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Running Head: The Extent of Overweight Among US Children

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Abstract

Context. The prevalence of overweight among children in the United States has increased during the last three decades, but prevalence measures fail to reveal that the extent to which overweight children exceed the overweight threshold.

Objective. To measure the amount by which overweight children exceed the overweight threshold. To examine the trend in this measure over the last three decades using data with measured weights and heights.

Design, Setting and Participants. Data used for analysis are from the National Health and Nutrition Examination Survey (NHANES) for persons between 2 and 19 years of age from 1971 to 2000. Anthropometric measures were obtained by trained health technicians, and the sample sizes range from 4,037 in 1999-2000 to 10,590 in 1988-1994.

Main Outcome Measure. The extent of overweight is measured as the average amount by which each child's body mass index (BMI) exceeds their age-and-gender specific overweight threshold. This measure is examined by sex, age group, and race/ethnicity. The overweight threshold for those aged 2 through 19 years is defined as at or above the 95th percentile of the sex-specific BMI for age growth charts.

Results. The extent of child overweight has been increasing faster than the prevalence of child overweight for all classifications considered in this paper, including the analysis by age, sex, race and ethnicity. The prevalence of overweight for children age 2 through 19 years increased by 182 percent between 1971-1974 and 1999-2000, while the extent of overweight increased by 247 percent over the same time period.

Conclusions. Unlike prevalence measures, the measure of the extent of child overweight is sensitive to changes in the BMI distribution of the overweight. This analysis reveals that not only have more children become overweight in the last three decades, but overweight children have been getting heavier.

Key Words: Child and Adolescent Overweight, Obesity, Body Mass Index, NHANES.

1. Introduction

Data from the 1999-2000 National Health and Nutrition Examination Survey (NHANES) indicate that the overweight prevalence in US children and adolescents has continued to increase through the 1990s.[1] Overweight prevalence for children between the ages of 2 and 19 years was 10 percent in 1988-1994 (age-adjusted to 2000 Census population estimates) and this increased to 14.4 percent by 1999-2000. Overweight children face increased risk of morbidity from coronary heart disease, hypertension and diabetes mellitus;[2, 3, 4] and children who are overweight are more likely to become overweight adults.[5, 6] Due to the increasing prevalence of both child and adult overweight, the Surgeon General reports that being overweight could soon overtake tobacco usage as the primary cause of preventable death in the United States.[7, 8]

A child or adolescent is considered overweight if their body mass index (BMI, defined as weight in kilograms divided by the square of height in meters) is at or above the 95th percentile of the revised 2000 Center for Disease Control (CDC), sex-specific BMI for age growth charts.[9] The CDC growth charts for children and adolescents are based on nationally representative data obtained from 5 surveys conducted between 1963 and 1994 (cycles II and III of the National Health and Examination Survey and rounds I, II, III of the National Health and Nutrition Examination Survey).

Prevalence indices describe the proportion of overweight children in the population, but provide no information on the extent to which they exceed the threshold. Research indicates that the risks of health problems for adults associated with being overweight are increasing in BMI (or in other words, someone who is 50 percent overweight faces greater health risks than someone who is 10 percent overweight).[10, 11, 12] For example, the risk of heart failure increases 5 percent in adult men and 7 percent in adult women with a unit increase in BMI.[11] Similarly, a one-unit increase in BMI is associated with a 6 percent increase in the relative risks of total, ischemic and

hemorrhagic stroke for men.[12] Because prevalence indices censor all information about the distribution of BMI, except whether it is above or below the overweight cutoff, they mask important information about the extent of the health problem. While research has not directly shown that health risks are also increasing in BMI for children and adolescents, this paper assumes that the evidence for adults warrants concern about the BMI distribution of overweight children. The purpose of this paper is to describe a measure of overweight that provides information on both the prevalence and extent (the extent to which BMI exceeds the overweight threshold) of child overweight. This measure can help to establish whether the prevalence of child overweight sufficiently describes the health problem or if there is more to be learned from a measure that is sensitive to changes in the BMI distribution of the overweight.

