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A Comparative Analysis of Nutritional Status in Adolescents from an Urban Versus a Peri-urban School in Kwazulu-Natal, South Africa

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Abstract: With the current nutrition transition occurring in low-to-middle-income countries (LMICs), incidences of both overweight/obesity and underweight/stunting are increasingly observed within the same population. This is an important phenomenon with regards to adolescent health, as poor nutritional status among adolescents may contribute towards susceptibility to both communicable and non-communicable diseases in adulthood. Research has shown that nutritional status can be affected by socioeconomic status (SES). The objective of this study was to conduct a comparative analysis of the anthropometric status of adolescents from two secondary schools in the KwaZulu-Natal province of South Africa that differ according to the SES of the learners. The study was cross-sectional and descriptive; and was carried out in an urban and a peri-urban high school in Hilton, KwaZulu-Natal. Grade nine to 11 learners (n=111) aged 14 to 21 years from the peri-urban high school and the urban high school (n=98) aged 14 to 17 years, volunteered to participate (N= 209). Anthropometric measurements including weight, height and mid-upper-arm circumference (MUAC) were measured and body mass index (BMI) was calculated. Results showed a higher incidence of overweight (> +1SD - 25kg/m2) and obesity (>+2SD - BMI 30 kg/m2) among urban school boys compared to peri-urban school boys ($p<0.01$) and among peri-urban school girls compared to urban school girls ($p<0.01$) across all grades. A higher prevalence of stunting (<-2SD and >-3SD) was observed among peri-urban school boys ($p<0.01$) compared to their urban school counterparts. Albeit a small sample size, results from this study indicates that SES and gender may play a determinant role in overweight, obesity and stunting prevalence, as boys in urban areas and girls in peri-urban areas may be at a higher risk of overweight/obesity, whereas peri-urban boys may be at a higher risk of stunting. It can also be concluded that a double burden of stunting and overweight/obesity may exist among adolescents from peri-urban areas, who were considered to be of low SES.

Key words: Stunting, Obesity, Adolescents, Socioeconomic Status

1. Introduction

An increasing number of low-to-middle income countries (LMICs) are faced with a double-burden of malnutrition; which is characterised by a growing prevalence of overnutrition (overweight/obesity), and an existing prevalence of undernutrition (underweight/stunting) [1,2]. Middle-income countries in particular have undergone rapid nutrition transitions; a phenomenon largely associated with globalisation [3]. Hence countries such as South Africa have experienced a shift in dietary patterns from traditional to more “globalised” foods rich in sugar, sodium, and saturated fat from animal sources [4]. A South African study utilising data from the Birth-to-Twenty cohort revealed that fast food was consumed between five and seven times a week by 30% of adolescent participants, while 20% consumed fast food at least twice to four times a week [5]. An increase in the consumption of such energy dense but micronutrient-poor foods may contribute to chronic nutritional problems such as stunting and overweight/obesity.

Stunting is defined as a low height-for-age [6]. Although largely associated with being underweight, stunting can occur independently of weight-for-age, making it possible for an individual to be both stunted and overweight or obese [1, 6]. Stunting is characterised by an inadequate diet over a long-term period, and among adolescent learners can lead to poor academic performance and a reduced physical capacity for work [1, 7]. In addition, the micronutrient deficiencies that leads to stunting comes with the increased risk of developing communicable diseases, as undernutrition and infection share a synergistic and cyclic relationship [8]. Research conducted in Colombia observed a 44% increase in respiratory infections among stunted school children compared to those who were not stunted [9].

Overweight and obesity are defined as a high weight-for-height or BMI-for-age [6]. In contrast to stunting, obesity has mainly been associated with affluence [10]. However, it has become more widely prevalent in low-income areas due to the increased availability and affordability of globalised foods [11, 12]. Obesity is linked to a rise in non-communicable diseases (NCDs), including type 2 diabetes, hypertension, various cancers, and cardiovascular diseases (CVDs), which is the leading cause of death worldwide [4, 13, 14]. Future predictions attribute approximately 77% of global deaths to NCDs by 2030, the majority of which will occur in LMICs [15]. Using disability-adjusted life years (DALYS), the World Health Organisation (WHO) estimated that in 2008, there were approximately 92,400 male and 98,100 female NCD-related mortalities in South Africa [16].

