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ORIGINAL ARTICLE

Social determinants of malnutrition among Serbian children aged <5 years: ethnic and regional disparities

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Abstract
Objectives To assess the association between growth indicators of Serbian children aged <5 years of Roma and non-Roma populations and social determinants of health.
Methods This study used a cross-sectional secondary data analysis design to measure national and Roma population samples from the MICS 4 (UNICEF) performed in 2010 in Serbia. A total of 4,978 questionnaires were observed with children aged <5 years. Logistic regression analysis was performed to identify association between social determinants of health and growth indicators.
Results Roma children were more than three times more likely to exhibit stunted and/or severely stunted than non-Roma children from the lowest wealth quintile. Non-Roma children residing outside of the Belgrade region had a lower risk of stunted compared to children residing within the Belgrade region, while the risk of stunted among Roma children was nearly twofold greater than those residing in southern and eastern Serbia than in the Belgrade region.
Conclusions Our findings clarified the necessity to establish ethnically and regionally sensitive programs to solve the malnutrition problems.

Keywords Ethnicity · Regional disparities · Malnutrition · Roma · Poverty

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Introduction

Almost every culture holds that a society has the responsibility to ensure a nearly equal start in life for children, which implies the development to full health potential among all (Waterston et al. 2010; Barros et al. 2010). However, significant ethnic and regional differences exist that mast be considered in the development of global health policies. Differences in the health of individuals are largely determined by exposure to risk factors, which are, in turn, often related to social determinants of health (Marmot et al. 2012). The results of many European studies have identified the vulnerability of Roma population in Central and Eastern European (CEE) countries, which are often associated with poverty and substandard living conditions (Parekh and Rose 2011). The predominant ethnic groups in Serbia, according to the 2011 census, are: Serbian, 83.3 %; Hungarian, 3.53 %; Roma, 2.05 %; and Bosnian, 2.02 %. The official 2011 census data note that a total of 147,604 Roma reside in Serbia (Statistical Office of the Republic of Serbia 2012), which is an increase of 36 % from the previous census conducted in 2002, while the non-Roma population decreased by 4.2 % over the same period (Statistical Office of the Republic of Serbia 2012). Data collected from different surveys and the records of international and domestic organizations estimated that about 40,000–50,000 Roma were displaced from Kosovo during

the recent war and migrated to the other parts of the Republic of Serbia (The Ministry of Human and Minority rights RS 2010).

The Roma often live in substandard conditions compared to the general population and espouse particular social and cultural norms. Adequate housing is a major issue faced by the Roma population in Serbia, as many occupy dwellings made of unstable cheap materials and only 28 % of Romani settlements registered in Serbia in 2002 were constructed in accordance with standard urban building codes (UNDP 2006). Obviously, the poor living conditions of Roma have led to increased vulnerability of this minority group (Parekh and Rose 2011; Milcher 2010; Janevic et al. 2012).

Poverty is also a significant issue faced by the non-Roma population in Serbia. According to the Country Indicator for Fournier Policy Report of Assessing the State Fragility, Serbia was ranked only ahead of Macedonia and Bosnia in comparison to other countries in the Western Balkans region (Carment and Samy 2012). For example, Radovanovic and Maksimovic (2010) described regional poverty and unemployment disparities in Serbia that, we believe, have contributed to current situations.

Moreover, the lack of employment is an acute, significant and recurrent problem in Serbia. In fact the number of employed Serbians totaled 1.816.959 in March 2010, which was only 36.6 % of the total working age population (Radovanovic and Maksimovic 2010). Regionally, the percentage of unemployed in 2011 was highest in Southern and Eastern Serbia (SE Serbia), where as Vojvodina, Sumadija and Western Serbia (SW Serbia) were moderately impacted by unemployment and the Belgrade region had the lowest unemployment (Statistical Office of the Republic of Serbia 2011). In the first 6 months of 2013, the average salary was highest in the Belgrade region. In the regions of Vojvodina, SE Serbia, SW Serbia, the average salaries were 21, 30 and 31 % lower, respectively, than in the Belgrade (Statistical Office of the Republic of Serbia 2013a).

The societal impacts described above likely dictate the overall health of growing children, especially among the Roma population. According to the United Nations Children's Fund (UNICEF) and the World Health Organization (WHO) (2012), adequate nutrition during early childhood is essential to ensure proper organ formation and function, a strong immune system, and the neurological and cognitive development. However, childhood under-nutrition remains a pervasive condition in low-to middle-income countries. Therefore, the framework developed by UNICEF has emphasized the basic causes of undernutrition, which included poverty as a major cause, and the environment, economy, and the socio-political context as contributing factors (Black et al. 2008).

