RESEARCH REPORT

Relatively poor, absolutely ill? A study of regional income inequality in Russia and its possible health consequences

Per Carlson

J Epidemiol Community Health 2005;**59**:389–394. doi: 10.1136/jech.2003.017301

Correspondence to:
Dr P Carlson, Stockholm Centre on Health of Societies in Transition, University College of South Stockholm, S-14189 Huddinge, Sweden;
per.carlson@sh.se

Accepted for publication
6 September 2004

Study objective: To investigate whether the income distribution in a Russian region has a ''contextual'' effect on individuals' self rated health, and whether the regional income distributions are related to regional health differences.
Methods: The Russia longitudinal monitoring survey (RLMS) is a survey (n = 7696) that is representative of the Russian population. With multilevel regressions both individual as well as contextual effects on self rated health were estimated.
Main results: The effect of income inequality is not negative on men's self rated health as long as the level of inequality is not very great. When inequality levels are high, however, there is a tendency for men's health to be negatively affected. Regional health differences among men are in part explained by regional income differences. On the other hand, women do not seem to be affected in the same way, and individual characteristics like age and educational level seem to be more important.
Conclusions: It seems that a rise in income inequality has no negative effect on men's self rated health as long as the level of inequality is not very great. On the other hand, when inequality levels are higher a rise tends to affect men's health negatively. A curvilinear relation between self rated health and income distribution is an interesting hypothesis. It could help to explain the confusing results that arise when you look at countries with a high degree of income inequality (USA) and those with lower income inequality (for example, Japan and New Zealand).

Since the fall of the communist regime in the early 1990s, and with the introduction of ''shock therapy'' in January 1992, Russia has experienced dramatic economic and social changes. In response to these, Russian public health deteriorated with an increasing mortality and a falling life expectancy.[1] Between 1994 and 1998 the life expectancy recovered somewhat, but only to start falling again in 1999 and 2000.[2]

The economic changes have been difficult for many Russians. Rising unemployment rates and large groups of people falling into poverty can illustrate this. The income distribution has widened substantially, but only a very small group of Russians have benefited economically from the recent changes. A good example of this is that about 80% of the citizens in the city of Taganrog (Rostovskaya Oblast), judged their financial situation to have worsened between 1988 and 1998.[3]

Moreover, there is good reason to believe that different parts of Russia have been affected differently economically, socially, and in health, with some parts of the country managing the transition better than others. Shkolnikov and Cornia[4] found a greater deterioration in life expectancy in the north and northwest regions between 1989 and 1994. Both the Moscow and St Petersburg areas experienced the biggest deteriorations during this period and therefore, they concluded, the decreases cannot be attributable to the economic crisis as these two areas performed relatively better than other areas during this period. Walberg *et al*[5] concluded that the decline in Russian life expectancy cannot be attributed to impoverishment only. Regions that have experienced the most dramatic transition, with, for example, increasing income inequalities as one result, have lost their social cohesion and therefore experienced a rise in mortality. The economic and social changes during the early 1990s, created a psychosocial stress among people that led to harmful behaviours such as increased heavy alcohol consumption or increased criminality.

Kennedy *et al*[6] found an association between indicators of social capital and life expectancy in the Russian regions. Regions with higher mistrust in government, higher criminality, worse working relations, and poorer engagement in politics also had a lower life expectancy. Therefore, they suggested ''… that indicators of social capital could account for an important portion of the cross-sectional variation in mortality and life expectancy across the regions of the country.'' (page 2037). Moreover, the relation between social capital and mortality persisted when they controlled for per capita income and poverty.

Thus, it seems that poverty in itself cannot explain regional variations in mortality or life expectancy, but rather social and social-psychological factors associated with the economic and political changes.