The nutritional status of an individual is heavily influenced by biological and social factors related to sex/gender [17]. The sex of a person plays a unique role in disease susceptibility. For instance, owing to the specific nutritional requirements needed during pregnancy and lactation, Poor nutritional status such as malnutrition or obesity can place females at risk of pregnancy complications [2]. This is of particular concern for adolescents in LMICs, where adolescent fertility is three times higher compared to high-income countries [18]. Also, a high nutritional demand is already required during adolescence to facilitate the rapid growth rate due to pubertal development; hence nutrient deficiencies during this period can result in delayed sexual maturation and poor overall growth [19]. Despite having a lower rate compared to other middle-income countries, teenage pregnancy in South Africa is believed to be around 30% in 15-19 year olds [20].

From a social outlook, the nutrition transition in LMICs may disproportionally affect women, as they are often believed to be less physically active and hence have lower caloric requirements than men. Thus women may be more likely to gain weight from consumption of energy-dense, globalised foods [17]. This in addition to factors such as a lower muscle mass in women than men, and weight retention after pregnancy have been cited as possible reasons for overweight and obesity among women [21]. The perception of an ideal body image may also differ in LMICs as cultural norms may encourage women to have a larger size. In South Africa it has been reported among Black women that having a larger size is linked to being more attractive, more affluent and to having a husband that is well capable of caring for his wife [22]. Also, in light of the clinical wasting associated with the HIV/AIDS epidemic, a woman with a larger body mass is generally considered healthier than a slimmer woman [21].

Research has highlighted the co-existence of obesity and stunting in the same population, as individuals even in the same household can be both stunted and obese [10, 23]. In rural South Africa, a stunting and overweight/obese prevalence of 11.1% and 22.9% respectively was observed in primary school learners [1]. Also in rural South Africa, a study showed an increased risk of overweight/obesity among girls and an increased risk of stunting among boys, both of adolescent age [24]. In adolescence, such a combination can exacerbate the risk of developing communicable and NCDs in later years [24, 25, 26].

The objective of this study was to conduct a comparative assessment of the anthropometric status of adolescents from an urban versus a peri-urban school in the KwaZulu-Natal province.

2. Methods

2.1. Study Area, Population and Demographics

For this cross-sectional descriptive study, the study population consisted of grade 9-11 adolescents from two secondary schools participating in an outreach programme; one being a private urban school, and the other a peri-urban school, both situated in Hilton. Hilton is a small town situated on the outskirts of Pietermaritzburg in KwaZulu-Natal, South Africa. The private urban school runs an outreach programme, for which formal training for principals and teachers is provided to schools from peri-urban communities within the Hilton area. Also, learners from the private urban school provide academic support to learners from the peri-urban school [27].

Secondary schools in South Africa are classified according to national and provincial quintiles ranging from 1 to 5. Classification is based on socioeconomic information from the community or area where the school is located; including parental income, education levels, and employment status. Quintile 1 (Q1) schools represent the 20% of schools situated in areas with the lowest socioeconomic status (SES), while quintile 5 (Q5) schools represent the 20% of schools present in areas of high SES. The private urban school, classified as a Q5 school, consisting of a diverse learner population (Black, Indian, White and Coloured), whereas the peri-urban school is classified as a Q1 school and consists of predominantly Black learners. The age of those participants that attended the private urban school, varied between 14 -17 years, whereas those from the peri-urban school were aged between 14 and 21 years.

A total of 209 learners (98 from the Q5 and 111 from the Q1 School) volunteered to participate in the study. Data were collected between June and August 2013. Prior to data collection, volunteers were briefed on the study objectives in English and IsiZulu, after which they signed an informed consent form. Grades 8 and 12 were excluded from the study, as grade 8 learners were considered too young to participate, whereas grade 12 learners were in the process of preparing for their matriculation exams.