The aim of this study was to identify potential associations between growth indicators of Serbian children aged less than 5 years belonging to Roma and non-Roma populations, and social determinants of health, such as the wealth index, the region of Serbia and the type of settlement.

Method

Study design

UNICEF and the Statistical Office of the Republic of Serbia conducted the Multiple Indicator Cluster Survey round 4 (MICS 4) in November and December 2010. The MICS 4 in Serbia was a national representative sample survey of households, women, young men and children aged <5 years, which included: (a) a national sample representative of the entire Serbian population; (b) a sample from a Roma settlement representative of the Roma population living in Serbia. The national sample survey provided representative estimates for four regions: (1) Belgrade, (2) Vojvodina, (3) Sumadija and Western Serbia (SW Serbia), and (4) the Southern and Eastern Serbia (SE Serbia), representative of urban and rural areas. Twenty-five areas were identified as the main sampling strata. The samples were selected in two stages: (1) within each sampling strata, a specified number of proportional census counting areas were selected, and (2) after selecting households within the selected areas, each was allocated to one of two groups, those with and without children <5 years. Of the national sample of 6,885 selected households, 6,803 had children aged <5 years and 3,650 did not. Of 1,815 selected Roma households, 1,782 had children aged <5 and 1,711 did not. A random sampling approach was used to select household samples with children for the survey. The sampling plan provided reliable estimates for defined indicators at the national level and at the urban and the rural levels.

The study protocol was based on the commitment of Republic of Serbia to monitor progress towards goals from international agreement related to the Millennium Declaration and the National Plan of Action for Children. Interviewers explained the purpose of the study to all participants and informed consent was obtained from each prior to participation in compliance with the Helsinki Declaration.

The detailed methodology is described in the Multiple Indicator Cluster Survey 2011, final report (Statistical Office of the Republic of Serbia 2011).

Study instruments

In the present study, we used secondary data from two sets of questionnaires (Children-under-five questionnaire and Household questionnaire) out of the four (Children-under-five questionnaire, Household questionnaire, Women

questionnaire, and Young man questionnaire) included in the MICS survey. In addition, 3,398 children aged <5 years within the national sample were included in the household questionnaires. Completed questionnaires were obtained from households with a total of 3,374 children, which corresponded to a response rate of 99 % of the interviewed households. Among the Roma settlements, a total of 1,618 children aged <5 years were included in the household questionnaire. Completed questionnaires were obtained from households with a total of 1,604 of these children, corresponding to a response rate of 99 % of the interviewed households (Statistical Office of the Republic of Serbia and UNICEF 2011).

The administered questionnaires covered socio-demographic characteristics, anthropometric measurements of children aged <5 years, and household demographics. The Children-under-five questionnaire was administered first to mothers or primary caretakers of all children aged <5 years who were living in the household. The following data were collected from the questionnaire: child's age, birth registration, early childhood development, breast-feeding history, care of illness, and anthropometric measures (weights and heights of children were measured using anthropometric equipment recommended by UNICEF). The Household questionnaire provided data on households and household members (Statistical Office of the Republic of Serbia 2011).

Study variables and statistical analysis

Descriptive and interferential statistical methods were used for data analysis. We employed two sets of variables: (1) child socio-demographic variables and (2) anthropometric variables (growth indicators).

The following child socio-demographic variables were used to describe the socio-demographic characteristics of children <5 years: (1) gender (1: male; 2: female); (2) ethnicity (1: Roma children; 0: non-Roma children); (3) type of settlement (1: urban; 2: rural); (4) region (1: Belgrade; 2: Vojvodina; 3: SW Serbia; 4: SE Serbia); (5) child's age in months (1: 0–5 months old; 2: 6–11 months; 3: 12–23; 4: 24–35 months; 5: 36–47 months; 6: 48–59 months); (6) mother's education (1: none; 2: primary; 3: secondary; 4: higher/high); (7) wealth index (1: poorest; 2: second; 3: middle; 4: fourth; 5: richest).

The anthropometric variables (growth indicators) used in this study included: (1) length/height in regard to age (length/height-for-age); (2) weight in regard to age (weight-for-age); (3) weight in regard to length/ height (weight-for-length/height); and (4) body mass index (BMI) in regard to age (BMI-for-age).

To assess frequencies of growth indicators, we used the classification according to WHO growth standards (WHO 2006, 2008). For length/height-for-age parameter the frequencies were coded as follows: 0: normal (z score value, −2 to 3 SD from the reference population median); 1: very tall (z score >3 SD); 2: stunted (z score, −3 to −2 SD); 3: severely stunted (z score <−3 SDs). For the weight-for-age parameter, the frequencies were graded as follows: 0: normal (z score, −2 to 1 SD); 1: possible growth problem (z score >1 SD), 2: underweight (z score, −3 to −2 SD); and 3: very low weight (z score <−3 SDs). The categories for the weight-for-length/height and the BMI-for-age were as follows: 0: normal (z score, −2 to 1 SD); 1: possible risk for overweight (z score, 1 to 2 SD); 2: overweight (z score, from 2 to 3 SD); 3: obese (z score >3 SD); 4: wasted (z score, −3 to −2 SD); 5: severely wasted (z score, <−3 SD).

