Volume Number 10 || Issue Number 1 || Year 2025 || Page 37 || * Corresponding Author: younas@sbbu.edu.pk||

ISSN (Online) = 2522-6754 ISSN (Print) = 2522-6746

WORLD JOURNAL OF BIOLOGY AND BIOTECHNOLOGY

Research Manuscript www.sciplatform.com Peer review

Assessing the nutritional status and disparities among schoolchildren in three districts in the North-West of Pakistan

[a] Rehman Mehmood Khattak, [b] Saira Saira, [a] Aisha Imtiaz, [b] Muhammad Altaf Khan, [c] Waqar Ali, [c] Nadia Qazi, [d] Birgit Schauer, [d] Muhammad Nasir Khan Khattak, [d] Henry Völzke, [d] Till Ittermann, [e] Muhammad Tariq Hamayun Khan, [f] Majeed Ullah [f] Abdus Salam, [f] Badshah Hussain, [e] Muhammad Younas *

[a] Department of Zoology, Islamia College (CU), Peshawar, Pakistan, [b] Department of Zoology, Qurtaba University of Science and Information Technology, Pakistan, [c] Department of Community Medicine, Northwest School of Medicine, Peshawar, Pakistan, [d]Institute for Community Medicine, University Medicine Greifswald, Germany, [e] Burn and Plastic Surgery Centre HMC Hayatabad Peshawar, Pakistan, [f] Department of Zoology Shaheed Benazir Bhutto University Sheringal Dir Upper, Pakistan.

Contribution Khattak, R.M., S. Saira, A. Imtiaz, M. A. Khan, W. Ali & N. Qazi conducted the research; M. Ullah, A. Salam and B. Hussain collected data. B. Schauer, M. N. K. Khattak, H. Völzke, T. Ittermann, M. T. H. Khan reviewed the manuscript and extended support in data analysis. M. Younas proof read the paper.

ABSTRACT

Owing to the stern importance of nutritional intakes for the growth and shaping life long events , we aim to elucidate the nutritional status of the schoolchildren according to the as definitions of the International Obesity Task Force (IOTF) and the Centres of Disease Control and Prevention (CDC) in 6 to 12 year-old schoolchildren from the rural districts of the Khyber Pakhtunkhwa (KPK) province of Pakistan. Anthropometric data was collected from 3595 schoolchildren (1811 boys and 1784 girls) in a random cluster sampling study. Underweight, overweight and obesity was determined from body mass index (BMI) and associated with age and sex by multinomial regression, while age was associated to BMI z-score by linear regression. Kappa statistics determined agreement/disagreement between the two cut-offs in our data. A higher frequency of children was affected by underweight (IOTF: 29.5%, CDC: 21.1%), than overweight (IOTF: 3.60%, CDC: 11.5%) and obesity (IOTF: 5.80%, CDC: 9.32%). There was high overweight prevalence in boys, while a positive association of age and female sex with prevalence of underweight, and of age only for prevalence of obesity was observed. The two cut-offs showed substantial agreement when assessing underweight {(kappa (κ) = 0.78)} and obesity (κ= 0.75). The frequency of underweight prevalence was high in socioeconomically deprived districts. We hypothesize that cultural tendencies apart from other factors were contributing to the higher prevalence and critical co-existence of underweight and obesity particularly in girls. The disparity in our results, between CDC and IOTF cut-offs in comparison to other populations, suggest the influence of different socioeconomics, cultural and genetic factors.

Keywords: Body mass index, underweight, overweight, obesity, international obesity task force

INTRODUCTION: Globally, the occurrence of obesity has prospectively duplicated in the years between 1990 and 2015 in those children who were in preschool age (De Onis *et al.*, 2010). As compared to the developing countries which has prevalence of (6.1%) the prevalence of obesity was however double (11.7%) in developed countries, in spite the fact that a greater number of affected children beyond 35 million were still in the developing countries. Moreover, this was also highlighted by the higher obesity prevalence in the middle and lower middle income nations than in the economically flourished nations in the last few decades (De Onis *et al.*, 2010). An increase in the prevalence of obesity and overweight was likewise reported in school aged children of developing countries (Janssen *et al.*, 2005). The risk of childhood obesity reinstation in adulthood with associated diseases was also higher. Obesity in childhood comes with severe health complications and consequences including difficulties in breathing, higher risks of fractures, cardiovascular diseases, insulin insensitivities and certain others (Dietz, 1998).Due to poor economics, underweight is also a devastating problem in low income countries (Best *et al.*, 2010). A global projected decline in underweight prevalence in children younger than five years was outlined to be 17.6% (a -34% change) between 1990 and 2015, however, still affecting 52 million children in the developing world (De Onis *et al.*, 2004; Best *et al.*, 2010). The public health effects of underweight are delayed pubertal maturation, poor cognitive abilities, reduced muscular potency and work capacity (Best *et al.*, 2010). A major constraint in the growth-related studies was the selection of the growth charts. The cut points of the International Obesity Task Force (IOTF) and Center of Disease Control and Prevention (CDC) for childhood and adolescence (Kuczmarski *et al.*, 2000; Cole and Lobstein, 2012) have previously shown comparability and non-comparability in results in high, middle and low income countries (Hesketh and Ding, 2000; Wang *et al.*, 2002; Neovius *et al.*, 2004; Janssen *et al.*, 2005; Vidal *et al.*, 2006; Cole *et al.*, 2007; Kelishadi *et al.*, 2007; O'Neill *et al.*, 2007; Tuan and Nicklas, 2009; Caleyachetty *et al.*, 2012; Cole and Lobstein, 2012; Wamba *et al.*, 2013). The IOTF references (Cole *et al.*, 2000; Cole *et al.*, 2007) were more versatile for including data from six countries in three continents, whereas CDC cut-offs were based on the American population only. However, their use in non-reference population was still uncertain (Hesketh and Ding, 2000; Neovius *et al.*, 2004; Cole *et al.*, 2007). Some recent studies from Pakistan have also highlighted the issue, but all the studies were conducted either in the urban settings, some had a wider age range and some were conducted in the under five years of age. All these studies show high prevalence of underweight, overweight and obesity (Mushtaq *et al.*, 2011; Aziz *et al.*, 2012; Mushtaq *et al.*, 2012; Tanveer *et al.*, 2024; Atta Ullah *et al.*, 2023).

OBJECTIVES: The minor objective of our study was to investigate the prevalence of these outcomes in schoolchildren in the three rural Districts of the KPK province of North-West of Pakistan and disparity between IOTF and CDC cut-offs applied on schoolchildren.