There has been a lively discussion in the medical and social sciences about whether (and how) income inequalities can affect the health of the individual.[7–9] Wilkinson[7] suggested that the distribution of incomes in a society may affect people's health, at least in economically developed societies. It is hypothesised that wide differences in income will negatively affect social cohesion and feelings of trust and solidarity, which in turn will affect all members of the society, but in particular those in a disadvantaged social position. These will feel disadvantaged compared with others higher up. Lynch *et al*[9] are sceptical about this ''psychosocial'' interpretation and argue that ''Interpretation of links between income inequality and health must begin with the structural causes of inequalities, and not just focus on perceptions of that inequality.'' (page1200) Income inequality is a consequence of several structural processes and these also affect the individual's possibilities of getting, for example, education, occupation, food, housing, health

services, etc, which all are related to health. In other words, to understand the relation between income inequality and health, you should focus on those processes that create these inequalities. It is reasonable to believe that these structural processes have both psychosocial as well as material effects on health.[10] However, the question is how to separate them.

It has also been argued that attention should be directed away from income inequality. Deaton[11] argues that income inequality in itself does not have any causal effect on population health and therefore any relation found can be explained by some other factors, for example, poverty. Instead, he argues, focus should be on the health promoting role of income.

Several studies have examined the relation between income inequality and public health in various countries and the results are mixed. Kennedy *et al*[8] found from the USA that people living in states with the greatest inequality were more likely to report poor health than others. On the other hand, evidence from New Zealand (mortality) and Japan (self rated health) show no, or only a very weak, association.[12 13] A Canadian study showed some evidence that higher income inequality was related to better health, but the most important factor, however, seemed to be household income.[14] Studies on this topic conducted in Russia or other eastern European countries are more sparse. Bobak *et al*[15] found no relation between income inequality and self rated health in seven post-communist countries. Instead, individual factors such as education and material deprivation were most strongly related to self rated health.

The aim of the study is (1) to investigate whether in the regions of Russia income distribution has a "contextual" effect on people's self rated health, and (2) whether regional income distributions are related to regional differences in health.

DATA AND METHODS

The Russia longitudinal monitoring survey (RLMS) is a survey that is representative of the Russian population and has been carried out at repeated intervals since 1992. It is obviously very difficult to obtain a sample that is representative of the entire Russian population. In brief, the selection procedure entailed the following three steps. (1) In accordance with certain criteria (including degree of urbanisation) a number of regions were selected that together would represent the vast country's enormous heterogeneity. (2) A number of electoral districts were chosen at random. (3) A register of households in each electoral district was used to select a total of some 7000 households. The response rate was around 90% for the earliest surveys and about 80% for the later ones. In this paper, the 1998 survey is analysed (a detailed explanation of the study design and selection strategy is available on the RLMS web site http://www.cpc.unc.edu/rlms). It contains 7696 interviews (3306 men and 4390 women).

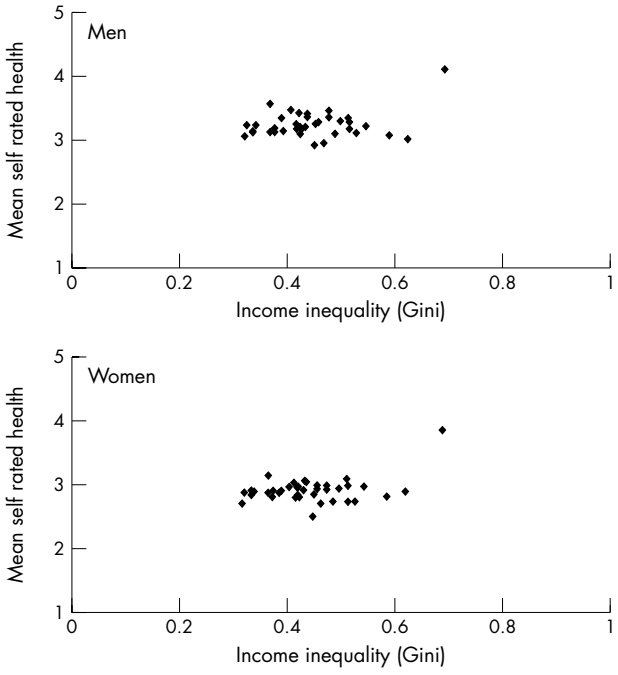

Figure 1 Regional income inequality and mean self rated health in 38 Russian regions.

