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Prevalence of overweight and obesity in rural and urban settings of 10 European countries

I. Peytremann-Bridevaux [a,b,*], D. Faeh [c,d], B. Santos-Eggimann [a]

[a] Health Services Research Unit, Institute for Social and Preventive Medicine, University of Lausanne, Switzerland
[b] Institute of Health Economics and Management, University of Lausanne, Switzerland
[c] Group for Cardiovascular Disease and Epidemiological Transition, Institute for Social and Preventive Medicine, University of Lausanne, Switzerland
[d] Physiology Department, University of Lausanne, Switzerland

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Abstract

Objectives. First to explore differences in prevalence of overweight and obesity between rural and urban areas of 10 European countries, then to determine whether body mass index varies with the countries' gross domestic product.

Methods. We used baseline data (2004) from countries participating in the Study of Health, Ageing and Retirement in Europe, which included 16,695 non-institutionalized individuals aged 50–79 years with body mass index ≥ 18.5 kg/m^2. Height and weight were self-reported and body mass index categorized as normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2) and obesity (≥ 30 kg/m^2). Weighted prevalences of overweight and obesity in rural and urban areas were estimated, and logistic regressions performed to investigate the association between rural residence and body mass index, adjusting for age, sex, household income and education. Spearman's correlation examined the relationship between body mass index and gross domestic product.

Results. We found no differences in the prevalence of overweight and obesity between rural and urban areas. Separate analysis by gender, age, education or income level did not reveal additional rural–urban variations. Body mass index was slightly higher when gross domestic product was lower.

Conclusions. Programs aimed at preventing or managing overweight and obesity in the 50–79 years age range should be addressed to residents of both rural and urban areas, but tailored to their specific characteristics.

Keywords: Prevalence; Overweight; Obesity; Rural population; Urban population; Middle-aged; Aged

Introduction

The prevalence of obesity may differ significantly between regions of the same country (Tran et al., 1998; Willms et al., 2003) often reflecting unfavorable socio-economic status and/or environmental conditions. In developing countries with the lowest gross domestic product (GDP), residents of urban regions are more likely to be overweight or obese than people living in rural areas. With increasing GDP, however, this variation decreases and the prevalence of obesity in rural and urban regions converges in most countries. This trend may be due to economic growth that starts first in cities and progressively extends to rural regions (Mendez et al., 2005).

In contrast to developing countries with low GDP, many western countries show a greater regional distribution of obesity in rural areas. Studies from Sweden, Germany, Canada and the United States suggest that the prevalence of obesity may be higher in rural than in urban settings (Boehm et al., 2005; Borders et al., 2006; Jackson et al., 2005; Kettle et al., 2005; Rasmussen et al., 1999; Reeder et al., 1997). Borders et al. (2006) also showed that in Texas (US), the odds for being obese were higher in rural regions compared to central cities. In that study, however, within the urban environment, people living in the center of a city showed the same lower tendency toward excess weight as those living in counties adjacent to a city. This

* Corresponding author. Health Services Research Unit, Institute of Social and Preventive Medicine, University of Lausanne, 17 Bugnon, CH-1005 Lausanne, Switzerland. Fax: +41 21 314 7373.
E-mail address: Isabelle.Peytremann-Bridevaux@hospvd.ch (I. Peytremann-Bridevaux).

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is somewhat surprising since suburban environments may be regarded as obesogenic (Kushi, 2006).

In the US, some regions appear to be more affected by poverty than others and its residents may be particularly disadvantaged with respect to opportunities for physical activity, healthy nutrition and health care (Jackson et al., 2005; Patterson et al., 2004; Tai-Seale and Chandler, 2003). Hence, information about the regional distribution of obesity is needed in order to tailor public health interventions directed to the management and prevention of the obesity epidemic. To date, however, no study has contrasted rural–urban prevalence of overweight and obesity across European countries, using standardized questionnaires. In this study, we aimed at comparing rural and urban prevalence of overweight and obesity across 10 European countries. We also explored whether body weight changed in accordance with changing GDP, in these 10 countries.