MATERIALS AND METHODS: This study was conducted in 3 districts Charsadda, Kohat and Karak of the KPK province in the North-West of Pakistan (table 1). A population-based 40 cluster sampling method was adopted to collect data from 60 (stratified by sex equally) primary level Government schools from each district. Per class 3-4 children in the age range between 6-12 years ensuring randomization were selected from grade 1-5 resulting in a net sample of 3595 children (1784 girls). Data was recorded from healthy children by trained researchers in school premises through planned questionnaires assessing information regarding age, sex, place of birth, date of birth, school grade and father's occupation. The ethical approval was obtained from the academic council of the University of Hazara, Mansehra, Pakistan with strict adherence to the ethical guidelines of the declaration of Hilsinki. Standing height and body weight were measured through standard protocols by stadiometer (Seca 217 Mobile Stadiometer, Hamburg, Germany) and by Tanita digital bathroom scale (HD-313; Tanita, Tokyo, Japan), and converted into BMI (kg/m^2). An sex-specific BMI related to the age z-score was adopted from the WHO (WHO, 2007). Quantitative data were presented as mean and standard deviation and prevalence reported as percentages. Based on IOTF, the revised international child BMI cut-offs; 16, 17, 18.5, 27, 30 and 35 were considered as three levels of thinness from high to low underweight, elevated than normal weight, obesity and morbid obesity=obesity, respectively (Cole and Lobstein, 2012). According to CDC cut-offs, children having a BMI below the fifth percentile, between the 85^{th} and 95^{th} percentile and above 95^{th} percentile were categorized as underweight overweight, and obese, respectively (Kuczmarski *et al.*, 2000). The standardized -1 to 1 kappa scale defined the level of agreement/disagreement between the IOTF and CDC cut-offs (Cohen, 1960). Differences in age and sex specific prevalence were compared by χ^2 test. Age and sex were associated with outcome measures by multinomial regression analysis, whereas association between age and BMI z-score controlled for the district was tested

Name of district	Location in KPK province	Topography	Estimated population (in millions); 2017 census	Population residing in rural conditions (%)	Economic situation	Total schools (boys/girls)	Total Children (boys/girls)
Charsadda	Part of Peshawar valley	Plain fertile	1.61	81.25	Stable	60 (30/30)	1206 (606/600)
Kohat	East of Indus river, southern	Barren intricate	0.99	73	Moderate	60 (30/30)	1194 (601/594)
Karak	East of Indus river, further southern	Barren intricate	0.70	93	Poor	60 (30/30)	1195 (599/594)

Table 1: Description of the selected Districts.

Age (Years)	Sex	Mean Weight (kg) ±SD			Mean height (cm) ±SD			Mean BMI ±SD		
		District Charsadda	District Kohat	District Karak	District Charsadda	District Kohat	District Karak	District Charsadda	District Kohat	District Karak
6	B	26.8 ±5.22	21.6 ±4.10	19.0 ±3.60	1.21±0.10	1.08 ±0.10	1.13 ±0.07	19.2±6.25	18.8±4.78	14.7±1.57
	G	26.7 ±5.18	18.7 ±3.00	18.7 ±3.00	1.18 ±0.11	1.14 ±0.07	1.14±0.07)	19.8±6.90	15.9±3.72	14.3±1.29
7	B	26.4±4.61	22.0±5.61	22.7 ±4.11	1.19±0.10	1.17 ±0.10	1.21 ±0.09	18.8±3.24	16.1±3.90	15.6±2.17
	G	26.7 ±4.71	20.1 ±2.82	20.1 ±2.82	1.21 ±0.09	1.17 ±0.10	1.17±0.06	18.2±3.63	16.7±4.20	14.5±1.53
8	B	27.9±4.00	25.1 ±6.11	23.1 ±3.40	1.23±0.07	1.24 ±0.09	1.25 ±0.08	18.5±2.08	16.3±3.50	14.8±1.45
	G	29.1 ±5.60	22.7±3.08	22.7 ±3.80	1.25 ±0.10	1.24 ±0.08	1.24±0.07	18.7±3.35	15.6±3.63	14.7±1.42
9	B	28.9±3.70	26.4 ±5.72	26.2 ±5.11	1.27±0.09	1.29 ±0.08	1.30 ±0.08	17.9±1.81	15.9±3.44	15.4±2.35
	G	31.0 ±6.15	24.7 ±3.97	24.7 ±3.90	1.29 ±0.10	1.30 ±0.07	1.29±0.07	18.7±3.18	16.3±3.82	14.8±1.40
10	B	30.4±3.94	26.8 ±6.32	28.3 ±4.70	1.28±0.07	1.33 ±0.08	1.34 ±0.08	18.4±1.87	14.9±3.00	15.8±1.90
	G	32.0 ±6.41	27.0 ±4.94	27.0 ±4.94	1.31 ±0.08	1.33 ±0.07	1.33±0.07	18.6±3.05	16.4±4.23	15.2±1.93
11	B	34.0±4.90	30.9 ±7.00	30.3 ±6.01	1.34±0.07	1.38 ±0.09	1.39 ±0.07	18.8±2.11	16.2±3.03	15.7±2.35
	G	36.9 ±6.60	29.7 ±6.74	29.7 ±6.74	1.38 ±0.08	1.38 ±0.13	1.39±0.08	19.4±3.15	14.9±2.81	15.3±2.09
12	B	38.7±5.92	31.5 ±7.20	32.2 ±6.82	1.41±0.07	1.44 ±0.10	1.42 ±0.09	19.4±2.03	15.2±3.30	15.9±2.13
	G	40.0 ±7.04	35 ±6.27	35.0 ±6.30	1.41 ±0.08	1.45 ±0.14	1.44±0.08	20.2±3.43	16.4±4.15	16.7±1.70

Table 2: Descriptive Statistics for Weight, Height and BMI among Schoolchildren Aged 6-12 Years.
BMI: body mass index, SD: standard deviation, B= Boys, G: Girls

IOTF	CDC				
	Normal (%)	Underweight (%)	Overweight (%)	Obesity (%)	Total (%)
Normal	1783	0	290	127	2200
(%)	(49.6)	(0.00)	(8.07)	(3.53)	(61.20)
Underweight	3.2	757	0	0	1059
(%)	(8.40)	(21.06)	(0.00)	(0.00)	(29.46)
Overweight	5	0	123	0	128
(%)	(0.14)	(0.00)	(3.42)	(0.00)	(3.56)
Obesity	0	0	0	208	208
(%)	(0.00)	(0.00)	(0.00)	(5.79)	(5.79)
Total	2090	757	413	335	3595
(%)	(58.14)	(21.06)	(11.49)	(9.32)	(100)

Table 3: Cross tabulation showing categorization of growth standards based on CDC and IOTF cut-offs.

by linear regression analysis. Significant level was determined by a p value <0.05. A software Stata version 14.1 was used for all statistical deductions (Stata Corporation, College Station, TX).