2. Methods

The data used in this paper are from four rounds of the National Health and Nutrition Examination Survey (NHANES), which is conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention. The NHANES samples are representative of the U.S. civilian, non-institutionalized population and observations were selected following a stratified, multi-stage design. Measures of child overweight are estimated at four points in time: 1971-1974 (NHANES I), 1976-1980 (NHANES II), 1988-1994 (NHANES III) and 1999-2000 (two-year cycle NHANES). Anthropometric measures were obtained by trained health technicians, and effective sample sizes of children and adolescents between 2 and 19 years of age range from 4,037 in 1999-2000 to 10,590 in 1988-1994 (NHANES III).

To measure the extent of child overweight, this paper considers the following index:

$$OW = 1/n \sum_i I(BMI_i \geq f_i)[(BMI_i - f_i)/f_i] \quad (1)$$

where n is the sample size, i subscripts the child, f is the cutoff point identifying who is overweight, and I is an indicator function which takes the value of one if the statement is true and zero otherwise. More specifically, the indicator function will take the value of one if the child is overweight and zero if the child's BMI is less than the 95th percentile of the sex-specific BMI for age growth charts. This paper also examines children and adolescents who are at risk of being overweight, in which case the 85th percentile is used as the threshold value for f_i.

I refer to the term in square brackets, $[(BMI_i-f_i)/f_i]$, as the proportionate overweight gap because it measures the amount by which each overweight child's BMI exceeds their overweight threshold, and this amount is expressed as a proportion of the threshold. Examination of this term reveals that OW treats BMI as a continuous variable for the overweight population. It embeds the assumption that public health worsens as average BMI increases in the overweight population. This is in contrast to the prevalence measure which views overweight as a dichotomous outcome, and is not sensitive to the extent to which the overweight exceed their threshold. Expressing excess BMI as a proportion of the overweight threshold is particularly important for children since the threshold varies by age and sex. The resulting measure, OW, is the sum of the proportionate overweight gaps divided by the sample size, or the sample average value of the proportionate overweight gaps. (In the case where BMI is less than the threshold, the indicator function is zero, and so too is the product of the two terms.)

To illustrate this measure, consider for example, an eight-year old boy with a BMI of 22. His overweight threshold is approximately 20, and his proportionate overweight gap is ten percent. Consider now another boy with a BMI of 22, but this one is nine years old instead of eight. This

older boy has an overweight threshold of about 21 and his proportionate overweight gap would be just under five percent. An examination of the prevalence of child overweight would register both of these boys as overweight, and both would contribute equally to the prevalence measure. In contrast, the OW measure captures the fact that the eight-year old boy is more overweight than the nine-year old boy and thereby provides a measure of the extent of overweight problem. OW will increase when the prevalence of overweight increases, but unlike the prevalence measure, it will also increase when the overweight become heavier on average.

The usefulness of this measure can further be illustrated by considering an overweight person who gains weight. This weight gain has no effect on the overweight prevalence, but the health of this person has changed and this change is reflected through an increase in OW. In terms of describing the magnitude of the public-health problem and in shaping public-health policy, OW provides important information. For example, consider a hypothetical health policy that focused on helping the extremely overweight loose weight. If successful, this policy would result in an improvement in public health which would be indicated by a lowering of OW, but there might very well be no change in the prevalence measure.

The average extent of overweight for the *entire* population, OW, when combined with information about the prevalence of overweight, additionally provides insight into the extent of overweight for the *overweight* population. The interpretation of the ratio of OW to prevalence can be seen by noting that the OW measure is the sample sum of the proportionate overweight gaps divided by the entire sample size, n. The overweight prevalence measure can be expressed as the number of overweight in the sample, say n_j, divided by the sample size n. Dividing OW by the overweight prevalence results in the sum of the proportionate overweight gaps divided by n_j, the sample size of those who are overweight. This ratio is then the average proportionate amount by which the overweight exceed their BMI threshold.