Methods

Data source, setting and participants

This study involved the secondary analysis of data from the Survey of Health, Ageing and Retirement in Europe (SHARE), a new international data source on ageing (Börsch-Supan and Jürges, 2005a, Börsch-Supan et al., 2005). Nationally representative samples (Börsch-Supan and Jürges, 2005b) of non-institutionalized individuals aged 50 years and over were drawn from 10 European countries (Austria, Denmark, France, Germany, Greece, Italy, the Netherlands, Spain, Sweden, Switzerland), and baseline data collection organized in 2004. An overall response rate of 61.8% was obtained, varying across countries from 50.2% to 73.6%, except in Switzerland (37.6%) (Börsch-Supan et al., 2005). SHARE data were self-reported and collected through standardized face-to-face interviews (entire generic English and translated survey questionnaires available online: http://www.share-project.org/). Of the 19,123 non-institutionalized individuals aged 50 years and over participating in SHARE, we excluded 548 individuals due to missing or implausible information regarding height, weight, or body mass index. We also excluded 170 underweight (body mass index (BMI) <18.5 kg/m^2) individuals as extreme cases in this age range. Indeed, underweight participants represented only 1% of the total sample and their exclusion did not change the prevalence estimates. Individuals aged 80 years and over were not included because a sizable proportion of this population does not live in the community, and their proportion may be related to BMI as well as to the rural/urban nature of residence. Our working sample size therefore consisted of 16,695 individuals aged 50–79 years, with a BMI ≥ 18.5 kg/m^2.

Measures

Height and weight were used to compute BMI, which was divided into three categories: normal weight (BMI 18.5–24.9 kg/m^2), overweight (BMI 25.0–29.9 kg/m^2) and obesity (BMI ≥ 30 kg/m^2). We will use the term of excess weight (BMI ≥ 25.0 kg/m^2) when referring both to overweight and obese individuals.

The rural–urban variable was developed from a single question on the survey, answered primarily by the trained interviewer: "In which type of area is the building located? A big city; the suburbs or outskirts of a big city; a large town; a small town; a rural area or village?". If the interview did not take place at home, the participant was asked a similar question: "How would you describe the area where you live? ", using the same response categories. Big cities, their suburbs or outskirts, and large and small towns are difficult to truly separate in Europe. Therefore, we decided a priori to dichotomize (0/1) that variable into urban and rural, the latter including only people living in a rural area or a village. We hypothesized that rural areas or villages would be more accurately defined, and therefore less prone to misclassification.

Statistical analysis

For each country, we first described the population and estimated the prevalence of overweight and obesity in rural and urban areas. Then we stratified the prevalence analyses individually by gender, age category (50–64 years or 65–79 years), income level ($<$ or $>$ median income) and education ($<$ or ≥ 12 years) in order to detect possible rural–urban differences in the prevalence of overweight and obesity. Finally, we built multivariate logistic regression models to examine the relation between BMI and rural residence (reference: normal weight), adjusting for i) age, gender, and ii) age, gender, years of education and purchasing power parity-household income (euros) adjusted for the size of the household (ppp-household income) (Huisman et al., 2003). The relationship between BMI and GDP was explored using the Spearman's correlation coefficient.

None of the variables considered had $\geq 2\%$ missing data. All analyses were performed on weighted data (age, gender and non-response), using Stata 8.0. P-values <0.05 were considered significant.

Results

Characteristics of the study populations are presented in Table 1. Except for the participants' mean age and the proportion of women included, all other variables showed significant differences across countries (P-values of Chi-squared test: <0.001). According to SHARE, 43.5% of Europeans aged 50 to 79 years were overweight and 18.2% were obese (Table 2). The estimated prevalence of overweight and obesity across countries highlights that Austria, Greece and Spain had the highest prevalence of obesity, ranging from 19.9% to 24.0%.

Fig. 1 shows that, except for Greece, the rural and urban prevalences of overweight and obesity in the 10 countries were essentially equal. Only in Greece was the 29% rate of rural obesity significantly higher than the 20% for urban obesity. The prevalence of excess weight was significantly higher when gross domestic product (GDP) per capita (US$, purchasing power parity) (OECD, 2005) was lower (Spearman's rho -0.09, P-value <0.001). In none of the countries were rural–urban differences apparent when separate prevalence estimations were performed by gender, age, education or income level. In addition, BMI was normally distributed with a similar pattern in both rural and urban areas (rural mean 26.7 kg/m^2, 95% confidence interval (CI): 26.5, 26.9; urban mean 26.6 kg/m^2, 95% CI: 26.5, 26.7).

Table 3 shows the adjusted odds ratios for overweight and obesity according to rural residence, relative to normal weight individuals. The only significant association (Greece: obesity OR 1.5, 95% CI: 1.0, 2.2, P-value 0.035) disappeared after further adjustment for education and household income.

Discussion

We found no differences in the prevalence of overweight and obesity between rural and urban areas of 10 European countries, except in Greece. In this country however, the difference was explained by socio-economic factors.