RESULTS: Overall, the mean BMI was found higher in children in Charsadda District as compared to Kohat and Karak, while mean values of body weight, height, and BMI were higher in boys than in girls in all districts excluding Charsadda (table 2). A substantial percentage of children (IOTF: 38.8% and CDC: 41.8%) were facing underweight, overweight or obesity (table 3). The prevalence of underweight (IOTF: 29.5%, CDC: 21.1%) was markedly higher than the prevalence of overweight (IOTF: 3.60%, CDC: 11.5%) or obesity (IOTF: 5.80%, CDC: 9.32%). An elevated occurrence of underweight was observed in female as compared with male in all ages (table 4) with significant differences with age in both sexes. However, an increase in underweight prevalence with age was observed only in girls with a positive association of age and female with underweight prevalence (table 5). The prevalence of overweight was higher in boys as compared with girls in almost all age (table 4). Overweight prevalence was inversely associated with age only based on CDC cut-offs (table 5). Overall, the female were more affected by obesity than the male among all children (table 4). Prevalence of obesity differed significantly over age more pronounced in children aged six to eight years, higher in boys as compared to girls but afterwards it was other way around and decreased with age. The association between age and obesity prevalence was significantly positive (table 5), while, it was inverse with female sex.

The prevalence of underweight was markedly higher in Kohat and Karak (figure 1), while, the occurrence of elevated than normal weight and obesity was high in Charsadda. Underweight existence was higher in girls than in boys among all the 3 districts, while overweight prevalence was less frequent for girls as compared with boys (figure 1). Against the higher obesity prevalence in boys than in girls in Karak, obesity prevalence was higher in girls than in boys for the Charsadda and Kohat. A high BMI z-score was observed for children ≤ 10 years in Charsadda which declined with age in all the 3 districts and in both sexes (figure 1& 2). In all the 3 districts BMI z-score was increased in male as compared with female. Kappa coefficients showed substantial agreement between the IOTF and CDC cut-offs applied for the definition of underweight (κ= 0.78) and obesity (κ= 0.75) (table 2), whilst for the definition of overweight agreement was just moderate (κ= 0.42) (table 4). There was almost perfect agreement between IOTF and CDC cut-offs for underweight prevalence in sex and age strata except 7 and 8 years boys and six and older than 10 years girls (figure 3). For overweight prevalence generally there were either fair or moderate levels of agreement between the two cut-offs in the age and sex strata (figure 3). For the prevalence of obesity in the sex and age strata usually there was either moderate or substantial agreement between the two cut-offs. A perfect agreement were also recorded in 6 and 7 years old girls (figure 3).

DISCUSSION: Against the lower overweight prevalence, the underweight prevalence was remarkably high in children (significantly high in girls), with a high prevalence for obesity. A disparity in results was observed between the two cut-offs (IOTF and CDC) in the sex and age strata for the definition of all these outcomes. Under nutrition, the leading cause of underweight in children was estimated to be the largest contributor to global burden of diseases in Africa and South Asia (De-Onis *et al.*, 2004; Reddy *et al.*, 2009; Best *et al.*, 2010; Caleyachetty *et al.*, 2012; Wamba *et al.*, 2013). Our results were in concordance with mean underweight prevalence estimates for the Asian region (34%) (Best *et al.*, 2010) and previously reported national estimates of 30% and 27% (Jafar *et al.*, 2008) and a recent study conducted in District Swabi (35.34%) (Atta Ullah *et al.*, 2025). Our results were in contrast to the lower underweight prevalence in the countries in Europe, North and South America (Rolland-Cachera *et al.*, 2002; Wang *et al.*, 2002; De-Onis *et al.*, 2004; Yngve *et al.*, 2008) and to the reports from Brazil (3.2%) (De-Assis *et al.*, 2005), Mauritius (12.7%) (Caleyachetty *et al.*, 2012), Cameroon (9.5%) (Wamba *et al.*, 2013), mean prevalence for East Mediterranean Region (13%) and previous from urban Lahore (10%) in Pakistan (Mushtaq *et al.*, 2011).

However, comparisons between studies should be interpreted with caution due to differences in socioeconomics, culture, age range studied, cut-offs to establish nutritional status and geographic settings.

Age	Under Weight (%)	p-value	Abs. Diff.	ᶜκ	Overweigh. (%)	p-value	Abs. Diff.	κ	Obesity (%)	p-value	Abs. Diff.	κ	Cut-offs
Boys													
6	20.6		4.50		3.02		-7.08		20.1		-7.00		IOTF
	16.1				10.1				27.1				CDC
7	20.0		5.30		4.00		-14.2		10.7		-8.90		IOTF
	14.7				18.2				19.6				CDC
8	24.6		11.2		4.29		-12.8		5.00		-6.10		IOTF
	13.4				17.1				11.1				CDC
9	27.6		12.3		6.13		-8.07		2.30		-1.15		IOTF
	15.3				14.2				3.45				CDC
10	33.3		6.40		4.09		-5.61		1.17		-0.58		IOTF
	26.9				9.70				1.75				CDC
11	28.8		4.10		1.92		-7.08		0.96		-2.57		IOTF
	24.7				9.00				3.53				CDC
12	26.2		4.80		5.35		-5.35		0.53		-1.61		IOTF
	21.4				10.7				2.14				CDC
Total	26.6	0.006	4.12	0.83	4.04	0.241	-4.28	0.47	5.09	0.000	-1.86	0.72	IOTF
	19.6	0.000			12.6	0.002			8.80	0.000			CDC
Girls													
6	21.2		8.10		3.15		-6.76		14.4		-3.60		IOTF
	13.1				9.91				18.0				CDC
7	25.4		6.70		2.61		-10.1		9.33		-3.37		IOTF
	18.7				12.7				12.7				CDC
8	30.1		10.5		4.08		-6.22		6.90		-4.40		IOTF
	19.6				10.3				11.3				CDC
9	32.1		10.9		2.32		-10.08		5.02		-2.32		IOTF
	21.2				12.4				7.34				CDC
10	36.3		7.80		3.78		-5.54		4.94		-2.91		IOTF
	28.5				9.30				7.85				CDC
11	53.6		16.4		2.40		-5.60		0.80		-2.80		IOTF
	37.2				8.00				3.60				CDC
12	20.6		7.90		2.38		-7.92		4.00		-4.73		IOTF
	12.7				10.3				8.73				CDC
Total	32.4	0.000	4.90	0.79	3.08	0.818	-3.64	0.40	6.50	0.000	-1.67	0.79	IOTF
	22.6	0.000			10.4	0.594			9.84	0.000			CDC
Overall	29.5		8.40	0.78	3.60		-7.90	0.42	5.80		-3.52	0.75	IOTF
	21.1				11.5				9.32				CDC