For example, if this ratio is equal to 0.15 this means that on average, the overweight are fifteen percent in excess of their thresholds. Increases in this measure indicate that the overweight are becoming increasingly overweight on average. As a measure of the public-health problem though (and in contrast to OW), this measure has the undesirable characteristic that it is not monotonically increasing in BMI. For example, if a child's BMI increases and moves from being classified as not overweight to overweight, then OW will increase. The average amount by which the overweight exceed their threshold may actually decline, though, because this new overweight child will likely bring down the average value of excess BMI of the overweight. Nonetheless, when combined with information about the prevalence and extent of overweight, this ratio readily conveys important information about the BMI distribution of the overweight population. It is useful to note that an alternative method of treating BMI as a continuous variable would be to plot out and compare shifts in the BMI distribution over time. A comparison of NHANES II and NHANES III illustrates that indeed the entire BMI distribution appears to be shifted to the right between 1976 and 1994.[13]

3. Results

Tables 1 – 4 all provide weighted estimates of OW, the overweight prevalence, and the ratio of these two measures. The sample weights reflect the unequal probability of selection resulting from the sample design (including corrections for oversampling) and also correct for nonresponse. All standard errors correct for the stratified and multi-stage nature of the sample design. Estimates from NHANES I, II, and III are based on the NHANES pseudo-strata and pseudo-PSUs.[14] In the case of the NHANES 1999 – 2000 cycle, no pseudo design variables are yet available in these files, so the standard errors are derived following the method of balanced repeated replication with Fay's adjustment parameter set to 0.8.[15]

Table 1 presents estimates of overweight and at risk of being overweight for ages 2 through 19. At risk of overweight is defined as having a BMI at or above the 85th percentile of the sex-specific BMI for age growth charts. The estimates are age-standardized by the direct method to the 2000 population estimates to adjust for the changing distribution of age over the decades. The patterns of change for overweight and at risk of overweight are similar. During the 1970s there was little change, with the overweight prevalence around 5 percent and the at-risk-of-overweight prevalence at 15 percent. During the 1980s and 1990s both measures increased dramatically. By 1999-2000, 14.4 percent of children and adolescents were overweight and 28.4 percent were at risk of being overweight.

[INSERT TABLE 1 APPROXIMATELY HERE]

While this significant increase in both prevalence measures is alarming, the increase in the extent of overweight was larger. Between 1971-1974 and 1999-2000 the overweight prevalence increased by 182 percent while the extent of overweight, OW, increased by 247 percent. The increasing extent of overweight has resulted both from the increasing prevalence and also from noting that in 1971-1974, overweight children were on average 12 percent in excess of their thresholds. By 1999-2000, overweight children were 14 percent in excess of their thresholds. The increasing extent of overweight indicates that the health risks associated with excess adipose are likely even greater than what is indicated by the increased prevalence rates. More children are becoming overweight, and these overweight children are getting heavier on average.

The same phenomenon is occurring with at risk of overweight. The extent of this measure increased at more than twice the pace of the increase in the prevalence rate. Again this result is driven by both the increasing at-risk-of-overweight prevalence and a mean shift in the BMI

distribution of the at-risk children. In 1971-1974 those children who were at risk of being overweight were on average 12 percent over their at-risk thresholds (85th percentiles of the sex-specific BMI for age growth charts). By 1999-2000, the at-risk children were on average 18 percent in excess of their thresholds. The fast-paced growth of children who are at risk of being overweight and the extent of this measure indicates that there is significant risk that the growth in child overweight will continue in the near future.

[INSERT TABLE 2 APPROXIMATELY HERE]

Table 2 examines child overweight by three age categories (2-5 years, 6-11 years and 12-19 years). Over each category, the prevalence of overweight more than doubled between 1971-1974 and 1999-2000, with the greatest increase in prevalence for those between the ages of 6 and 11 years. For each age category, the extent of overweight, OW, increased at a rate faster than the increasing prevalence. The increase in the average amount by which overweight children exceed their threshold was relatively small, increasing from 8 to 9 percent for ages 2-5 years and from 11 to 13 percent for ages 6-11 years. The largest increase in this measure is for adolescents between the ages of 12 and 19 years. In 1971-1974 (and 1976-1980), overweight adolescents were on average 13 percent in excess of their overweight thresholds, and by 1999-2000 this increased to 17 percent.

Breaking out adolescents by sex provides a further example of the usefulness of examining the extent of overweight, OW. The change in overweight prevalence between 1971-1974 and 1999-2000 was very similar for male and female adolescents. Both rates were slightly higher than 6 percent in the early 1970s and both were 15.5 percent in 1999-2000, suggesting essentially no sex differences in adolescent overweight. The measure of the extent of overweight though, reveals that

there have been important differences. In the early 1970s, male adolescents had a lower extent of overweight than female. An implication of this is that in 1971-1974, overweight male adolescents were on average 11 percent in excess of their overweight threshold, while overweight female adolescents were much more overweight on average (15 percent in excess of their thresholds). By 1999-2000, this sex difference vanished and overweight adolescent boys were slightly more overweight than adolescent girls. This relative change in the sex-distribution of the extent of overweight is readily observed by noting that the growth rate of OW for adolescent boys was 293 percent compared to 165 percent for adolescent girls between 1971-1974 and 1999-2000.