Thus, RLMS is designed to obtain a national representative sample; results at the regional level may therefore not be representative. Thus, to control for statistical problems related to the sample design and to separate the "contextual effects" (that is, the effects of group level properties on the individuals) from individual ones, a multilevel technique with random intercepts was used, whereby you can control for some statistical problems (for example, clustering) and thereafter estimate both individual and contextual effects.[16–18] The statistical software used was MLwiN 1.10. The multilevel model includes five levels, but only the regional level and the individual level will be commented on here. The other three levels—that is, family, census district, and population centre—are included only to control for possible design problems related the sampling procedure.

The logic of the regression models look like this;

$$y_{ijklm} = \beta_{0ijklm}x_0 + \beta_1 x_{1ijklm} + \beta_2 x_{2jklm} + \beta_3 x_{3m}$$
$$\beta_{0ijklm} = \beta_0 + g_{0m} + f_{0lm} + v_{0klm} + u_{0jklm} + e_{0ijklm}$$

β_0 is the intercept, and is allowed to vary on five levels: i (individual), j (family), k (census district), l (population centre), and m (primary sampling unit, i.e. region).

β_1 represents the effects of the independent variables (here illustrated by x_{1ijklm}) at individual level.

β_2 represents the effects of the independent variables (here illustrated by x_{2jklm}) at family level.

β_3 represents the effects of the independent variables (here illustrated by x_{3m}) at regional level.

Accordingly, the models allow for random intercepts and fixed effects, which means that the intercepts are allowed to vary between, for example, regions, but the slopes (β) are assumed to be equal.[19]

Dependent variable

Self rated health is measured on a five point scale indicating whether the respondent rates their health as "very good" (5), "good" (4), "average" (3), "poor" (2) or "very poor" (1).

Independent variables

The household's reported total income was used to estimate the individual's economic situation, the mean income level of each region, and the regional income distribution. To control for family composition, the household's total income was divided by the number of household members. However, the household members were weighted differently. The first adult person in the household had a weight of 1.0, while all others received a weight of 0.8. The most appropriate equivalence scale has been discussed earlier,[20] and the choice made here was based on a study from another post-Soviet economy—that is, Estonia.[21] The Gini coefficient was used to

Table 1 Regional distributions of self rated health, household income, and household income distribution in Russia 1998