Table 4: Age and sex stratified prevalence of underweight, overweight and obesity in schoolchildren (6-12 years age) and comparative agreements/disagreements of IOTF and CDC cut-offs, underweight absolute differences: obtained for prevalence: prevalence IOTF-prevalence CDC, ᶜκ: Kappa coefficient, ᵈ Overweight.

Exposure	IOTF growth standards Underweight		Overweight		Obesity	
	Coeff. (95%-CI)	p-value	Coeff. (95%-CI)	p-value	Coeff. (95%-CI)	p-value
Age	0.08 (0.05-0.13)	0.000	-0.01 (-0.10- 0.09)	0.825	-0.47 (-0.57- -0.38)	0.000
Female sex	0.32 (0.18- 0.47)	0.000	-0.17 (-0.54- 0.19)	0.344	0.25 (-0.05- 0.54)	0.099
	CDC growth standards					
Age	0.08 (0.04-0.13)	0.000	-0.09 (-0.15- -0.03)	0.001	-0.40 (-0.46- -0.32)	0.000
Female sex	0.20 (0.04- 0.37)	0.017	-0.18 (-0.40- 0.03)	0.092	0.05 (-0.18- 0.30)	0.669

Table 5: Association of various IOTF and CDC growth standards with age and sex.

Apart from the socioeconomic differences with the studies from European and American countries the difference with studies from Brazil, Mauritius and Cameroon, may be explained by the age range of the studies (Brazil: 7-10 years; Mauritius: 9-10 years; Cameroon: 8-15 years) and its urban population. This may not account for the probable declining trend in pace of growth at age 11-13 years (Kelishadi *et al.*, 2007; Reddy *et al.*, 2009), and reported sudden shift or growth spurt at the age of nine years in girls (Tanner, 1981; Kelishadi *et al.*, 2007; Mushtaq *et al.*, 2012). Overall, these results reflect poor economic growth, lack of health education and facilitation, no regular growth monitoring of the children, lack of political will and consequences of social classification in Pakistani society. A positive association of age and female sex with underweight prevalence and age related trend in girls in our study was in consonance with some studies (De-Assis *et al.*, 2005; Yngve *et al.*, 2008), but in contrast to others (Wang *et al.*, 2002; Jafar *et al.*, 2008; Mushtaq *et al.*, 2011; Wamba *et al.*, 2013). However, age related trend was not a consistent phenomenon (Rolland-Cachera *et al.*, 2002; De-Assis *et al.*, 2005; Reddy *et al.*, 2009; Mushtaq *et al.*, 2012). The current study infers that apart from socioeconomics, the social and cultural aspects may have leading contributions. Culturally, in Pakistan girls are at a disadvantage from birth and are subject to discrimination from childhood, while boys are perceived as an economic and social utility and enjoy more family resources and care than girls of the same age (Qadir *et al.*, 2011). This was also visible from our results in Charsadda for having low underweight prevalence and minor differences between girls and boys for its more cultural flexibility than the remaining districts.

Our results revealed lower prevalence estimates of overweight than the studies conducted in Europe (Yngve *et al.*, 2008), North America (Janssen *et al.*, 2005), Southeast Asia and the Eastern Mediterranean region (Best *et al.*, 2010) as compared with the study conducted in Swabi distract of Pakistan (Atta Ullah *et al.*, 2023) and a study conducted in 7 districts of Punjab Province of Pakistan (Tanveer *et al.*, 2024).

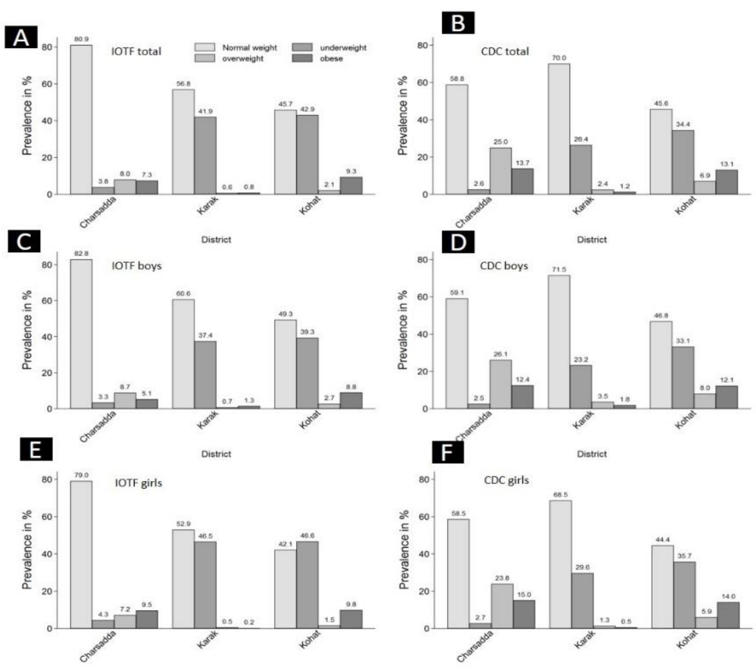

Figure 1: Prevalence differences in underweight, overweight and 0besity among districts based on IOTF and CDC cut-offs.