[INSERT TABLE 3 APPROXIMATELY HERE]

Table 4 provides a final example of the additional information gained from the measure of the extent of overweight. An analysis of the prevalence of adolescent overweight by race and ethnicity indicates that non-Hispanic Blacks have the highest prevalence (23.6 percent) with a rate that is just less than twice the rate for non-Hispanic whites (12.7 percent). The measure of the extent of overweight for non-Hispanic Blacks is more than 2.8 times greater than the measure of extent for non-Hispanic Whites. These measures reveal that overweight non-Hispanic Blacks are on average 23 percent in excess of their overweight threshold while this figure for non-Hispanic Whites is much lower at 15 percent. The overweight prevalence measure indicates that this health problem is more pervasive for non-Hispanic Blacks than for Hispanics and non-Hispanic Whites, and the measure of the extent indicates that the health issues associated with being overweight are likely to be more severe for non-Hispanic Blacks.

[INSERT TABLE 4 APPROXIMATELY HERE]

4. Conclusion

This paper examines children and considers a measure of overweight that is sensitive to both changes in the prevalence of overweight and also to changes in the BMI distribution of the overweight. This measure, OW, is referred to as the extent of overweight because it measures the average amount by which the population exceeds the overweight threshold. While previous research has shown that the prevalence of child overweight has increased between 1971-1974 and 1999-2000, the extent of overweight has been increasing at a faster rate. In other words, not only has the proportion of overweight children been increasing, but it is also the case that overweight children have been getting steadily more overweight. The extent of child overweight has been increasing faster than the prevalence of child overweight for all classifications considered in this paper, including the analysis by age, sex, race and ethnicity.

Research indicates that health risks for adults are increasing in BMI and therefore shifts in the BMI distribution of overweight adults has important health implications. The research in this paper indicates that there have been large shifts in the BMI distribution of overweight children that the overweight prevalence doesn't fully reveal. This finding suggests that future research into the health consequences of child and adolescent overweight would add useful insights by examining whether health risks for children are increasing in BMI, as they are for adults. If this is the case, then the implication of the results in this paper is that the public-health problem of child overweight is even greater than what is revealed by the increasing overweight prevalence rates.

Table 1: Overweight and at Risk of Overweight, Ages 2-19 Years

Indices of Overweight	1971-1974	1976-1980	1988-1994	1999-2000	Change: 1971-2000
Panel A: At Risk, Ages 2-19					
Prevalence	15.3	14.7	23.1	28.4	86%
	(0.65)	(0.53)	(0.98)	(1.27)	
Extent, OW	1.9	2.0	3.8	5.1	174%
	(0.1)	(0.13)	(0.31)	(0.39)	
Avg. Overweight Gap[1] (OW/Prevalence)*100	12%	13%	16%	18%	
Panel B: Overweight, Ages 2-19					
Prevalence	5.1	5.5	10	14.4	182%
	(0.3)	(0.38)	(0.58)	(0.71)	
Extent, OW	0.6	0.7	1.5	2.0	247%
	(0.05)	(0.07)	(0.19)	(0.14)	
Avg. Overweight Gap[1] (OW/Prevalence)*100	12%	12%	15%	14%	
Sample Size	*7,037*	*7,349*	*10,590*	*4,037*	

[1] Average Overweight Gap is the average amount by which the overweight population exceeds the overweight threshold, expressed as a percent of the threshold.

Source: NHANES I, II, III, 1999-2000 NHANES.

Notes: At risk of overweight is defined as a BMI for age at the 85th percentile or higher, and overweight is defined as a BMI for age at the 95th percentile or higher. Indices are multiplied by 100 and estimated with the exam sample weights. Estimates for ages 2 to 19 years are age-standardized by the direct method to the 2000 Census population using age groups 2-4, 5, 6-8, 9, 10-11, 12-14, 15-17, 18-19. Standard errors, in parentheses and also multiplied by 100, are corrected for sample-design effects.