Region (PSU)	Mean self rated health			Mean household income	Household income distribution
	Total	Men	Women	(Eq scale)	(Gini)
Altaiskij Krai: Biisk CR	3.12	3.28	2.99	373.79	0.455
Altaiskij Krai: Kurisnkij Rajon	2.92	3.07	2.81	234.56	0.585
Amurskaja Oblast: Arkharinhsskij Rajon	2.95	3.01	2.89	504.33	0.620
Cheliabinsk	3.03	3.23	2.88	625.16	0.320
Cheliabinsk Oblast: Krasnoarmeiskij Rajon	2.98	3.18	2.81	333.30	0.421
Chuvashskaya ASSR: Shumerlja CR	2.89	3.09	2.73	385.68	0.485
Gorkovskaya Oblast: Nizhnij Novgorod	3.03	3.33	2.87	656.49	0.385
Kabardino-Balkarija, Zolskij Rajon	3.96	4.09	3.85	592.06	0.688
Kalinin Oblast: Rzehv CR	2.96	3.11	2.85	484.48	0.332
Kaluzhskaya Oblast: Kuibyshev Rajon	2.67	2.92	2.50	365.46	0.447
Khanty-Mansiiskij AO: Surgut CR	3.20	3.36	3.05	1590.13	0.434
Komi ASSR: Syktyvar	3.06	3.19	2.97	682.91	0.419
Komi ASSR: Usinsk CR	3.08	3.21	2.97	1256.57	0.542
Krasnodar CR	2.94	3.08	2.85	925.88	0.419
Krasnodarskij Kraj: Kushchevskij Rajon	3.15	3.44	2.92	344.81	0.473
Krasnojarskij Kraj: Krasnojarsk	3.09	3.29	2.94	942.98	0.495
Krasnojarskij Kraj: Nazarovo CR	3.09	3.28	2.94	569.21	0.455
Kurgan	3.14	3.36	2.98	655.72	0.473
Leningrad Oblast: Volosovskij Rajon	3.02	3.22	2.89	470.25	0.338
Lipetskaya Oblast: Lipetsk CR	3.00	3.12	2.90	558.09	0.373
Moscow City	2.97	3.18	2.81	1014.32	0.372
Moscow Oblast	3.20	3.40	3.06	857.94	0.433
Orenburg Oblast: Orsk	3.28	3.56	3.14	385.97	0.365
Perm Oblast: Solikamsk City & Rajon	3.00	3.13	2.90	640.79	0.332
Pezenskaya Oblast: Zemetchinskij Rajon	2.93	3.16	2.73	310.00	0.512
Rostov Oblast: Batajsk	3.02	3.24	2.84	527.25	0.449
Saratov CR	3.00	3.13	2.90	630.46	0.389
Saratov Oblast: Volskij Gorsovet & Rajon	3.18	3.46	2.97	360.84	0.403
Smolensk CR	2.95	3.16	2.80	537.39	0.415
St Petersburg City	3.13	3.42	2.95	881.85	0.418
Stavropolskij Kraj: Georgievskij CR	2.91	3.10	2.74	464.20	0.525
Tambov Oblast: Uvarovo CR	2.79	2.94	2.71	327.89	0.463
Tatarskaya ASSR: Kazan	3.11	3.25	3.03	626.66	0.412
Tomsk City and Rajon	3.03	3.20	2.93	568.44	0.429
Tulskaya Oblast: Tula	2.85	3.05	2.71	542.06	0.317
Udmurt ASSR: Glasov CR	2.97	3.11	2.88	559.49	0.364
Vladivostok	3.21	3.34	3.09	975.26	0.510
Volgograd Oblast: Rudnjanskij Rajon	3.12	3.27	2.98	414.26	0.512

measure regional income inequality and was calculated as follows;

$$Gini = \frac{1}{2N^2\mu}\sum_{i=1}^{N}\sum_{j=1}^{N}|y_i - y_j|$$

N represents the number of households, μ is the mean household income, y_i symbolises household ''I'', and y_j symbolises household ''j''. As we do not have any expressed hypotheses about how the relation between income inequality and health may look like, linear or non-linear, we tested several models. A non-linear model, where the Gini coefficient was squared, fitted the data best and was therefore finally kept.

Both at individual and regional level the natural logarithm of household income is used, as it is assumed that the possible effects on health will stagnate at higher income levels, both at individual and regional level.

Background variables

Several background variables are controlled for in the analyses (models 2–4). These are; age (in years), marital status (married or not married), type of settlement ((1) urban, (2) urban-rural, (3) rural) and education ((1) graduate school, (2) university, academy, (3) technical, medical, music, pedagogical, art school, (4) vocational technical school with a secondary education, (5) vocational school without a secondary education, (6) professional courses).

RESULTS

Comparisons and interpretations from table 1 must be carried out with caution, as the results may not be representative for each region. However, we can see significant ''regional'' variations in self rated health as well as in income and income distribution. One region (Kabardino-Balkarija, Zolskij Rajon) was excluded from further analyses, because of its great deviation from the other regions and it was therefore considered an outlier (see fig 1).

In tables 2 and 3, men and women were analysed separately.

