$\chi^2(7, \infty) = 14.07$ $\chi^2(6, \infty) = 12.59$

Conducting Specification Tests of the Ordinary Least Squares Model of BMI

Male:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, F-statistic
  = [(1160247.6 – 1145216.75)/7]/[1145216.75/(56233 - 26)] = 105.387

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, F-statistic
  = [(1145216.75 – 1137167.42)/6]/[1137167.42/(53233 – 37)] = 49.736

  Conclusion: Reject the null hypothesis

Female:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, F-statistic
  = [(1668664.26 - 1642766.95)/7]/[1642766.95/(59212 – 26)] = 133. 291

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, F-statistic
  = [(1642766.95 – 1635020.41)/ 6]/[1635020.41/(59212 – 37)] = 116.629

  Conclusion: Reject the null hypothesis

Conducting Specification Tests of the Linear Probability Model of BMI

Male:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, F-statistic
  = [(8648.51 – 8600.67)/7]/[8600.67/(56233 – 26)] = 44.663

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, F-statistic
  = [(8600.67 – 8573.88)/ 6]/[8573.88/(56233 – 37)] = 29.265

  Conclusion: Reject the null hypothesis

Female:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, F-statistic
  = [(7678.53 – 7633.08)/7]/[7633.08/(59212 – 26)] = 50.345

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, F-statistic
  = [(7633.08 – 7616.95)/ 6]/[7633.08/(59212– 37)] = 20.885

  Conclusion: Reject the null hypothesis

Conducting Specification Tests of the Probit Model of BMI

Male:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, likelihood ratio
  = -2 * [(-26996.94) – (-27202.33)] = 410.780

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, likelihood ratio
  = -2 * [(-26905.89) – (-26996.94)] = 182.100

  Conclusion: Reject the null hypothesis

Female:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, likelihood ratio
  = -2 * [(-25103.11) – (-24855.77)] = 494.680

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, likelihood ratio
  = -2 * [(-24855.77) – (-24784.72)] = 142.100

  Conclusion: Reject the null hypothesis

Conducting Specification Tests of the Ordered Probit Model for BMI

Male:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, likelihood ratio
  = -2 * [(-58264) – (-57853)] = 822.00

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, likelihood ratio
  = -2 * [(-57853) – (-57697)] = 312.00

  Conclusion: Reject the null hypothesis

Female:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, likelihood ratio
  = -2 * [(-61874) – (-61332)] = 1084.00

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, likelihood ratio
  = -2 * [(-61332 – (-61203)] = 258

  Conclusion: Reject the null hypothesis

Conducting Specification Tests of the Ordered Probit Model for Self-Perceived Health

Male:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, likelihood ratio

  = -2 * [(-71535) – (-71478)] = 114.00

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, likelihood ratio

  = -2 * [(-71478) – (71213)] = 530.00

  Conclusion: Reject the null hypothesis

Female:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, likelihood ratio
  = -2 * [(-75969) – (-75948)] = 42.00

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, likelihood ratio
  = -2 * [(-74948) – (-75773)] = 350.00

  Conclusion: Reject the null hypothesis

Conducting Specification Tests of the Linear Probability Model of Hypertension

Male:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, F-statistic

  = [(5595.1 - 5590.26)/7]/[5590.26/(56180– 26)] = 6.945

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, F-statistic

  = [(5590.26 - 5583.84)/ 6]/[5583.84/(56180 – 37)] = 10.758

  Conclusion: Reject the null hypothesis

Female:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, F-statistic

  = [(5118.49 - 5110.99)/7]/[-5110.99/(59192 – 26)] = 12.403

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, F-statistic

  = [(5110.99 – 5099.06)/ 6]/[-5099.06/(59192 – 37)] = 23.067

  Conclusion: Reject the null hypothesis

Conducting Specification Tests of the Probit Model of Hypertension

Male:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, likelihood ratio
  = -2 * [(-18435.92) – (-18408.01)] = 55.820

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, likelihood ratio
  = -2 * [(-18408.01) – (-18376.13)] = 63.760

  Conclusion: Reject the null hypothesis

Female:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, likelihood ratio
  = -2 * [(-16991.05) – (-16902.79)] = 176.520

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, likelihood ratio
  = -2 * [(-16902.79) – (-16883.11)] = 39.360

  Conclusion: Reject the null hypothesis

Conducting Specification Tests of the Linear Probability Model of Heart Disease

Male:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, F-statistic
  = [(1821.81 – 1820.12)/7]/[1820.12/(56218 – 26)] = 7.454

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, F-statistic
  = [(1820.12 – 1818.54)/5]/[1818.54/(56218 – 37)] = 8.135

  Conclusion: Reject the null hypothesis

Female:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, F-statistic
  = [(1244.27 – 1243.98)/7]/[1243.98/(59192 – 26)] = 1.970

  Conclusion: Fail to reject null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, F-statistic
  = [(1243.98 – 1243.13)/5]/[1243.12/(59192 – 37)] = 6.741

  Conclusion: Reject the null hypothesis

Conducting Specification Tests of the Probit Model of Heart Disease

Male:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, likelihood ratio

  = -2 * [(-7273.6) – (-7239.23)] = 68.740

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, likelihood ratio

  = -2 * [(-7239.23) – (-7221.69)] = 35.080

  Conclusion: Reject the null hypothesis

Female:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, likelihood ratio

  = -2 * [(-5610.05) – (-5596.79)] = 26.520

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, likelihood ratio

  = -2 * [(-5596.79) – (-5582.87)] = 27.840

  Conclusion: Reject the null hypothesis

Conducting Specification Tests of the Linear Probability Model of Diabetes

Male:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, F-statistic

  = [(3382.23 – 3378.54)/7]/[3378.54/(56225 – 37)] = 8.769

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, F-statistic

  = [(3378.64 – 3376.43)/6]/[3376.43/(56225 – 26)] = 5.852

  Conclusion: Reject the null hypothesis

Female:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, F-statistic

  = [(8209 – 8191.54)/7]/[8191.54/(59200 – 37)] = 18.018

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, F-statistic

  = [(8191.54 – 8185.56)/6]/[8185.56/(59200 – 26)] = 7.203

  Conclusion: Reject the null hypothesis

Conducting Specification Tests of the Probit Model of Diabetes

Male:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, likelihood ratio

  = -2 * [(-13367.56) – (-13352.43)] = 30.260

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, likelihood ratio

  = -2 * [(-13352.43) – (-13318.23)] = 68.400

  Conclusion: Reject the null hypothesis

Female:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, likelihood ratio

  = -2 * [(-26602.65) – (-26530.03)] = 145.24

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, likelihood ratio

  = -2 * [(-26530.03) – (-26508.52)] = 43.020

  Conclusion: Reject the null hypothesis

Conducting Specification Tests of the Ordered Probit Model for Physical Activity Index

Male:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, likelihood ratio

  = -2 * [(-58148) – (-58090)] = 116.000

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, likelihood ratio

  = -2 * [(-58090) – (-57979)] = 222.000

  Conclusion: Reject the null hypothesis

Female:

- Comparing specification (2) to (3) where the null hypothesis is that (3) is the preferred specification, likelihood ratio

  = -2 * [(-60799) – (-60753)] = 92.000

  Conclusion: Reject the null hypothesis

- Comparing specification (1) to (2) where the null hypothesis is that (2) is the preferred specification, likelihood ratio

  = -2 * [(-60753 – (-60679)] = 148.000

  Conclusion: Reject the null hypothesis