Table 2: Child and Adolescent Overweight by Age

Indices of Overweight	1971-1974	1976-1980	1988-1994	1999-2000	Change: 1971-2000
Panel A: Ages 2-5					
Prevalence	4.9	5.0	6.9	10.4	112%
	(0.57)	(0.59)	(0.79)	(1.19)	
Extent, OW	0.4	0.4	0.9	1.0	158%
	(0.06)	(0.05)	(0.27)	(0.13)	
Avg. Overweight Gap[1] (OW/Prevalence)*100	8%	7%	12%	9%	
Sample Size	*2,342*	*3,007*	*3,858*	*739*	
Panel B: Ages 6-11					
Prevalence	3.9	6.5	11.5	15.3	293%
	(0.53)	(0.64)	(0.98)	(1.18)	
Extent, OW	0.4	0.9	1.7	2.0	354%
	(0.08)	(0.13)	(0.18)	(0.21)	
Avg. Overweight Gap[1] (OW/Prevalence)*100	11%	14%	15%	13%	
Sample Size	*2,057*	*1,754*	*3,515*	*1,054*	
Panel C: Ages 12-19					
Prevalence	6.1	5.1	10.4	15.5	153%
	(0.59)	(0.48)	(0.91)	(0.84)	
Extent, OW	0.8	0.7	1.7	2.6	220%
	(0.09)	(0.1)	(0.32)	(0.19)	
Avg. Overweight Gap[1] (OW/Prevalence)*100	13%	13%	16%	17%	
Sample Size	*2,638*	*2,588*	*3,217*	*2,244*	

[1] Average Overweight Gap is the average amount by which the overweight population exceeds the overweight threshold, expressed as a percent of the threshold.

Source: NHANES I, II, III, 1999-2000.

Notes: Overweight is defined as a BMI for age at the 95th percentile or higher. Indices are multiplied by 100 and estimated with the exam sample weights. Standard errors, in parentheses and also multiplied by 100, are corrected for sample-design effects.

Table 3: Overweight by Sex, Ages 12-19 Years

Indices of Overweight	1971-1974	1976-1980	1988-1994	1999-2000	Change: 1971-2000
Panel A: Adolescent Boys, Ages 12-19					
Prevalence	6.1	4.8	11.2	15.5	155%
	(0.8)	(0.51)	(01.19)	(01.13)	
Extent, OW	0.7	0.6	2.0	2.7	293%
	(0.09)	(0.13)	(0.51)	(0.28)	
Avg. Overweight Gap[1] (OW/Prevalence)*100	11%	13%	18%	17%	
Sample Size	*1,324*	*1,349*	*1,565*	*1,155*	
Panel B: Adolescent Girls, Ages 12-19					
Prevalence	6.2	5.3	9.7	15.5	152%
	(0.76)	(0.77)	(1.11)	(1.13)	
Extent, OW	0.9	0.7	1.5	2.5	165%
	(0.15)	(0.15)	(0.25)	(0.24)	
Avg. Overweight Gap[1] (OW/Prevalence)*100	15%	13%	15%	16%	
Sample Size	*1,314*	*1,239*	*1,652*	*1,089*	

[1] Average Overweight Gap is the average amount by which the overweight population exceeds the overweight threshold, expressed as a percent of the threshold.

Source: NHANES I, II, III, 1999-2000.

Notes: Overweight is defined as a BMI for age at the 95th percentile or higher. Indices are multiplied by 100 and estimated with the exam sample weights. Standard errors, in parentheses and also multiplied by 100, are corrected for sample-design effects.