From model 1 (tables 2 and 3) we can see that the average self rated health for men is 3.19, and for women 2.87 (see intercept). As expected, men rate their health better than women. There also seems to be, both for men and women, a significant, but not particularly large, regional proportion, 2.28% and 1.73%, men and women respectively, of the total variation. In model 2 several background variables were included. Age, marital status (for men), and education but not type of settlement had a significant effect on self rated health. In other words, older people, unmarried men (compared with married men), and the lower educated (compared with those with the highest education) tend to rate their health as worse. The regional variation (that is, variance explained by region) seemed to increase somewhat among men (+8.3%, that is, from 2.28% to 2.47%) but decreased considerably among women (−42%). In model 3, the household's total income was introduced to the model together with the mean household income of the region.

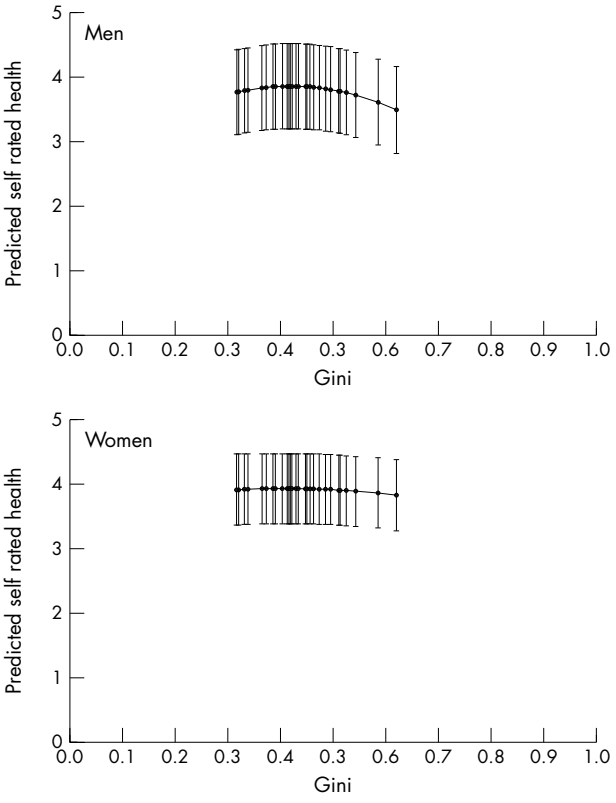

Figure 2 Regional income inequality and predicted self rated health in Russia.

None of these economic measures seemed to relate to the individual's perceived health. The regional variation remained the same, both for men and women.

Finally in model 4, regional income distribution (Gini) was included. For men (table 2), the squared Gini coefficient was significantly related to self rated health, showing a curve-linear relation. Thus, at ''lower'' levels of inequality an increase seems to slightly improve self rated health, but at ''higher'' levels an increase seems to have a negative effect on self rated health. However, the effect does not seem to be very strong. Among women there was a similar, but weak and non-significant, curve-linear relation (table 3). For a graphical presentation, see figure 2.

It is equally interesting to look at changes in the regional variation. Among men, variance explained by region changed from 2.48% (model 3) to 1.36% (model 4), which is a 45% reduction. However, there was no change at all for women.

DISCUSSION

May biases in the analysed data have affected the results? It should be noted that the data are not necessarily representative at the regional level. However, this is not a particular problem because the aim of the study was to analyse the possible relation between income inequality and self rated health, and not to present representative estimations of levels of household income, self rated health, etc. Moreover, the used multilevel design is intended to control for possible statistical problems, for example, clustering. Another problem is the level of aggregation of income inequality. In this study the primary sampling units were used because this is as close as we can get to where the federal political and economic structures are formed. At the same time it is a level that forms a significant cultural identity and to where people

Table 2 Self rated health regressed on independent variables (random intercept models): men