The chi-square test was used to assess the significant differences between the Roma and non-Roma populations in the categories defined by the child socio-demographic and anthropometric variables.

Associations between ethnicity and growth indicators were assessed using univariate and multivariate (classification) logistic regression models. Two dependent variables were used. The first (ethnicity) was used to describe associations among growth indicators in the Roma and non-Roma children. The second variable (Roma children vs. non-Roma children from the lowest wealth quintile) was used to assess the association between the growth indicators among Roma children and non-Roma children from the lowest wealth quintile, by reason of the similarity of these two groups according to the wealth index. In both models, the independent variables included the following: length/height-for-age, weight-for-age, weight-for-length/height, BMI-for-age, which were adjusted for the socio-demographic variables listed in the child socio-demographic criteria. In the first model, we included all socio-demographic variables listed in the Child socio-demographic criteria, while excluding the variable of wealth index from the second model.

The univariate and multivariate (prediction) logistic regression models were also used to define predictors of (1) stunted and severely stunted growth, (2) wasting and (3) overweight and obesity. Dependent variables included: (1) stunted and severely stunted growth (0: no; 1: <−2 SD form the reference median of height/length-for-age); (2) wasting and severely wasting (0: no; 1: <−2 SD form the reference median of weight-for-height/length); and (3) overweight and obese (0: no; 1: >2 SD of weight-for-length/height). Independent variables included: type of settlement, region and wealth index. Selection variables included: ethnicity and Roma children vs. non-Roma children from the lowest wealth quintile.

First, we performed univariate logistic analysis to assess stunting and severely stunting, wasting and severely wasting, and overweight and obese according to selection

criteria for the non-Roma children, Roma children and non-Roma children from the lowest wealth quintile. Next, multivariate logistic regression analysis was performed using all included variables in the child socio-demographic criteria. Odds ratios with estimated 95 % confidence intervals were calculated. Sample weighting was not applied in the statistical analysis in this report, thus conclusions were drawn using only the study samples and not the entire population of Serbian children aged <5 years.

Results

Mothers or other primary caretakers of a total of 5,016 children aged <5 years were asked to participate in this study, of which 4,978 questionnaires were completed, resulting in a response of 99.2 %. The range of missing data was 0–21 %. The distribution of Roma and non-Roma children based on socio-demographic characteristics is shown in Table 1. Boys and girls from the Roma and the non-Roma population were evenly represented and we found no difference in the child age parameters between groups. However, there were significant differences in the type of settlements, region, mothers' education and the wealth indices between Roma and non-Roma children (all, $p < 0.001$).

Also, there were significant differences in all measured variable indicators of growth (length/height-age, weight-age, weight-length/height, and BMI-age) between Roma and non-Roma children (all, $p < 0.001$). As shown in Table 2, non-Roma children were more frequently overweight and obese, while Roma children were more frequently wasted, stunted and severely stunted than their peers in the non-Roma population.

Table 1 Socio-demographic characteristics of Serbian children aged <5 years

Child socio-demographic characteristics	Non-Roma *N* (%)	Roma *N* (%)	Total *N* (%)	*p* value
Gender				0.333
Male	1,697 (50.7)	850 (52.2)	2,547 (51.2)	
Female	1,649 (49.3)	779 (47.5)	2,428 (48.8)	
Type of settlement				0.003**
Urban	1,894 (56.4)	1,044 (64.1)	2,938 (59.1)	
Rural	1,452 (43.4)	585 (35.9)	2,037 (40.9)	
Region				0.003**
Belgrade	594 (17.8)	349 (21.4)	943 (19.0)	
Vojvodina	1,043 (31.2)	362 (22.7)	1,414 (28.4)	
SW Serbia	1,016 (30.4)	166 (10.2)	1,182 (23.8)	
SE Serbia	693 (20.7)	744 (45.7)	1,437 (28.9)	
Child's age (months)				0.073
0–5	239 (7.1)	130 (8.0)	369 (7.4)	
6–11	305 (9.1)	133 (8.2)	438 (8.8)	
12–23	695 (20.8)	338 (20.7)	1,033 (20.8)	
24–35	709 (21.2)	336 (20.6)	1,045 (21.0)	
36–47	671 (20.1)	288 (17.7)	959 (19.3)	
48–59	727 (21.7)	404 (24.8)	1,131 (22.7)	
Mother's education				0.000**
None	12 (0.4)	366 (22.5)	378 (7.6)	
Primary	400 (12.0)	1,130 (69.4)	1,530 (30.8)	
Secondary	2,011 (60.1)	131 (8.0)	2,142 (43.1)	
Higher/high	923 (923)	2 (0.2)	925 (18.6)	
Wealth index				0.000**
Poorest	521 (15.6)	546 (33.5)	1,067 (21.4)	
Second	606 (18.1)	353 (21.7)	959 (19.3)	
Middle	636 (19.0)	263 (16.1)	899 (18.1)	
Fourth	697 (20.8)	267 (16.4)	964 (19.4)	
Richest	886 (26.5)	200 (12.3)	1,086 (21.8)	