We hypothesize that the absence of urban–rural differences may relate to the high GDP of these European countries. Indeed, no or only small differences in prevalence of obesity between rural and urban environments are also found in developing countries with relatively high GDP (e.g., Mexico, Brazil,

Table 1
Characteristics of the studied population, by country (weighted results, $n=16,695$)

Country	Overall response rate (%)	Working sample size	Mean age	% Women	Mean years education	% Retired	% Rural residence	% Excellent/very good/good subjective health [a]	% ≥2 Chronic diseases [b]	% Any of 5 ADL [c]
Switzerland	37.6	813	62.1	51.4	12.4	39.1	56.2	84.5	25.4	5.6
France	73.6	1 449	62.4	52.2	8.4	50.4	30.1	70.0	41.6	9.3
Denmark	63.2	1 384	61.7	50.8	13.1	46.1	19.9	78.1	40.2	6.6
Sweden	50.2	2 253	62.4	50.8	10.6	46.7	16.3	89.3	38.1	6.0
The Netherlands	61.3	2 041	61.7	50.7	11.2	29.8	23.0	74.1	33.0	5.4
Germany	63.4	2 096	62.9	52.2	13.6	49.4	31.7	63.8	38.0	7.4
Italy	55.1	1 804	63.4	52.9	8.1	53.0	28.9	63.9	41.5	7.8
Austria	58.1	1 697	62.8	53.3	11.5	59.4	11.3	73.6	32.3	8.0
Spain	53.3	1 433	63.1	51.1	6.0	32.7	8.2	61.9	47.3	8.7
Greece	61.4	1 725	63.1	52.1	8.8	48.2	15.9	70.9	38.7	6.5
All 10 countries	61.8	16 695	62.8	52.1	10.0	47.0	26.1	67.3	40.0	7.8

Baseline data (2004) from the Survey of Health, Ageing and Retirement in Europe (SHARE), individuals aged 50–79 years with body mass index ≥18.5 kg/m^2.
[a] Excellent/very good/good versus fair/poor.
[b] Physicians' diagnosed chronic conditions ("Has a doctor ever told you that you had any of the conditions on this card?"): high blood pressure or hypertension; high blood cholesterol; stroke or cerebrovascular disease; diabetes or high blood sugar; chronic lung disease such as bronchitis or emphysema; asthma; arthritis, including osteoarthritis or rheumatism; osteoporosis; cancer or malignant tumour, including leukaemia or lymphoma, but excluding minor skin cancers; stomach or duodenal ulcer, peptic ulcer; Parkinson disease; cataract; hip fracture or femoral fracture; other condition, not yet mentioned.
[c] Any of 5 ADL: difficulties associated with any of five activities of daily living (ADL: bathing, dressing, eating, walking across a room and getting in or out of bed).

S. Africa) (Mendez et al., 2005; Monteiro et al., 2004). In those countries as well as in western countries, rural residents may have similar access to food and transportation as urban residents, which may not be the case in developing countries with low GDP. In developing countries, a clear difference is observed, with a higher prevalence of excess weight occurring in urban areas as compared to rural areas. These differences, however, converge with increasing GDP (Mendez et al., 2005; Monteiro et al., 2004), perhaps due to better access to energy-dense food, predominantly motorized transportation, and increasingly sedentary leisure time activities associated with economic welfare (Wang et al., 2002). We suggest that the GDP of the European countries included in this study is too high to have an impact on the rural–urban differences in obesity prevalence.

Table 2
Estimated prevalence of normal weight, overweight and obesity, by country (weighted results, $n=16,695$)

Country	Normal weight (BMI [a] 18.5.0–24.9 kg/m^2) (%)	Overweight (BMI 25.0–29.9 kg/m^2) (%)	Obesity (BMI ≥30.0 kg/m^2) (%)
Switzerland	48.9	37.9	13.2
France	45.1	38.9	16.0
Denmark	45.9	39.4	14.7
Sweden	43.1	42.0	14.9
The Netherlands	41.1	42.5	16.5
Germany	37.3	44.8	17.9
Italy	37.1	45.0	17.9
Austria	36.6	43.5	19.9
Spain	30.6	45.4	24.0
Greece	31.1	48.1	20.8
All 10 countries	38.4	43.5	18.2

Baseline data (2004) from the Survey of Health, Ageing and Retirement in Europe (SHARE), individuals aged 50–79 years with body mass index ≥18.5 kg/m^2.
[a] BMI: body mass index.