	Model 1		Model 2		Model 3		Model 4	
Variable	***b***	**SE**	***b***	**SE**	***b***	**SE**	***b***	**SE**
Age			−0.021	(0.001)	−0.021	(0.001)	−0.021	(0.001)
Marital status								
Not married			ref		ref		ref	
Married			0.061	(0.028)	0.062	(0.028)	0.063	(0.028)
Type of settlement								
Urban			ref		ref		ref	
Urban-rural			0.024	(0.070)	0.031	(0.071)	0.056	(0.070)
Rural			0.054	(0.042)	0.069	(0.045)	0.103	(0.046)
Education								
1			ref		ref		ref	
2			−0.068	(0.038)	−0.068	(0.038)	−0.068	(0.038)
3			−0.112	(0.038)	−0.113	(0.038)	−0.115	(0.038)
4			−0.147	(0.041)	−0.149	(0.041)	−0.150	(0.041)
5			−0.076	(0.039)	−0.079	(0.039)	−0.074	(0.039)
6			−0.130	(0.042)	−0.134	(0.042)	−0.134	(0.042)
Household income (ln)					−0.011	(0.007)	−0.011	(0.007)
Mean household income (ln)					0.071	(0.059)	0.057	(0.051)
Income distribution (Gini)							7.221	(2.605)
Income distribution (Gini) (squared)							−8.617	(2.886)
Intercept	3.192	(0.024)	4.146	(0.047)	3.752	(0.381)	2.367	(0.653)
Variance components								
Region (PSU)	0.013	(0.005)	0.011	(0.004)	0.011	(0.004)	0.006	(0.003)
Population centre	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Census district	0.021	(0.007)	0.019	(0.005)	0.018	(0.005)	0.019	(0.005)
Family	0.000	(0.000)	0.025	(0.018)	0.026	(0.018)	0.025	(0.018)
Individual	0.535	(0.014)	0.390	(0.020)	0.389	(0.020)	0.390	(0.020)
Total variance	0.569		0.445		0.444		0.440	
Variance explained by region (PSU)	2.28%		2.47%		2.48%		1.36%	
−2×loglikelihood	7458.58 n = 3306		6633.21 n = 3306		6629.51 n = 3306		6619.28 n = 3306	

Table 3 Self rated health regressed on independent variables (random intercept models): women

	Model 1		Model 2		Model 3		Model 4	
Variable	***b***	**SE**	***b***	**SE**	***b***	**SE**	***b***	**SE**
Age			−0.021	(0.001)	−0.021	(0.001)	−0.021	(0.001)
Marital status								
Not married			ref		ref		ref	
Married			0.020	(0.020)	0.019	(0.020)	0.020	(0.020)
Type of settlement								
Urban			ref		ref		ref	
Urban-rural			−0.017	(0.056)	−0.011	(0.057)	−0.004	(0.057)
Rural			0.003	(0.032)	0.007	(0.036)	0.020	(0.038)
Education								
1			ref		ref		ref	
2			−0.045	(0.028)	−0.043	(0.028)	−0.043	(0.028)
3			−0.095	(0.036)	−0.090	(0.036)	−0.090	(0.036)
4			−0.075	(0.045)	−0.069	(0.045)	−0.069	(0.045)
5			−0.157	(0.039)	−0.153	(0.039)	−0.152	(0.039)
6			−0.198	(0.031)	−0.194	(0.032)	−0.194	(0.032)
Household income (ln)					0.008	(0.006)	0.008	(0.006)
Mean household income (ln)					−0.001	(0.043)	−0.004	(0.043)
Income distribution (Gini)							1.791	(2.123)
Income distribution (Gini) (squared)							−2.198	(2.350)
Intercept	2.874	(0.021)	3.935	(0.039)	3.894	(0.279)	3.558	(0.533)
Variance components								
Region (PSU)	0.010	(0.004)	0.004	(0.003)	0.004	(0.003)	0.004	(0.003)
Population centre	0.000	(0.000)	0.001	(0.003)	0.001	(0.003)	0.001	(0.003)
Census district	0.020	(0.005)	0.009	(0.004)	0.009	(0.004)	0.009	(0.004)
Family	0.009	(0.018)	0.037	(0.013)	0.037	(0.013)	0.037	(0.013)
Individual	0.540	(0.021)	0.351	(0.014)	0.351	(0.014)	0.351	(0.014)
Total variance	0.579		0.402		0.402		0.402	
Variance explained by region (PSU)	1.73%		1.00%		1.00%		1.00%	
−2×loglikelihood	9992.23		8413.49		8411.60		8410.15	
	n = 4390		n = 4390		n = 4390		n = 4390	