UNICEF (2010) Multiple Indicator Cluster Survey (MICS); $N = 4{,}978$

SW Serbia Sumadija and Western Serbia, *SE Serbia* in Southern and Eastern Serbia

* $p < 0.05$; ** $p < 0.01$

Assotiation between ethnicity and growth indicators

After adjusting for gender, age, type of settlement, region, mother's education and wealth index, as shown in Table 3, Roma children were nearly threefold more likely to have stunted growth and twofold more likely to have severely stunted growth than non-Roma children (AOR = 3.23, 95 % CI 2.11–4.96 and AOR = 2.66, 95 % CI 1.60–4.41, respectively). Moreover, Roma children were twofold more likely to be underweight (AOR = 2.09, 95 % CI 1.02–4.27). In contrast, Roma children were 31 % less likely to be overweight than non-Roma children (AOR = 0.69, 95 % CI 0.46–0.99).

Moreover, the ratio of non-Roma children from the lowest wealth quintile to Roma children was adjusted for all previously defined variables, with the exception of the wealth index. Our results showed that Roma children were nearly five times more likely to be very tall, and more than three times more likely to have stunted or severely stunted growth than non-Roma children from the lowest wealth quintile (AOR = 5.37, 95 % CI 1.95–14.82; AOR = 3.38, 95 % CI 1.62–7.03; and AOR = 3.22, 95 % CI 1.79–5.78; respectively).

Predictors of stunting and severely stunting

Predictive indicators of stunted and severely stunted growth in non-Roma, Roma and non-Roma children from the lowest wealth quintile are listed in Table 4.

After adjusting, non-Roma children residing in urban areas were 36 % less likely to exhibit stunted growth than

Table 2 Growth indicators of Serbian children aged <5 years from UNICEF (2010) Multiple Indicator Cluster Survey, according to classification of World Health Organization (2006)

z score (SD)	Growth indicators							
	Length/height-for-Age		Weight-for-age		Weight-for-length/height		BMI-for-age	
	Non-Roma *N* (%)	Roma *N* (%)	Non-Roma *N* (%)	Roma *N* (%)	Non-Roma *N* (%)	Roma *N* (%)	Non-Roma *N* (%)	Roma *N* (%)
Above 3	111 (4.2)[a]	54 (4.2)[a]	1,227 (41.4)[b]	246 (16.9)[b]	153 (5.8)[c]	62 (4.8)[c]	160 (6.0)[c]	76 (5.7)[c]
Above 2	*2,389 (89.7)*[d]	*946 (72.9)*[d]			296 (11.2)[e]	112 (8.7)[e]	290 (10.9)[e]	132 (9.9)[e]
Above 1					614 (23.2)[f]	252 (19.5)[f]	625 (23.5)[f]	274 (20.6)[f]
0 (median)			*1,699 (57.3)*[d]	*1,118 (76.9)*[d]	*1,507 (57.0)*[d]	*806 (62.3)*[d]	*1,503 (56.4)*[d]	*781 (58.7)*[d]
Below-1								
Below-2	92 (3.5)[g]	186 (14.3)[g]	25 (0.8)[h]	69 (4.7)[h]	47 (1.8)[i]	36 (2.8)[i]	50 (1.9)[i]	34 (2.6)[i]
Below-3	71 (2.7)[g]	112 (8.6)[g]	15 (0.5)[j]	20 (1.4)[j]	29 (1.1)[k]	26 (2.0)[k]	35 (1.3)[k]	34 (2.6)[k]
p value	0.000**		0.000**		0.000**		0.011*	

Italic values represent the difference between children with normal growth and children with potential malnutrition

* $p < 0.05$; ** $p < 0.01$

[a] Very tall

[b] Possible growth problem

[c] Obese

[d] Normal developments

[e] Overweight

[f] A point above 1 shows possible risk, a trend towards the 2 *z* score line shows definite risk for overweight

[g] Stunted or severely stunted

[h] Under-weights

[i] Wasted

[j] Very low weight

[k] Severely wasted

their peers from rural areas (AOR = 0.64, 95 % CI 0.44–0.92). Also, non-Roma children in Vojvodina, SW Serbia, and SE Serbia were at a lower risk for stunted growth compared to children residing in Belgrade (AOR = 0.33; 95 % CI 0.21–0.52; AOR = 0.37; 95 % CI 0.24–0.59; and AOR = 0.55; 95 % CI 0.35–0.86, respectively).