A further explanation for the lack of difference between rural and urban prevalences of overweight and obesity, found in our sample, may be inherent in the definition of the terms "rural" and "urban", for which no consensus exists (Hart et al., 2005). While "rural" generally includes several aspects such as lower population density and degree of urbanization, differences between rural and urban areas in Western Europe have become less clear and were further minimized by increasing migration between those regions. The aggregation of heterogeneous rural areas may also weaken a rural–urban difference in the prevalence of excess weight (Hart et al., 2005).

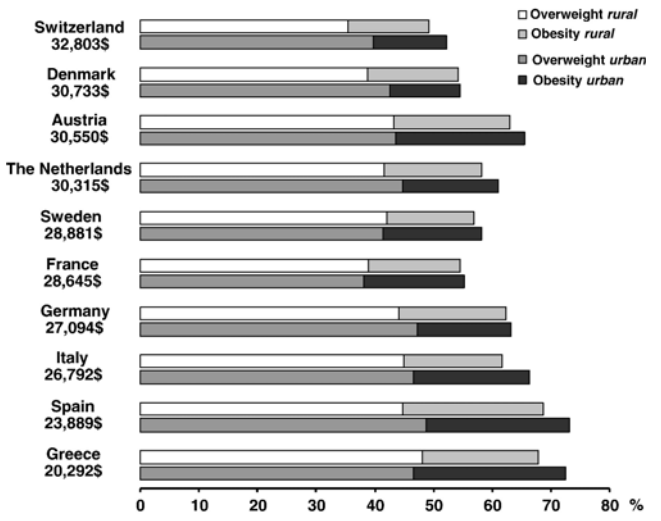

Fig. 1. Urban and rural estimated prevalence of overweight (BMI 25.0–29.9 kg/m^2) and obesity (BMI ≥30.0 kg/m^2), by country (weighted results, $n=16,695$). Results are presented in decreasing order of gross domestic product/capita (2003, US$, purchasing power parity). Baseline data (2004) from the Survey of Health, Ageing and Retirement in Europe (SHARE), individuals aged 50–79 years with body mass index ≥18.5 kg/m^2.

Table 3
Adjusted odds ratios (95% CI) for overweight and obesity, according to rural residence (reference=normal weight category)

Country	Adjusting for age and gender				Adjusting for age, gender, education and income			
	Overweight		Obesity		Overweight		Obesity	
	OR	(95%CI)	OR	(95%CI)	OR	(95%CI)	OR	(95%CI)
Switzerland	1.2	(0.9–1.7)	1.0	(0.6–1.5)	1.2	(0.9–1.7)	0.9	(0.6–1.4)
France	0.9	(0.7–1.2)	1.1	(0.8–1.5)	0.9	(0.7–1.1)	1.0	(0.7–1.4)
Denmark	1.1	(0.8–1.4)	0.7	(0.5–1.2)	1.0	(0.7–1.4)	0.7	(0.4.1–1)
Sweden	1.0	(0.8–1.3)	1.2	(0.8–1.6)	1.0	(0.7–1.3)	1.1	(0.7–1.5)
The Netherlands	1.1	(0.9–1.4)	1.0	(0.8–1.4)	1.1	(0.9–1.4)	1.0	(0.7–1.4)
Germany	1.1	(0.9–1.3)	0.8	(0.6–1.1)	1.1	(0.8–1.3)	0.8	(0.6–1.1)
Italy	1.2	(0.9–1.6)	1.4	(0.9–2.0)	1.1	(0.8–1.5)	1.1	(0.8–1.6)
Austria	1.1	(0.8–1.5)	1.2	(0.8–1.8)	1.0	(0.7–1.5)	1.1	(0.7–1.8)
Spain	1.3	(0.7–2.2)	1.1	(0.6–2.1)	1.1	(0.6–2.0)	0.9	(0.5–1.7)
Greece	1.1	(0.8–1.5)	1.5*	(1.0–2.2)	1.0	(0.7–1.4)	1.3	(0.9–2.0)
All 10 countries	1.0	(0.9–1.2)	1.0	(0.8–1.1)	1.0	(0.9–1.1)	0.9	(0.8–1.1)

Baseline data (2004) from the Survey of Health, Ageing and Retirement in Europe (SHARE), individuals aged 50–79 years with body mass index ≥ 18.5 kg/m^2.
* P-value <0.05.