can relate. Of course it would be possible to analyse inequalities on other levels, for example cities, neighbourhoods, families, etc, to where people can relate. However, it can still be argued that the chosen level of aggregation here is meaningful, both from the individual perspective and from a macro structural one.

Self rated health was analysed as a continuous variable, but as it is unclear whether this variable forms a continuum or not,[22] an additional multilevel logistic regression was performed. However, the results were very similar and the less complex models were kept.

It seems that a rise in income inequality has no negative effect on men's self rated health as long as the level of inequality is not very high. On the other hand, at higher levels of inequality, a rise tends to affect men's health negatively. Women do not seem to be affected in the same way. Individual characteristics like age and educational level seem more important. A curvilinear relation between self rated health and income distribution is an interesting hypothesis. It could help to explain the confusing results that arise when you look at countries with a high degree of income inequality (USA) and those with lower income inequality (for example, Japan and New Zealand).

The regional variation in self rated health cannot be considered large in relation to the total variation and this is, of course, not very surprising. It is more interesting to look at the changes in regional variation between the models. Among women, there was only a change when individual characteristics (age, marital status, type of settlement, and education) were included. Perhaps these factors are more important in explaining female regional variations in self rated health. For men however, the regional variation in self rated health declined when income inequality was taken into account. Moreover, we can conclude that the effect that income inequality has on men's self rated health is not attributable to their own economic situation or that of the region in which they live.

Thus, regional income inequality in Russia seems to affect male self rated health to some extent, even though the effect cannot be seen as very strong. For women, it seems that other factors are more important. Why men seem to be more affected by income inequalities than women is a matter of speculation, but men and women may well be differently sensitive to different exposures.

Key points

- Regional income inequality in Russia seems to affect male self rated health to some extent, even though the effect cannot be seen as very strong.
- The effect that income inequality has on men's self rated health is not attributable to their own economic situation or that of the region in which they live.
- For women, it seems that other factors (age, marital status, type of settlement, and education) are more important.

ACKNOWLEDGEMENTS

I would like to thank Professor Denny Vågerö, Centre for Health Equity Studies at Stockholm University/Karolinska Institutet. I would also like to thank my colleagues at Stockholm Centre on Health of Societies in Transition, Södertörns Högskola for their help and critical reading.

Funding: this research was funded by the Swedish Baltic Sea Foundation.

Conflicts of interest: none declared.