2.2. Data Collection

The anthropometric data collected in this study included height (m), weight (kg) and mid-upper arm circumference (MUAC) (cm). A stadiometer was used to measure height whereas a Seca 813 heavy duty floor scale with a platform to accommodate large feet was used to measure weight. Body mass index (BMI) was calculated from the height and weight measurements according to the formula weight (kg)/height^2 (m^2). A non-elastic Seca tape with a slide-in mechanism to facilitate accurate circumference measurement was used to measure MUAC. All anthropometric data were collected by fieldworkers who were adequately trained by a level III anthropometrist in accordance with the International Standards for Kinanometry (ISAK) standards. Each measurement was repeated three times and the average of the two closest measurements were calculated to ensure accuracy. BMI-for-age and height-for-age were calculated using WHO z-scores, and used to determine overweight, obesity and stunting [26]. Overweight was defined as having a z-score greater than +1SD (25kg/m2 at 19 yrs), and obesity as having a z-score greater than+2SD (BMI 30 kg/m2 at 19 yrs). Moderate stunting was defined as having a z-score between -2SD and -3SD, whereas severe stunting was defined as having a z-score greater than-3SD [28]. During data collection at the peri-urban school, 28 learners (13 girls and 15 boys) left the school premises before their weight and height could be measured. As a result, they were not included in the anthropometric calculations of mean weight, mean height, BMI, BMI-for-age and height-for-age. Their MUAC however, was recorded.

2.3. Data Processing and Analysis

Results were analysed using SPSS® 19 (SPSS, Chicago, Illinois, USA). Descriptive statistics, Pearson correlation coefficients and chi-square tests were performed. The nutritional status of learners was stratified according to gender. Significance was measured at the 0.05 level (two-tailed).

2.4. Ethical Considerations

This study was conducted according to the guidelines laid down in the Declaration of Helsinki, the South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research. All procedures involving human subjects were approved by the Ethics Sub-Committee (Humanities and Social Sciences) of the University of KwaZulu-Natal (UKZN) (protocol reference number: HSS/0271/013D). Written informed consent was obtained from all participants.

3. Results

Urban school learners had a more diverse ethnic background, whereas peri-urban school learners were predominantly Black African. Grade 10 and 11 learners from the urban school were younger than their counterparts at the peri-urban school (Table 1).

Table 1. *Characteristics of study population.*

	Urban (Q5) [n =98]	% of entire group	Peri-Urban (Q1) [n=111]	% of entire group
Grade 9	36	17.2	30	14.4
Grade 10	39	18.7	46	22.0
Grade 11	23	11.0	35	16.7
Black	30	14.4	108	51.7
White	56	26.8	0	0
Coloured	7	3.3	3	1.4
Indian	5	2.4	0	0
Male	56	26.8	65	31.1
Female	42	20.1	46	22.0
Age range (y)	14.3 – 17.5		14.16 –21.83	

3.1. Overall

The nutritional status of the entire group of adolescent learners from the urban and peri-urban school is shown in Tables 2 and 3.

Using WHO cut-off values for BMI-for-age, the overall prevalence of overweight in the peri-urban school was reported as 14.5% (n=12), and the obesity prevalence was 9.6% (n=8).

In the urban school, overall overweight prevalence was 18.4% (n=18) and obesity prevalence was 16.3% (n=16).

Using WHO cut-off values for height-for-age, stunting in the peri-urban school was reported as 13.3% (n=11). Stunting was considerably lower in the urban school, with a 1.0% (n=1) prevalence.

Table 2. *Overall overweight and obesity prevalence in grades 9-11 from urban and peri-urban school.*

	Urban (N=98)	Peri-Urban (N=83)
Overweight	18.4% (n=18)	14.5% (n=12)
Obese	16.3% (n=16)	9.6% (n=8)

BMI-for-age:
Overweight > +1SD (25kg/m2 at 19 yrs)
Obese >+2SD (BMI 30 kg/m2 at 19 yrs)

Table 3. *Overall stunting prevalence in grades 9-11 from urban and peri-urban school.*

	Urban (N=98)	Peri-Urban (N=83)
Moderate Stunting	1.0% (n=1)	13.3% (n=11)

Height-for-age: Moderate stunting: <-2SD and >-3SD

3.2. Gender Stratification

3.2.1. Girls

In the urban school, girls had a 16.7% (n=7) prevalence of overweight and a 4.8% (n=2) prevalence of obesity. In the peri-urban school, girls had an overweight prevalence of 33.3% (n=11) and an obesity prevalence of 18.2% (n=6) (Table 4).