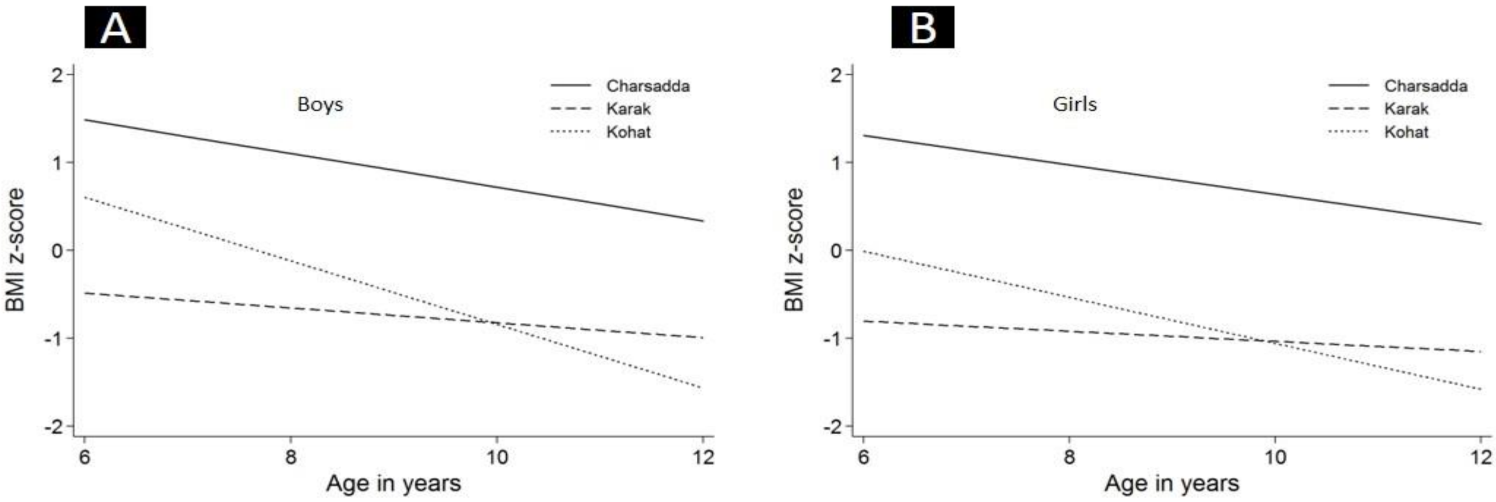

Figure 2: Association of age with BMI z-score among boys and girls in the studied districts.

The potential explanations were differences in eating habits, nutrition transition and early recognition of weight gain as a public health problem. However, it highly depends on the selection of cut-offs, as when applying CDC cut-offs, our results were closer to mean prevalence of overweight in the Southeast Asian region (Best *et al.*, 2010). Furthermore, the regional trends also cannot be undermined. Studies from Brazil (De-Assis *et al.*, 2005) and Mexico (Hernaindez *et al.*, 2003) reported an increased occurrence of prevalence of elevated than normal weight of 15.6% and 19.5% respectively, applying the same cut-offs and age range like ours justifying to the general tendency of higher overweight prevalence in Latin America (Best *et al.*, 2010). Regarding higher overweight prevalence in boys in all ages our results were in agreement with previous studies (Sharma *et al.*, 2007; Yngve *et al.*, 2008; Khadilkar *et al.*, 2011) but were in contrast to other (Wang *et al.*, 2002; Suter and Ruckstuhl, 2006).

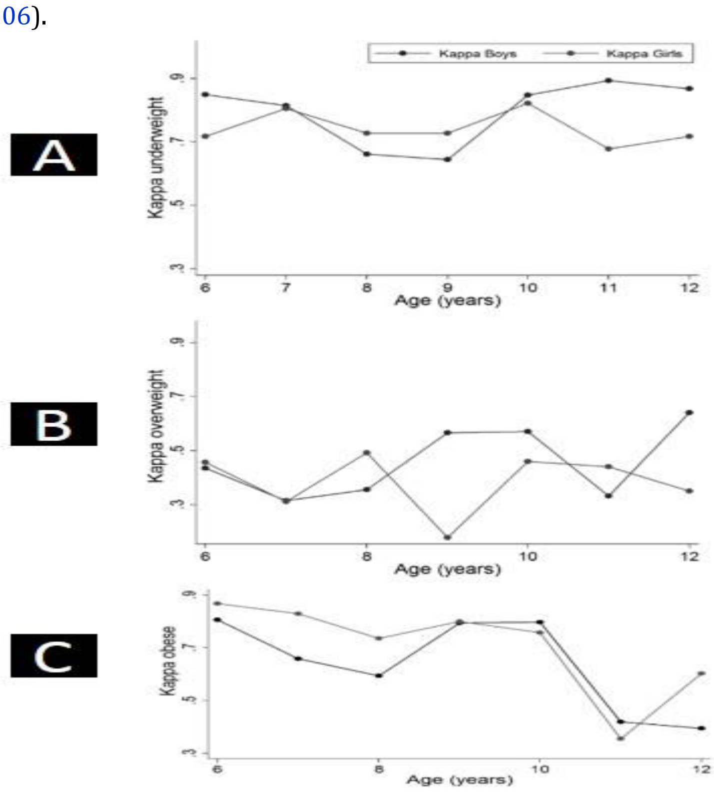

Figure 3: Age and sex-stratified kappa-statistics for the underweight, overweight and obesity prevalence based on CDC and IOTF cut-offs.

Evidence suggest greater chances of obesity among children from more deprived families (Knai *et al.*, 2012). Obesity other than overweight was more vulnerable as it can be a lonely risk factor that lead to death of an individual (WHO, 2015). Our study was primarily conducted in children of social disadvantage and resulted in a reasonably higher prevalence of obesity in children in comparison to European countries, North America (Janssen *et al.*, 2005; Suter and Ruckstuhl, 2006; Yngve *et al.*, 2008), Cameroon (Wamba *et al.*, 2013), Mauritius (Caleyachetty *et al.*, 2012) and previous studies from the Indian sub-continent including Pakistan (Sharma *et al.*, 2007; Khadilkar *et al.*, 2011; Aziz *et al.*, 2012). The higher prevalence of obesity in younger aged children (6-8 years) and in girls than in boys, was in agreement with some studies (Suter and Ruckstuhl, 2006; Sharma *et al.*, 2007; Yngve *et al.*, 2008; Wamba *et al.*, 2013), but not all including studies from Pakistan (Reddy *et al.*, 2009; Khadilkar *et al.*, 2011; Khadilkar *et al.*, 2011; Tanveer *et al.*, 2024).