Our lack of difference contrasts with the higher prevalence of overweight and obesity found in rural regions of some western countries (Boehm et al., 2005; Kettle et al., 2005; Reeder et al., 1997). Poorer health behaviors (energy-dense dietary intake and a sedentary lifestyle) (Crooks, 2000; Frank et al., 1977; Patterson et al., 2004), fewer opportunities for physical activity (Parks et al., 2003; Wilcox et al., 2000), and also the rapid transition from heavy labor activities to more sedentary professions and lifestyles are factors more often described in rural than urban regions that may contribute to this discrepancy (Patterson et al., 2004; Tai-Seale and Chandler, 2003). However, such structural and behavioral differences between rural and urban regions, particularly pronounced in the United States (Cummins and Macintyre, 2006; Kushi, 2006) might not be expected within the framework of European countries. Moreover, studies reporting higher prevalence of overweight and obesity in rural areas also included individuals younger than 50 years (generally ≥ 18 years). Compared to these younger individuals, SHARE participants may have been less influenced by the socioeconomic and structural changes of the past decades (Rasmussen et al., 1999).

Across the 10 European countries participating in SHARE, the prevalence of overweight and obesity was significantly higher when the GDP was lower (inverse relationship between BMI and GDP), which is an opposite picture of what is described in developing countries. Independently of socio-economic status, European countries with higher GDP may offer easier access to fruits and vegetables, places and institutions offering leisure time physical activities, and better healthcare than European countries with lower GDP. In developing countries, those with the lowest GDP showed the lowest prevalence of excess weight. The lower prevalence of excess weight may reflect a scarcity in energy dense food and higher levels of daily physical activity related to work and transportation (Monteiro et al., 2004; Prentice, 2006), predominantly found in low GDP countries.

Strengths of our study included a large database of nationally representative samples of non-institutionalized individuals aged 50–79 years old, from 10 European countries, and the use of standardized questionnaires and procedures. However, the data source had some potential limitations. Firstly, height and weight were self-reported. Most people underestimate their BMI because they overestimate their height and underestimate their weight (Palta et al., 1982; Rowland, 1990). The true percentage of overweight and obesity may therefore be lower than if objectively measured. However, there is no published evidence that patterns of self-reporting differ between urban and rural settings. In addition, the proportion of subjects with obesity class I (BMI 30–34.9) and class II/III (BMI ≥ 35) were similar in rural and urban areas. This is an important factor, since severely obese individuals tend to underestimate their BMI more strongly than moderately obese individuals (Roberts, 1995; Spencer et al., 2002). Secondly, response-bias may be possible because of the modest overall response rate (62%), which was particularly affected by a poor participation rate in Switzerland (37.8%). Despite the lower level of response, age, sex, subjective health, and BMI characteristics of the Swiss sample were similar to those of the 2002 Swiss Health Care Survey (unpublished results). Finally, the use of self-reported data could result in informational and recall biases, and residual and/or unmeasured confounding obviously cannot be excluded.

Conclusions

In the 50–79 years old living in 10 European countries with high GDP, we found no differences in the prevalence of overweight and obesity between urban and rural regions. Hence, programs aimed at preventing overweight and obesity in these populations should be addressed to residents of both rural and urban areas. However, they should be tailored to their specific needs, characteristics and environment.

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References

Boehm, B.O., Claudi-Boehm, S., Yildirim, S., et al., 2005. The Romerstein Group; The Emil-Study Group, 2005. Prevalence of the metabolic syndrome in southwest Germany. Scand. J. Clin. Lab. Invest., Suppl. 240, 122–128.

Borders, T.F., Rohrer, J.E., Cardarelli, K.M., 2006. Gender-specific disparities in obesity. J. Commun. Health 31, 57–68.

Börsch-Supan, A., Jürges, H. (Eds.), 2005a. Health, Ageing and Retirement in Europe: First Results from the Survey of Health, Ageing and Retirement in Europe. Mannheim Research Institute for the Economics of Ageing (MEA), Mannheim.

Börsch-Supan, A., Jürges, H. (Eds.), 2005b. The Survey of Health, Ageing and Retirement in Europe: Methodology. Mannheim Research Institute for the Economics of Aging (MEA), Mannheim.

Börsch-Supan, A., Hank, K., Jürges, H., 2005. A new comprehensive and international view on ageing: introducing the "Survey of Health, Ageing and Retirement in Europe". Eur. J. Ageing 2, 245–253.

Crooks, D.L., 2000. Food consumption, activity, and overweight among elementary school children in an Appalachian Kentucky community. Am. J. Phys. Anthropol. 112, 159–170.