Among Roma children, the incidence of stunted growth was nearly twofold greater in SE Serbia than in Belgrade (AOR = 1.73; 95 % CI 1.20–2.49). The strongest predictor of stunted growth in Roma children was the wealth index. Children belonging to the lowest wealth quintile were nearly threefold more inclined and from the second quintile, nearly two times more inclined, to exhibit stunted growth compared to their peers from the richest quintile (AOR = 2.93, 95 % CI 1.69–5.08; and AOR = 1.92, 95 % CI 1.09–3.38, respectively). Non-Roma children from the lowest wealth quintile residing in Vojvodina, SW Serbia, and SE Serbia were at a lower risk for stunted growth than their peers from the Belgrade region (AOR = 0.24, 95 % CI 0.08–0.68; AOR = 0.12, 95 % CI 0.04–0.36; and AOR = 0.21, 95 % CI 0.06–0.73, respectively).

Predictors of wasting

As shown in Table 4, among the assessed populations, wasting was not associated with the type of settlement. After adjusting, region and wealth index were identified as significant predictors of wasting in non-Roma children.Non-Roma children from SW Serbia had a 66 % lower risk of wasting compared to children from Belgrade (AOR = 0.34, 95 % CI 0.16–0.73). Also, non-Roma children from the second and fourth wealth quintile showed a 60 % lower risk of wasting (AOR = 0.37, 95 % CI 0.15–0.92; and AOR = 0.36, 95 % CI 0.17–0.77, respectively). Roma children from SW Serbia were at a nearly 100 % lower risk of wasting, while children from SE Serbia were at a 61 % lower risk than children from Belgrade (AOR = 0.08, 95 % CI 0.01–0.60; and AOR = 0.36, 95 % CI 0.19–0.68, respectively).

Predictors of overweigh and obesity

The results of our study demonstrated that the parameter "region" was the only significant predictor of becoming

Table 3 Associations between ethnicity and growth indicators of Serbian children aged <5 years from UNICEF (2010) Multiple Indicator Cluster Survey

Growth indicators	Non-Roma children vs. Roma children						Non-Roma- lowest wealth quintile vs. Roma children					
	Univariate association			Multivariate association			Univariate association			Multivariate association		
	OR	95 % CI		AOR	95 % CI		OR	95 % CI		AOR	95 % CI	
Length/height for-age												
Normal	Ref.			Ref.			Ref.			Ref.		
Very tall	1.23	0.88	1.71	2.45**	1.42	4.26	2.85**	1.29	6.33	5.37**	1.95	14.82
Stunted	5.11**	3.93	6.63	3.23**	2.11	4.96	3.83**	2.32	6.29	3.22**	1.79	5.78
Severely stunted	3.98**	2.93	5.41	2.66**	1.60	4.41	3.19**	1.78	5.73	3.38**	1.62	7.03
Weight-for age												
Normal	Ref.			Ref.			Ref.			Ref.		
Possible growth problem	0.30**	0.26	0.35	0.39**	0.31	0.50	0.36**	0.29	0.46	0.45**	0.33	0.62
Underweight	4.19**	2.64	6.67	2.09*	1.02	4.27	2.04	0.97	4.29	1.62	0.68	3.86
Very low weight	2.03*	1.03	3.97	0.97	0.37	2.55	0.59	0.26	1.35	0.77	0.26	2.28
Weight-for length/height												
Normal	Ref.			Ref.			Ref.			Ref.		
Possible risk for overweight	0.77**	0.65	0.91	0.83	0.62	1.09	0.76	0.57	1.01	0.92	0.64	1.33
Overweight	0.71**	0.56	0.89	0.69*	0.46	0.99	0.66*	0.45	0.96	0.83	0.50	1.38
Obese	0.76	0.56	1.03	0.70	0.43	1.15	0.84	0.49	1.42	0.76	0.39	1.46
Wasted	1.43	0.92	2.23	1.53	0.69	3.38	0.89	0.44	1.78	1.63	0.59	4.48
Severely wasted	1.68	0.98	2.87	1.92	0.86	4.29	1.41	0.54	3.72	2.07	0.69	6.16
BMI for age												
Normal	Ref.			Ref.			Ref.			Ref.		
Possible risk for overweight	0.84*	0.71	0.99	0.87	0.66	1.16	0.89	0.67	1.18	0.87	0.60	1.26
Overweight	0.88	0.70	1.09	0.82	0.57	1.18	0.81	0.56	1.17	0.97	0.58	1.57
Obese	0.91	0.69	1.22	0.72	0.46	1.14	0.93	0.57	1.53	0.69	0.37	1.28
Wasted	1.31	0.84	2.04	1.53	0.69	3.34	1.20	0.55	2.63	1.69	0.57	4.95
Severely wasted	1.87*	1.16	3.02	2.22*	1.05	4.67	1.20	0.55	2.63	1.52	0.60	3.85