REFERENCES

1 **Leon DA**, Chenet L, Shkolnikov VM, *et al*. Huge variation in Russian mortality rates 1984–94: artefact, alcohol, or what? *Lancet* 1997;**350**:383–8.
2 **Goskomstat**. *The demographic yearbook of Russia 2000*. Moscow: Goskomstat, 2000.
3 **Carlson P**. Risk behaviours and self rated health in Russia 1998. *J Epidemiol Community Health* 2001;**55**:806–17.
4 **Shkolnikov VM**, Cornia GA. Population crisis and rising mortality in transitional Russia. In: Cornia GA, Paniccià R, eds. *The mortality crisis in transitional economies*. Oxford: Oxford University Press, 2000:253–79.
5 **Walberg P**, McKee M, Shkolnikov V, *et al*. Economic change, crime, and mortality crisis in Russia: regional analysis. *BMJ* 1998;**317**:312–18.
6 **Kennedy BP**, Kawachi I, Brainerd E. The role of social capital in the Russian mortality crisis. *World Development* 1998;**26**:2029–43.
7 **Wilkinson RG**. *Unhealthy societies. The afflictions of inequality*. London: Routledge, 1996.
8 **Kennedy BP**, Kawachi I, Glass R, *et al*. Income distribution, socioeconomic status, and self-rated health in the United States: multilevel analysis. *BMJ* 1998;**317**:917–21.
9 **Lynch JW**, Davey Smith G, Kaplan GA, *et al*. Income inequality and mortality: importance to health of individual income, psychosocial environment, or material conditions. *BMJ* 2000;**320**:1200–4.
10 **Marmot M**, Wilkinson RG. Psychosocial and material pathways in the relation between income and health: a response to Lynch *et al*. *BMJ* 2001;**322**:1233–6.
11 **Deaton A**. Health, inequality, and economic development. *Journal of Economic Literature* 2003;**XLI**:113–58.
12 **Blakely T**, Atkinson J, O'Dea D. No association of income inequality with adult mortality within New Zealand: a multi-level study of 1.4 million 25–64 year olds. *J Epidemiol Community Health* 2003;**57**:279–84.
13 **Shibuya K**, Hashimoto H, Yano E. Individual income, income distribution, and self rated health in Japan: cross sectional analysis of national representative sample. *BMJ* 2002;**324**:1–5.
14 **McLeod CB**, Lavis JN, Mustard CA, *et al*. Income inequality, household income, and health status in Canada: a prospective cohort study. *Am J Public Health* 2003;**93**:1287–93.
15 **Bobak M**, Pikhart H, Rose R, *et al*. Socioeconomic factors, material inequalities, and perceived control in self-rated health: cross-sectional data from seven post-communist countries. *Soc Sci Med* 2000;**51**:1343–50.
16 **Goldstein H**. *Multilevel statistical models*. London: Oxford University Press, 1995.
17 **Rice N**, Leyland AH. Multilevel models: applications to health data. *Journal of Health Services Research and Policy* 1996;**1**:154–64.
18 **Duncan C**, Jones K, Moon G. Context, composition and heterogeneity: using multilevel models in health research. *Soc Sci Med* 1998;**46**:97–117.
19 **Rasbach J**, Browne W, Goldstein H, *et al*. *A users guide to MLwiN. Version 2.1*. London: University of London, 2000.
20 **Coulter F**, Cowell F, Jenkins S. Equivalence scale relativities and the extent of inequality and poverty. *The Economic Journal* 1992;**102**:1067–82.
21 **University of Tartu, Ministry of Social Affairs, United Nations Development Programme**. *Poverty reduction in Estonia: background and guidelines*, (In Estonian). Tartu: UNDP, 1999.
22 **Smith AMA**, Shelley JM, Dennerstein L. Self-rated health: biological continuum or social discontinuity? *Soc Sci Med* 1994;**39**:77–83.

THE *JECH* GALLERY

Relationships, context, and embedded systems: illustrating complexity science

Increasingly attention is focusing on the inadequacies of attempting to understand and address many contemporary health-care problems from a reductionist biomedical paradigm.[1–3] Complex adaptive systems theory redirects attention towards understanding the patterns of non-linear behaviour that emerge from contextually embedded and highly interactive agents. This picture (view from Canal Street during ManchesterPride parade 2004) shows that a broadened perspective and patterns of order can emerge from a more careful examination of the relationships between components (each window's reflection) and the dynamic interplay of embedded contexts.

Cary A Brown
School of Health Sciences, University of Liverpool, Johnston Building, Brownlow Hill, Liverpool L69 3GB, UK; cabrown@liv.ac.uk

REFERENCES

1 **Wilson T**, Holt T, Greenhalgh T. Complexity science: complexity and clinical care. *BMJ* 2001;**323**:685–8.
2 **Plsek PE**, Greenhalgh T. Complexity science: the challenge of complexity in health care. *BMJ* 2001;**323**:625–8.
3 **Sweeney K**, Griffiths F. *Complexity and healthcare: an introduction*. Oxford: Radcliffe Medical Press, 2002.