The current study postulate the following aspects, which can be the factors for the high existence of less than the normal weight and obesity. First, in Pakistan an aspect of, children being more vulnerable to inadequate nutrition, but on the other hand, they consume energy-dense, micronutrient-poor foods (WHO, 2015). These dietary routine and habits consequence by and lower physical exertion, result in the increase of obesity occurrence, while under-nutrition issue remain unsolved (WHO, 2015). The most typical example presented was in Kohat for the parallel prevalence of underweight and obesity. Secondly, reduced mobility, particularly in girls, may have partly increased the overall prevalence of obesity because of cultural restrictions. In Pakistan, boys gain autonomy and freedom of movement, while girls are systematically restricted to houses at a young age. It was recorded in a transitional shift of obesity prevalence in children of both sexes at the age of 9 years. Thirdly, the higher use of motorized commuting in spite of social disadvantage in such rural areas in recent years may have partially been contributing (Bell *et al.*, 2002), because bicycle use was hampered due to lacking tracks and socio-cultural tendencies. Additionally, in Pakistan the planned structured physical activities were either lacking or reduced in school or at home, which might contribute to an increasing weight gain. Finally, the hypothesis of direct-independent and causal association between television (TV) viewing and higher indices of obesity (Robinson, 1999; Bettoni, 2002; Janssen *et al.*, 2005) may not be a dominant factor in our study area, because of long breakages in electricity supply (locally called as load shedding) in rural areas. TV watching imposing molecular habit formation (Sudakov, 2001) for sedentary life style and fashioned foods leading to programming of childhood obesity (Ludwig and Gortmaker, 2004). Such a multitasking during eating was a risk factor for passive overeating (Suter and Ruckstuhl, 2006). This aspect may particularly affect children of younger ages before the start of extensive schooling and may be affecting children in Charsadda and Kohat given their comparatively high urban facilitation. Our results also depict a direct effect of economic richness in districts for parallel high prevalence of overweight along with higher obesity prevalence in Charsadda and Kohat. In current study, a sudden drop in obesity prevalence at an age of 9 years and onwards probably for the increase in parental spending on schooling introducing economic stress in the family, actual schooling stress and for comparatively higher chances of physical activities at this age and onwards.

In our study the two cut-offs (IOTF and CDC) showed disparity of results in both sex and age strata when applied to the same population. The underweight prevalence defined by IOTF cut-offs, may have overestimated it with an absolute difference compared to CDC cut-offs of 8.40%. These results were similar with previous studies (Tuan and Nicklas, 2009; Mushtaq *et al.*, 2012; Wamba *et al.*, 2013), owing to the fact of an organized increase in underweight prevalence defined by IOTF cut-offs in comparison to CDC growth charts. Differences of economics, population size and social heterogeneities and adult's cut-offs adopted for children may have led to higher rates of underweight in our population based on IOTF definition.

In case of overweight and obesity the IOTF cut-offs determines inclined lower estimate of the weight problem because of the mean differences in the reference values in comparison to CDC cut-offs. Based on sexes, for male children the differences between the 2 references values for elevated than normal weight and obesity were ~0.5 and 1.5–2.0 BMI units, respectively in favour of IOTF. Having no differences for female children, related to elevated than normal, even then for in male children, the IOTF cut-offs are ~1.0 BMI unit higher for boys (Flegal *et al.*, 2001). As a result the IOTF cut-offs favours identifying the issues when it has already surpassed the level (Vidal *et al.*, 2006). These differences explain the lower prevalence estimate of our sample and in the previous studies with the IOTF cut-offs (Flegal *et al.*, 2001; Jafar *et al.*, 2006; Vidal *et al.*, 2006), however, this was in contrast to other studies (Kelishadi *et al.*, 2007; Wamba *et al.*, 2013). These comparisons include studies predominantly from high-income countries, but also include middle and low income countries. Therefore, economic, genetic, cultural, and nutritional factors may have contributed to the differences in the results. Our results and varying prevalence around the globe support the increasing opinion for developing population-specific references because of these factors. In line with the general trend (Zimmermann *et al.*, 2004; Kelishadi *et al.*, 2007; Wamba *et al.*, 2013), but not in all (O'Neill *et al.*, 2007; Jafar *et al.*, 2008), the obesity prevalence in our study was lower based on IOTF cut-offs than CDC cut-offs with an absolute difference of -3.52%. We propose that different population dynamics and accuracy and sensitivity of IOTF cut-offs for defining elevated than normal weight was more than that of obesity (Cole *et al.*, 2000). Other than that, the higher sensitivity and specificity of CDC reference for obesity than the IOTF (Zimmermann *et al.*, 2004) and the false-negative rate for IOTF cut-offs was estimated as 38% for boys and 52% for girls (Zimmermann *et al.*, 2004). Based on IOTF references 40-50% obese children remained unidentified in Swiss children population, which may be the case in our population as well (Zimmermann *et al.*, 2004).

The previous studies conducted in Chinese, Indonesian and Vietnamese children revealed that the absolute differences between CDC and IOTF cut-offs and kappa statistics varied with the different ethnicities, sex and age (Tuan and Nicklas, 2009). The authors further postulated that the differences in maturation timing may be contributing to ethnic differences (Kaplowitz, 2006; Euling *et al.*, 2008). In comparison differential distributions of underweight, overweight and obesity in the three districts may be partly attributable to different tribal affiliations, which in turn be associated with variations in maturation timing, sociocultural factors, inheritance lines, nutritional intakes and other variable factors. Overall our results were in consonance with the previous studies for showing combined existence of both underweight and obesity prevalence (Wang *et al.*, 2002; De-Assis *et al.*, 2005). The transition in weight trends was an important delima for Pakistan likely that of the other countries of similar stature. Currently, the main focus in nutritional programs was dealing with under nutrition, which may push the obesity prevalence in those populations with slight under nutrition (Uauy *et al.*, 2001).

CONCLUSION: Irrespective of the method used, there is critical co-existence of underweight and obesity in children living in the rural low socioeconomic population of North-West Pakistan. The current study hypothesize that cultural tendencies apart from other factors were contributing to the higher prevalence and critical co-existence of underweight and obesity particularly in the girls. The disparity in our results, between CDC and IOTF cut-offs in comparison to other populations, suggest the influence of different socioeconomics, cultural and genetic factors.

FUNDING: This research was conducted without any funding.
CONFLICT OF INTEREST: All the authors declared no conflict of interest.

LIFE SCIENCE REPORTING: In current research article, no life science threat was reported.

ETHICAL RESPONSIBILITY: This is original research, and not submitted in whole or in parts to another journal for publication purpose.