In model, non-Roma children vs. Roma children we included: age, gender, mother's education, welth status, region and the type of settlement. In model, non-Roma children from the lowest wealth quintile vs. Roma children, we included all socio-demographics variables listed above excluding of wealth index

* $p < 0.05$; ** $p < 0.01$

overweight or obese among non-Roma and Roma children alike. Non-Roma children from Vojvodina had a 34 % lower risk of being overweight, while Roma children from SW Serbia had a 61 % less chance of being overweight than their peers from Belgrade (AOR = 0.66, 95 % CI 0.48–0.89; and AOR = 0.39, 95 % CI 0.18–0.85, respectively) (Table 4).

Discussion

Malnutrition is a global public health concern and has been correlated to both under-nutrition and the obesity (Mehta et al. 2013). The association between poverty and malnutrition is well-established, as is poverty as a negative predictor of healthy child development and childrearing (Bornstein et al. 2012). Countries with positive economic growth, such as China, have achieved improved nutritional status of children nationally (De Brauw and Mu 2011). However, Roma children in settlements in Serbia live in extreme poverty and are socially marginalized, as demonstrated by substandard living conditions (United Nations Development Programme 2006). A review article by Cook et al. (2013) described considerable evidence of poorer nutrition among Roma children and the results of our study indicated that ethnic affiliation was a significant predictor of stunted and severely stunted growth among Serbian children. In accordance, in comparisons of Roma and non-Roma children from the lowest wealth quintile, ethnicity remained a significant predictor of stunted growth. In fact, our results showed that Roma children had a threefold greater risk of stunted growth compared to non-Roma children from the lowest wealth quintile, even after adjusting the data for sex, age, mother's education, region

Table 4 Predictors of stunting, wasting and obesity among Roma, non-Roma and non-Roma children from the lowest wealth quintile in Serbia from UNICEF (2010) Multiple Indicator Cluster Survey (MICS)