Table 4: Overweight by Race and Ethnicity, Ages 12-19 Years

Indices of Overweight	1971-1974	1976-1980	1988-1994	1999-2000	Change: 1971-2000
Panel A: Nonhispanic White Adolescents					
Prevalence	5.7	4.2	9.8	12.7	123%
	(0.63)	(0.47)	(1.25)	(1.2)	
Extent, OW	0.7	0.5	1.6	1.9	165%
	(0.11)	(0.11)	(0.44)	(0.28)	
Avg. Overweight Gap[1] (OW/Prevalence)*100	13%	12%	17%	15%	
Sample Size	*1,841*	*1,954*	*837*	*470*	
Panel B: Nonhispanic Black Adolescents					
Prevalence	7.6	8.5	14.5	23.6	212%
	(1.56)	(1.4)	(1.02)	(1.45)	
Extent, OW	1.4	1.3	2.8	5.4	292%
	(0.35)	(0.34)	(0.28)	(0.39)	
Avg. Overweight Gap[1] (OW/Prevalence)*100	18%	16%	19%	23%	
Sample Size	*618*	*401*	*1,134*	*630*	
Panel C: Hispanic Adolescents					
Prevalence	8.8	9.1	14.2	18.8	113%
	(3.82)	(2.51)	(1.72)	(1.42)	
Extent, OW	0.8	1.1	2.0	3.0	271%
	(0.45)	(0.43)	(0.31)	(0.31)	
Avg. Overweight Gap[1] (OW/Prevalence)*100	9%	12%	14%	16%	
Sample Size	*159*	*188*	*1,084*	*1,080*	

[1] Average Overweight Gap is the average amount by which the overweight population exceeds the overweight threshold, expressed as a percent of the threshold.

Source: NHANES I, II, III, 1999-2000.

Notes: Overweight is defined as a BMI for age at the 95th percentile or higher. Indices are multiplied by 100 and estimated with the exam sample weights. Standard errors, in parentheses and also multiplied by 100, are corrected for sample-design effects. Sample sizes don't match those in Tables 1 – 3 because race and ethnicity is missing for some observations (less than 5% of the sample).

REFERENCES

[1] Ogden CL, Flegal KM, Carroll MD, Johnson, CL. Prevalence and trends in overweight among US children and adolescents, 1999-2000. *JAMA* 2002; **288**: 1728-1732.

[2] Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics* 1998; **101**: 518-525.

[3] Power C, Lake JK, Cole TJ. Measurement and long-term health risks of child and adolescent fatness. *Int J Obes Relat Metab Disord* 1997; **21**: 507-526.

[4] Must A, Strauss R. Risks and consequences of childhood and adolescent obesity. *Intl J of Obesity* 1999; **23**: S2-S11.

[5] Serdula MK, Ivery D, Coates RJ, Freedman DS, Williamson DF, Byers T. Do obese children become obese adults? a review of the literature. *Prev Med*. 1993; **22**: 167-177.

[6] Guo SS, Roche AF, Chumela WC, Gardener JD, Siervogel RM. The predictive value of childhood body mass index values for overweight at age 35 y. *Am J Clin Nutr* 1994; **59**: 810-819.

[7] U.S. Department of Health and Human Services. *The Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity*, Rockville, MD: U.S. Department of Health and Human Services, Public Health Service, Office of the Surgeon General, 2001.

[8] Allison D, Fontaine K, Manson J, Stevens J, Vanltallie T. Annual deaths attributable to obesity in the United States. *JAMA* 1999; **282**:1530-1538.

[9] Kuczmarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM, Flegal KM, Mei Z, Wei R, Curtin LR, Roche AF, Johnson CL. 2000 CDC growth charts for the United States: Methods and development. *Vital Health Stat* 2002;11:1-190.

[10] Willett WC, Dietz WH, Colditz GA. Guidelines for healthy weight. *N Engl J Med* 1999; **341**: 427-434.

[11] Kenchaiah S, Evans JC, Levy D, Wilson PW, Benjamin EJ, Larson MG, Kannel WB, Vasan RS. Obesity and the Risk of Heart Failure. *New Engl J Med* 2002; **347**: 305-313.

[12] Kurth T, Gaziano M, Berger K, Kase C, Rexrode K, Cook N, Buring J, Manson J. Body Mass Index and the Risk of Stroke in Men. *Arch Intern Med* 2002; **162**: 2557-2562.

[13] Flegal K, Troiano R. Changes in the distribution of body mass index of adults and children in the US population. *Intl J of Obesity* 2000; **24**: 807 – 818.

[14] Jolliffe D, Semykina A. Robust standard errors for the Foster-Greer-Thorbecke class of poverty indices: SEPOV. *Stata Technical Bulletin* 1999, STB-51.

[15] Kish L, Frankel M. Balanced repeated replications for standard errors. *J of the American Statistical Association* 1970, **65** (331):1071-1094.