INFORMED CONSENT: The author(s) have reviewed the entire manuscript and approved the final version before submission.

REFERENCES:
Atta Ullah, S., S. Ali, A. S. Qadri, B. H. Naqash Khan, M. Armaghan, A. Wajid and M. Ahmad, 2023. Prevalence of thinness, overweight, and obesity among school children in district Swabi, Khyber Pakhtunkhwa, Pakistan. Journal of Xi'an shiyou university, natural science edition, 9(11): 527-537.

Aziz, S., W. N. Ain, R. Majeed, M. A. Khan, I. Qayum, I. Ahmed and K. Hosain, 2012. Growth centile charts (anthropometric measurement) of Pakistani pediatric population. Journal of the pakistan medical association, 62(4): 367.

Bell, A. C., K. Ge and B. M. Popkin, 2002. The road to obesity or the path to prevention: Motorized transportation and obesity in china. Obesity research, 10(4): 277-283.

Best, C., N. Neufingerl, L. Van Geel, T. van den Briel and S. Osendarp, 2010. The nutritional status of school-aged children: Why should we care? Food and nutrition bulletin, 31(3): 400-417.

Bettoni, M., 2002. Prevalence and determinants of overweight and obesity in 9–12 years old children in Ticino. (pra¨valenz und determinanten des u¨ bergewichtes und der adipositas bei 9–12 ja¨hrigen primarschu¨lern im tessin). PhD dissertation: Department of Medicine, University Hospital Zurich: pp: 1-61.

Caleyachetty, R., A. R. Rudnicka, J. B. Echouffo-Tcheugui, K. R. Siegel, N. Richards and P. H. Whincup, 2012. Prevalence of overweight, obesity and thinness in 9-10 year old children in mauritius. Globalization and health, 8(1): 1.

Cohen, J., 1960. A coefficient of agreement for nominal scales. Educational and psychosocial measurement, 20, 37-46.

Cole, T. J., M. C. Bellizzi, K. M. Flegal and W. H. Dietz, 2000. Establishing a standard definition for child overweight and obesity worldwide: International survey, 320(7244): 1240.

Cole, T. J., K. M. Flegal, D. Nicholls and A. A. Jackson, 2007. Body mass index cut offs to define thinness in children and adolescents: International survey, 335(7612): 194.

Cole, T. J. and T. Lobstein, 2012. Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. Pediatric obesity, 7(4): 284-294.

De-Assis, M., M. F. Rolland-Cachera, S. Grosseman, F. De Vasconcelos, M. E. P. Luna, M. Calvo, M. Barros, M. Pires and F. Bellisle, 2005. Obesity, overweight and thinness in schoolchildren of the city of Florianopolis, Southern brazil. European journal of clinical nutrition, 59(9): 1015-1021.

De-Onis, M., M. Blössner and E. Borghi, 2010. Global prevalence and trends of overweight and obesity among preschool children. The american journal of clinical nutrition, 92(5): 1257-1264.

De-Onis, M., M. Blössner, E. Borghi, E. A. Frongillo and R. Morris, 2004. Estimates of global prevalence of childhood underweight in 1990 and 2015. Jama, 291(21): 2600-2606.

Dietz, W. H., 1998. Health consequences of obesity in youth: Childhood predictors of adult disease. Pediatrics, 101 (Supplement 2): 518-525.

Euling, S. Y., S. G. Selevan, O. H. Pescovitz and N. E. Skakkebaek, 2008. Role of environmental factors in the timing of puberty. Pediatrics, 121 (Supplement 3): S167-S171.

Flegal, K. M., C. L. Ogden, R. Wei, R. L. Kuczmarski and C. L. Johnson, 2001. Prevalence of overweight in us children: Comparison of us growth charts from the centers for disease control and prevention with other reference values for body mass index. The american journal of clinical nutrition, 73(6): 1086-1093.

HernÃ¡ndez, B., L. a. Cuevas-Nasu, T. Shamah-Levy, E. A. Monterrubio, C. I. RamÃ-rez-Silva, R. GarcÃ-a-Feregrino, J. A. Rivera and J. SepÃºlveda-Amor, 2003. Factors associated with overweight and obesity in Mexican school-age children: Results from the national nutrition survey 1999. Salud pÃºblica de MÃ©xico, 45: 551-557.

Hesketh, T. and Q. J. Ding, 2000. Standard definition of child overweight and obesity worldwide. Young chinese people in hong kong are not representative of those in china. Clinical research education, 321(7269): 1158-1159.

Jafar, T. H., N. Chaturvedi and G. Pappas, 2006. Prevalence of overweight and obesity and their association with hypertension and diabetes mellitus in an indo-asian population. Canadian aedical association journal, 175(9): 1071-1077.

Jafar, T. H., Z. Qadri, M. Islam, J. Hatcher, Z. A. Bhutta and N. Chaturvedi, 2008. Rise in childhood obesity with persistently high rates of undernutrition among urban school-aged indo-asian children. Archives of disease in childhood, 93(5): 373-378.

Janssen, I., P. T. Katzmarzyk, W. F. Boyce, C. Vereecken, C. Mulvihill, C. Roberts, C. Currie and W. Pickett, 2005. Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns. Obesity reviews, 6(2): 123-132.

Janssen, I., P. T. Katzmarzyk, W. F. Boyce, C. Vereecken, C. Mulvihill, C. Roberts, C. Currie and W. Pickett, 2005. Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns. Obesity reviews, 6(2): 123-132.

Kaplowitz, P., 2006. Pubertal development in girls: Secular trends. Current opinion in obstetrics and gynecology, 18(5): 487-491.

Kelishadi, R., G. Ardalan, R. Gheiratmand, M. M. Gouya, E. M. Razaghi, A. Delavari, R. Majdzadeh, R. Heshmat, M. Motaghian and H. Barekati, 2007. Association of physical activity and dietary behaviours in relation to the body mass index in a national sample of Iranian children and Adolescents: Caspian study. Bulletin of the world health organization, 85(1): 19-26.

Khadilkar, V., A. Khadilkar, T. Cole, S. Chiplonkar and D. Pandit, 2011. Overweight and obesity prevalence and body mass index trends in indian children. International journal of pediatric obesity, 6 (2Part2): e216-e224.

Khadilkar, V. V., A. V. Khadilkar, T. J. Cole, S. A. Chiplonkar and D. Pandit, 2011. Overweight and obesity prevalence and body mass index trends in indian children. International journal of pediatric obesity, 6(sup3): e216-224.