	Univariate association						Multivariate association					
	Non-Roma		Roma		Non-Roma—lowest wealth quintile		Non-Roma		Roma		Non-Roma—lowest wealth quintile	
	OR (95 % CI)		OR (95 % CI)		OR (95 % CI)		AOR (95 % CI)		AOR (95 % CI)		AOR (95 % CI)	
Predictors of stunting and severely stunting												
Type of settlement												
Rural	Ref.		Ref.		Ref.		Ref.		Ref.		Ref.	
Urban	0.56**	0.41–0.76	0.63**	0.49–0.81	–	–	0.64**	0.44–0.92	0.81	0.62–1.05	0.32	0.09–1.07
Region												
Belgrade	Ref.		Ref.		Ref.		Ref.		Ref.		Ref.	
Vojvodina	0.44**	0.29–0.68	1.79**	1.20–2.66	0.27*	0.10–0.74	0.33**	0.21–0.52	1.23	0.81–1.87	0.24**	0.08–0.68
SW Serbia	0.54**	0.36–0.82	0.70	0.38–1.28	0.15**	0.05–0.47	0.37**	0.24–0.59	0.65	0.35–1.19	0.12**	0.04–0.36
SE Serbia	0.74	0.48–1.13	1.98**	1.39–2.82	0.31	0.09–1.01	0.55**	0.35–0.86	1.73**	1.20–2.49	0.21*	0.06–0.73
Wealth index												
Richest	Ref.		Ref.		Ref.		Ref.		Ref.		Ref.	
Lowest	1.75*	1.08–2.83	3.76**	2.24–6.32	–	–	0.95	0.51–1.76	2.93**	1.69–5.08	–	–
Second	1.67*	1.05–2.67	2.46**	1.42–4.26	–	–	1.17	0.67–2.05	1.92*	1.09–3.38	–	–
Middle	1.50	0.93–2.41	1.81*	1.01–3.27	–	–	1.17	0.69–1.98	1.50	0.82–2.74	–	–
Fourth	1.20	0.73–1.96	1.68	0.93–3.04	–	–	1.11	0.67–1.83	1.42	0.78–2.56	–	–
Predictors of wasting												
Type of settlement												
Rural	Ref.		Ref.		Ref.		Ref.		Ref.		Ref.	
Urban	1.25	0.78–1.99	0.95	0.56–1.60	–	–	1.18	0.67–2.08	0.81	0.46–1.42	0.26	0.03–2.04
Region												
Belgrade	Ref.		Ref.		Ref.		Ref.		Ref.		Ref.	
Vojvodina	0.56	0.30–1.05	0.72	0.38–1.37	0.55	0.11–2.79	0.55	0.29–1.06	0.70	0.35–1.41	0.54	0.10–2.83
SW Serbia	0.34**	0.17–0.71	0.09*	0.01–0.64	0.30	0.05–1.73	0.34**	0.16–0.73	0.08*	0.01–0.60	0.26	0.04–1.50
SE Serbia	1.03	0.56–1.88	0.39**	0.21–0.72	0.62	0.09–3.89	0.99	0.53–1.86	0.36**	0.19–0.68	0.52	0.08–3.43
Wealth index												
Richest	Ref.		Ref.		Ref.		Ref.		Ref.		Ref.	
Poorest	0.84	0.46–1.56	1.05	0.46–2.40	–	–	0.81	0.35–1.88	0.95	0.39–2.32	–	–
Second	0.36*	0.16–0.78	0.49	0.17–1.36	–	–	0.37*	0.15–0.92	0.52	0.18–1.51	–	–
Middle	0.47*	0.23–0.94	1.05	0.41–2.65	–	–	0.48	0.23–1.03	1.09	0.42–2.84	–	–
Fourth	0.35**	0.16–0.74	1.23	0.49–3.02	–	–	0.36**	0.17–0.77	1.38	0.55–3.46	–	–
Predictors of overweighting and obesity												
Type of settlement												
Rural	Ref.		Ref.		Ref.		Ref.		Ref.		Ref.	
Urban	0.84	0.68–1.02	1.32	0.94–1.85	–	–	0.85	0.67–1.08	1.36	0.95–1.94	0.71	0.35–1.42
Region												
Belgrade	Ref.		Ref.		Ref		Ref		Ref		Ref	
Vojvodina	0.69*	0.51–0.93	0.94	0.59–1.48	0.57	0.21–1.54	0.66**	0.48–0.89	0.99	0.61–1.60	0.60	0.22–1.61
SW Serbia	0.97	0.72–1.29	0.38	0.17–0.83	0.56	0.21–1.51	0.91	0.67–1.23	0.39*	0.18–0.85	0.54	0.20–1.47
SE Serbia	1.13	0.83–1.53	0.96	0.64–1.42	0.98	0.34–2.83	1.07	0.78–1.46	0.95	0.63–1.43	0.97	0.33–2.82
Wealth index												
Richest	Ref.		Ref.		Ref.		Ref.		Ref.		Ref.	
Poorest	1.08	0.78–1.49	1.23	0.69–2.17	–	–	0.80	0.53–1.21	1.33	0.72–2.44	–	–
Second	1.29	0.96–1.75	1.26	0.69–2.36	–	–	1.03	0.72–1.48	1.36	0.73–2.53	–	–
Middle	1.23	0.91–1.66	1.39	0.74–2.59	–	–	1.04	0.75–1.45	1.43	0.76–2.72	–	–

Table 4 continued

	Univariate association						Multivariate association					
	Non-Roma		Roma		Non-Roma—lowest wealth quintile		Non-Roma		Roma		Non-Roma—lowest wealth quintile	
	OR (95 % CI)		OR (95 % CI)		OR (95 % CI)		AOR (95 % CI)		AOR (95 % CI)		AOR (95 % CI)	
Fourth	1.22	0.91–1.63	1.57	0.85–2.90	–	–	1.12	0.82–1.51	1.57	0.84–2.93	–	–

Multivariate models were adjusted for all child socio-demographic variables with exception of measured prediction variable

SW Serbia Sumadija and Western Serbia, *SE Serbia* in Southern and Eastern Serbia

* $p < 0.05$; ** $p < 0.01$

and the type of settlement. The results of current UNICEF data and an MICS 3 conducted by Falkingham et al. (2012) identified variations in malnutrition status between ethnicities in all CEE countries, emphasizing that the rate of chronic malnutrition among the Roma population is especially predominant in Serbia, Montenegro and Macedonia. Moreover, previous studies from the Czech Republic and Slovakia reported differences in nutrition status between Roma, Czech and Slovak populations (Koupilová et al. 2001).