Cummins, S., Macintyre, S., 2006. Food environments and obesity—Neighbourhood or nation? Int. J. Epidemiol. 35, 100–104.

Frank, G.C., Voors, A.W., Schilling, P.E., Berenson, G.S., 1977. Dietary studies of rural school children in a cardiovascular survey. J. Am. Diet. Assoc. 71, 31–35.

Hart, L.G., Larson, E.H., Lishner, D.M., 2005. Rural definitions for health policy and research. Am. J. Public Health 95, 1149–1155.

Huisman, M., Kunst, A.E., Mackenbach, J.P., 2003. Socioeconomic inequalities in morbidity among the elderly; a European overview. Soc. Sci. Med. 57, 861–873.

Jackson, J.E., Doescher, M.P., Jerant, A.F., Hart, L.G., 2005. A national study of obesity prevalence and trends by type of rural county. J. Rural Health 21, 140–148.

Kettle, S.M., Roebothan, B.V., West, R., 2005. Prevalence of specific cardiovascular disease risk factors in young Newfoundland and Labrador adults living in urban and rural communities. Can. J. Rural Med. 10, 81–85.

Kushi, L.H., 2006. Epidemiologic research on the obesity epidemic: a socioenvironmental perspective. Epidemiology 17, 131–133.

Mendez, M.A., Monteiro, C.A., Popkin, B.M., 2005. Overweight exceeds underweight among women in most developing countries. Am. J. Clin. Nutr. 81, 714–721.

Monteiro, C.A., Conde, W.L., Lu, B., Popkin, B.M., 2004. Obesity and inequities in health in the developing world. Int. J. Obes. Relat. Metab. Disord. 28, 1181–1186.

OECD health data, 2005. Statistics and Indicators for 30 Countries [CD-ROM]. OECD, Paris.

Palta, M., Prineas, R.J., Berman, R., Hannan, P., 1982. Comparison of self-reported and measured height and weight. Am. J. Epidemiol. 115, 223–230.

Parks, S.E., Housemann, R.A., Brownson, R.C., 2003. Differential correlates of physical activity in urban and rural adults of various socioeconomic backgrounds in the United States. J. Epidemiol. Community Health 57, 29–35.

Patterson, P.D., Moore, C.G., Probst, J.C., Shinogle, J.A., 2004. Obesity and physical inactivity in rural America. J. Rural Health 20, 151–159.

Prentice, A.M., 2006. The emerging epidemic of obesity in developing countries. Int. J. Epidemiol. 35, 93–99.

Rasmussen, F., Johansson, M., Hansen, H.O., 1999. Trends in overweight and obesity among 18-year-old males in Sweden between 1971 and 1995. Acta Aediatr. 88, 431–437.

Reeder, B.A., Chen, Y., Macdonald, S.M., Angel, A., Sweet, L., Canadian Heart Health Surveys Research Group, 1997. Regional and rural–urban differences in obesity in Canada. CMAJ 157, S10–S16.

Roberts, R.J., 1995. Can self-reported data accurately describe the prevalence of overweight? Public Health 109, 275–284.

Rowland, M.L., 1990. Self-reported weight and height. Am. J. Clin. Nutr. 52, 1125–1133.

Spencer, E.A., Appleby, P.N., Davey, G.K., Key, T.J., 2002. Validity of self-reported height and weight in 4808 EPIC-Oxford participants. Public Health Nutr. 5, 561–565.

Tai-Seale, T., Chandler, C., 2003. Nutrition and overweight concerns in rural areas: a literature review. The Texas A&M University System Health Science Center, School of Rural Public Health, Southwest Rural Health Research Center, Rural Healthy People 2010: A Companion Document to Healthy People 2010, Volume 2. College Station, TX, pp. 115–130.

Tran, P.D., Leclerc, A., Chastang, J.F., Goldberg, M., 1998. Regional disparities in cardiovascular risk factors in France: a five-year analysis of the GAZEL cohort. Eur. J. Epidemiol. 14, 535–543.

Wang, Y., Monteiro, C., Popkin, B.M., 2002. Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China, and Russia. Am. J. Clin. Nutr. 75, 971–977.

Wilcox, S., Castro, C., King, A.C., Housemann, R., Brownson, R.C., 2000. Determinants of leisure time physical activity in rural compared with urban older and ethnically diverse women in the United States. J. Epidemiol. Community Health 54, 667–672.

Willms, J.D., Tremblay, M.S., Katzmarzyk, P.T., 2003. Geographic and demographic variation in the prevalence of overweight Canadian children. Obes. Res. 11, 668–673.