In urban girls, a stunting prevalence of 2.4% (n=1) was found, whereas a prevalence of 6.1% (n=5) was observed among peri-urban girls (Table 5). One grade 11 peri-urban girl was reported to be both stunted and overweight. Mean

BMI was higher in peri-urban girls than urban girls (24.5± 4.3 kgm^2 versus 22.3± 2.8 kgm^2 respectively; $p<0.05$). Peri-urban girls also had a significantly higher mean weight compared to urban girls (60.0± 11.8 kg versus 56.0± 8.5 kg respectively; $p<0.05$) (Table 6a).

Table 4. *Overweight and obesity prevalence in girls from urban and peri-urban school.*

	Urban (N=42)	Peri-Urban (N=33)
Overweight	16.7% (n=7)	33.3% (n=11)
Obese	4.8% (n=2)	18.2% (n=6)

Table 5. *Stunting prevalence in girls from urban and peri-urban school.*

	Urban (N=42)	Peri-Urban (N=33)
Moderate Stunting	2.4% (n=1)	6.1% (n=5)

Table 6a. *Mean and standard deviations for anthropometric measurements of girls from the urban versus the peri urban school.*

	Urban (N=42)	Peri-Urban (N=33)
Weight (kg)	56.0± 8.5	60.0± 11.8
Height (m)	1.6± 0.1**	1.6± 0.0**
BMI (kg/m2)	22.3± 2.8*	24.5± 4.3*
BMI-for-age	0.6± 0.9	0.2± 0.7
Height-for-age	-0.3± 1.0*	-0.9± 0.9*

Rows with the symbol * or ** differ significantly between urban and peri-urban groups for the same anthropometric variable
* = ($p<0.05$); ** = ($p<0.01$)

Table 6b. *Mean and standard deviations for MUAC of girls from the urban versus the peri urban school.*

	Urban (N=42)	Peri-Urban (N=46)
MUAC (cm)	26.3±2.7	28.2±3.1

Rows with the symbol * or ** differ significantly between urban and peri-urban groups for the same anthropometric variable
* = ($p<0.05$); ** = ($p<0.01$)

3.2.2. Boys

Amongst boys, the urban school had an overweight prevalence of 19.6% (n=11) and an obesity prevalence of 25.0% (n=14). In the peri-urban school, the overweight and obesity prevalence was lower at 2.0% (n=1) and 4.0% (n=2) respectively (Table 7). Among peri-urban boys, a stunting prevalence of 12.0% (n=6) was observed. There was no stunting reported among urban boys (Table 8). A higher mean weight was observed among urban boys compared to peri-urban boys (75.5± 18.8 kg versus 59.4± 9.0 kg respectively; $p<0.01$), as well as a mean BMI (24.6± 6.0kgm^2 versus 21.7± 3.3kgm^2 respectively; $p<0.05$) and MUAC (31.3± 5.7 cm versus 27.4± 2.6 cm respectively; $p<0.05$) (Table 9a and b).

Table 7. *Overweight and obesity prevalence in boys from urban and peri-urban school.*

	Urban (N=56)	Peri-Urban (N=50)
Overweight	19.6% (n=11)	2.0% (n=1)
Obese	25% (n=14).	4.0% (n=2)

Table 8. *Stunting prevalence in grade 9-11 boys from urban and peri-urban school.*

	Urban (N=56)	Peri-Urban (N=50)
Moderate Stunting	0% (n=0)	12.0% (n=6)

Table 9a. *Mean and standard deviations for anthropometric measurements of boys from the urban and peri urban school.*

	Urban (N=56)	Peri-Urban (N=50)
Weight (kg)	75.5± 18.8**	59.4± 9.0**
Height (m)	1.8± 0.1	1.7± 0.1
BMI (kg/m2)	24.6± 6.0*	21.7± 3.3*
BMI-for-age	1.0± 1.3*	0.3± 1.2*
Height-for-age	0.3± 1.0**	-0.9± 1.1**

Rows with the symbol * or ** differ significantly between urban and peri-urban groups for the same anthropometric variable ** = ($p<0.01$) * = ($p<0.05$)

Table 9b. *Mean and standard deviations for MUAC of boys from the urban and peri urban school.*

	Urban (N=56)	Peri-Urban (N=65)
MUAC (cm)	31.3± 5.7*	27.4± 2.7*

Rows with the symbol * or ** differ significantly between urban and peri-urban groups for the same anthropometric variable ** = ($p<0.01$) * = ($p<0.05$)

4. Discussion

Data from a socio-demographic questionnaire (not shown) revealed that parental education and employment status among learners from the urban school were higher than that of the peri-urban school, which is indicative of the differences in SES of the learners.