Regional disparities of malnutrition are extensively described in the literature (Koupilová et al. 2001; El-Mouzan et al. 2010; Arnold et al. 2004; Van de Poel et al. 2007; Ngare and Muttunga 1999; Larrea and Freire 2002). A study of Saudi children reported a greater prevalence of stunting, wasting and underweight the southwestern regions of the country compared to other regions (El-Mouzan et al. 2010). Also, reports from India showed large disparities among different states and point out that undernutrition is most pronounced in Bihar, Uttar Pradesh, Madhya Pradesh and Rajasthan (Arnold et al. 2004). Regional disparities are often connected with the level of poverty among regions (Koupilová et al. 2001). For example, a study by Van de Poeland et al. (2007) showed that the four most deprived regions of Ghana (Northern, Central, Upper East and Western regions) had the greatest burden of malnutrition. Our study showed that the risk of stunted growth among Roma children is significantly increased by living in SE Serbia. Notably, current census data show that the highest unemployment rate is in SE Serbia region and, in addition, this region is characterized by the highest number of Roma settlements (Statistical Office of the Republic of Serbia 2012). Besides, areas surrounding SE Serbia are frequently used to cross the border into Kosovo by Roma people (United Nations Development Programme 2006). A study conducted by Janevic et al. (2010), reported a nearly twofold increase in risk for stunted growth in Roma children in Belgrade compared to those in Central Serbia, which is in opposition to the findings of our study. A possible explanation for these discrepancies includes forced evictions in Belgrade, which has rapidly increased since May 2009, following the introduction of the "Action Plan for the Resettlement of Unhygienic Settlements" by the City of Belgrade (Amnesty International 2011). This plan led to uncertainty among most Roma people who were permanently accommodated in established settlements in Serbia at that time.

Regional differences were also identified among non-Roma population in different regions, where the risk of stunted growth after adjustment was lower in all other regions than in Belgrade. Frequently, non-Roma population migrate from homes in various villages to Belgrade (Mirkovic 2010), where they work for minimal wages and pay disproportionately high rents. During the period between the two latest censuses, the population of Belgrade has increased by 5.3 %, while the number of the inhabitants in Central Serbia and Vojvodina has decreased by 8.2 and 5.2 %, respectively (Statistical Office of the Republic of Serbia 2012). Our study indicated that non-Roma children residing outside of Belgrade are at a lower risk of stunted growth, even after adjusting for other social determinants of health. A possible explanation for this finding is the tendency of parents from Belgrade to work until late in the afternoon and the subsequent augmentation of the time that their children spend at nurseries and kindergartens. Hence, the Belgrade region had the highest percentage of nursery attendance in 2012/2013 and this region also had the highest percentage of children who spent more than 9 h at a nursery, in comparison to the regions of SW Serbia, Vojvodina and SE Serbia (Statistical Office of the Republic of Serbia 2013b). Our results also indicated that children residing in Vojvodina were at a lower risk of obesity in comparison to children in the Belgrade region. This was an unexpected result, considering the local dietary habits of this region. Hence, further research in this direction may prove interesting. Furthermore, we are compelled to acknowledge the disproportion at number of refugees from the former Yugoslavia who settled in Vojvodina, as this population has distinct dietary customs that may have influenced our results. Our study

showed that wealth status, was a strong predictor of stunted growth of children aged <5 years, in accordance with the findings of many previous studies (Van de Poel et al. 2007; Urke et al. 2011; Kanjilal et al. 2010).

Our study had several limitations. First, we used secondary data from a cross-sectional study. Also, the data describing Roma children are representative of those residing in Central Serbia, Vojvodina and the Belgrade region. Nonetheless, we analyzed data collected from regions of Central Serbia as SW Serbia and SE Serbia as defined in the national sample and the differences between these regions, as described by the census data. Finally, the primary aim of our analysis was to obtain a regional picture of impoverished children compared to the national sample of non-Roma children. Lastly, the estimated number of the Roma population in Serbia is reportedly much higher than described in the official census data, accounting for 6,00,000 persons or 8.8 % of the total population (Parekh and Rose 2011), which may have affected the sampling procedures.

From the perspective of social determinants of health, it is important to consider both ethnic and regional disparities at the micro-level. Local studies of the living conditions of vulnerable groups provide detailed evidence of the impacts of child malnutrition. Hence, the findings of such studies should be incorporated into global health policy framework. Political commitment and knowledge at the national and international levels are essential to reduce social inequities. Although empirical findings have shown that the overall progress and the implementation of programs specifically created in order to reduce social inequities have been affected by: (1) the scarcity of money, (2) insufficient monitoring and data for analysis,(3) the lack of governance and accountability, and (4) insufficient participation by the Roma people (Marmot et al. 2012), the political will must be maintained to continue to fund ethnically and regionally sensitive nutrition programs to feed children-at-need.

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