Knai, C., T. Lobstein, N. Darmon, H. Rutter and M. McKee, 2012. Socioeconomic patterning of childhood overweight status in Europe. International journal of environmental research and public health, 9(4): 1472-1489.

Kuczmarski, R. J., C. L. Ogden, L. M. Grummer-Strawn, K. M. Flegal, S. S. Guo, R. Wei, Z. Mei, L. R. Curtin, A. F. Roche and C. L. Johnson, 2000. Cdc growth charts: United states. Advance data (314): 1-27.

Ludwig, D. S. and S. L. Gortmaker, 2004. Programming obesity in childhood. The Lancet, 364(9430): 226-227.

Rolland-Cachera, K Castetbon, N Arnault, F Bellisle, M-C Romano, Y Lehingue, M-L Frelut and S. Hercberg, 2002. Body mass index in 7–9- years old French children: Frequency of obesity, overweight and thinness. International journal of obesity, 26: 1610-1616.

Mushtaq, M. U., S. Gull, U. Khurshid, U. Shahid, M. A. Shad and A. M. Siddiqui, 2011. Prevalence and socio-demographic correlates of stunting and thinness among pakistani primary school children. Public health, 11(1): 1.

Mushtaq, M. U., S. Gull, K. Mushtaq, H. M. Abdullah, U. Khurshid, U. Shahid, M. A. Shad and J. Akram, 2012. Height, weight and bmi percentiles and nutritional status relative to the international growth references among Pakistani school-aged children. Pediatrics, 12(1): 1.

Neovius, M., Y. Linné, B. Barkeling and S. Rössner, 2004. Discrepancies between classification systems of childhood obesity. Obesity reviews, 5(2): 105-114.

O'Neill, J. L., S. N. McCarthy, S. J. Burke, E. M. Hannon, M. Kiely, A. Flynn, M. A. T. Flynn and M. J. Gibney, 2007. Prevalence of overweight and obesity in irish school children, using four different definitions. European journal of clinical nutrition, 61(6): 743-751.

Qadir, F., M. M. Khan, G. Medhin and M. Prince, 2011. Male gender preference, female gender disadvantage as risk factors for psychological morbidity in pakistani women of childbearing age-a life course perspective. Public health, 11(1): 1.

Reddy, S., K. Resnicow, S. James, N. Kambaran, R. Omardien and A. Mbewu, 2009. Underweight, overweight and obesity among south african adolescents: Results of the 2002 national youth risk behaviour survey. Public health nutrition, 12(02): 203-207.

Reddy, S. P., K. Resnicow, S. James, N. Kambaran, R. Omardien and A. D. Mbewu, 2009. Underweight, overweight and obesity among south african adolescents: Results of the 2002 national youth risk behaviour survey. Public health nutrition, 12(02): 203-207.

Robinson, T. N., 1999. Reducing children's television viewing to prevent obesity: A randomized controlled trial. Jama, 282(16): 1561-1567.

Sharma, A., K. Sharma and K. P. Mathur, 2007. Growth pattern and prevalence of obesity in affluent schoolchildren of Delhi. Public health nutrition, 10(05): 485-491.

Sudakov, K. V., 2001. "Imprints of reality" in the systems mechanisms of brain activity. Neuroscience and behavioral physiology, 31(6): 561-571.

Suter, P. and N. Ruckstuhl, 2006. Obesity during growth in switzerland: Role of early socio-cultural factors favouring sedentary activities. International journal of obesity, 30: S4-S10.

Tanner, J. M., 1981. Growth and maturation during adolescence. Nutr Rev, 39(2): 43-55.

Tanveer, M., E. Asghar, G. Badicu, N. Roy, M. Siener, U. Tanveer, S. B. Al-Mhanna and A. J. A. i. P. H. Batrakoulis, 2024. Association of physical activity and physical education with overweight and obesity among school-aged children and adolescents in pakistan: An empirical cross-sectional study. 2024(1): 5095049.

Tuan, N. T. and T. A. Nicklas, 2009. Age, sex and ethnic differences in the prevalence of underweight and overweight, defined by using the CDC and IOTF cut points in Asian children. European journal of clinical nutrition, 63(11): 1305-1312.

Uauy, R., C. Albala and J. Kain, 2001. Obesity trends in Latin America: Transiting from under-to overweight. The Journal of nutrition, 131(3): 893S-899S.

Vidal, E., E. Carlin, D. Driul, M. Tomat and A. Tenore, 2006. A comparison study of the prevalence of overweight and obese Italian preschool children using different reference standards. European journal of pediatrics, 165(10): 696-700.

Wamba, P. C. F., J. Enyong Oben and K. Cianflone, 2013. Prevalence of overweight, obesity, and thinness in Cameroon Urban children and Adolescents. Journal of obesity.

Wang, Y., C. Monteiro and B. M. Popkin, 2002. Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China, and Russia. The American journal of clinical nutrition, 75(6): 971-977.

WHO, 2007. Who child growth standards; head circumference-for-age, arm circumference-for-age, triceps skinfold-for-age and subscapular skinfold-for-age: Methods and development: Http://www.Who.Int/childgrowth/standards/second set/technical report 2.Pdf?Ua=1 World Health Organization, Geneva, Switzerland.

WHO, 2015. Global strategy on diet, physical activity and health: Childhood overweight and obesity. World Health Organization, Geneva, Switzerland.

WHO, 2015. Media center, facts sheet: Obesity and overweight: Http://www.Who.Int/mediacentre/factsheets/fs311/en/. World Health Organization: Geneva, Switzerland.

Yngve, A., I. De Bourdeaudhuij, A. Wolf, A. Grjibovski, J. Brug, P. Due, B. Ehrenblad, I. Elmadfa, B. Franchini and K.-I. Klepp, 2008. Differences in prevalence of overweight and stunting in 11-year olds across Europe: The pro children study. The European journal of public health, 18(2): 126-130.

Zimmermann, M. B., C. Gübeli, C. Püntener and L. Molinari, 2004. Detection of overweight and obesity in a national sample of 6-12-y-old swiss children: Accuracy and validity of reference values for body mass index from the us centers for disease control and prevention and the international obesity task force. The American journal of clinical nutrition, 79(5): 838-843.

Questionnaire (For Respondent):

District: _____________, Tehsil: __________Village: ______________Name: _____________, Father name: ________ Sex: ________________________
Age (Years): ________, Weight (Kg): ___________________, Height (cm): ______________, BMI (kg/m2)": ___________________________________