The ethnic background of urban school learners was very diverse. The WHO Child Growth Standards (z-scores) were suited to define overweight/obesity and stunting in this study as they were designed to assess the normal human growth of children and adolescents irrespective of SES and ethnicity. This was achieved via universal cut points that were developed using nationally representative data sets from six countries/regions: Brazil, UK, US, Hong Kong, Singapore and the Netherlands; which made it easier to compare international data [29].

In low-income settings, MUAC has long been a practical and inexpensive field tool to identify severe acute undernutrition in infants and children aged 6–60 months [30]. However MUAC can also be used to measure obesity due to its ability to assess body fat tissue [31]. It has been recommended for use as a reliable indicator for overweight and obesity screening in child and adolescent populations [30, 31]. Prior to data collection, concerns were raised that possible skeletal deformities may be present among peri-urban school learners; hence MUAC was chosen over weight circumference (WC) as a more suitable nutritional status indicator [31].

Overall, a higher prevalence of overweight and obesity was observed in the urban school than the peri-urban school across all grades. However, when stratified according to gender, overweight and obesity prevalence were largely attributed to urban boys and peri-urban girls. Interestingly, the urban boys had a higher prevalence of overweight and obesity than urban girls, whereas the opposite was observed in the peri-urban school, as girls had a higher prevalence than boys.

Among peri-urban boys, stunting was considerably more prevalent. In addition to a higher overweight and obesity prevalence, peri-urban girls also had a higher stunting prevalence as indicated by a lower height-for-age. One girl from grade 11 reported as both overweight and moderately stunted, which may be indicative of a possible double burden of overweight/obesity and stunting amongst adolescents within this peri-urban population.

According to literature, both SES and urbanisation may contribute to perception of body image in both females and males. A study involving female participants from 26 countries across 10 different regions observed that slim as an ideal body size was more associated with high-income countries and with higher SES in low-income countries [32]. This supports the general perception that overweight and obesity among women are more associated with health, wealth and beauty in LMICs such as South Africa [33]. Yet overweight and obesity remains markedly present in high SES groups and urban populations. Lower levels of physical activity have been noted among adolescents with high SES and from urban areas, which may be attributed to a more sedentary lifestyle including increased vehicular transport and fewer outdoor activities [32]. Also, the presence of body dissatisfaction and pressure to lose weight among adolescents may de-motivate many from participating in available physical activities. Such issues affect boys and girls. A study conducted in Botswana showed that adolescent boys with a high SES were more dissatisfied with their bodies than their female counterparts [32].

Results from this study correlates with existing data from South Africa. Adolescents from the North West Province were investigated, and an overall stunting prevalence of 19% was shown, with a higher prevalence in rural areas and among boys. Although no significant relationship between stunting and overweight/obesity was found, it was observed that girls older than 14 years had increases in subcutaneous fat, likely due in part to the stunting prevalence [14].

Similarly, data from the first South African Youth Risk Behaviour Survey (2002) involving Black adolescents in grades 8–11, revealed a significantly higher stunting prevalence in boys than girls [34]. Also, overweight prevalence among girls was significantly higher than boys. Research conducted among rural South African adolescents, females aged 15-20 years were up to four times more obese than males in the same age group [24].

Limitations to this study included the sample size being relatively small, which made it difficult to stratify learners according to age and grade. Anthropometric data (weight and height) for 28 out of the total 111 peri-urban leaners were also not available, making the sample size even smaller. Also, despite its recommendation, few studies exist to validate the effectiveness of MUAC as an obesity indicator, which has been cited as its primary limitation [31]. In future a larger sample size could be used, as well as the use of triceps skinfold thickness could be adopted to measure subcutaneous fat, which is a non-invasive indicator of overweight and obesity [35].

5. Conclusion

A potential coexistence of overweight/obesity and stunting, particularly in adolescent girls from peri-urban areas is indicated by these results. The higher prevalence of overweight and obesity among peri-urban girls reflects a possibly higher risk of obesity-related issues such as pregnancy complications, as well as the development of NCDs in adulthood. Likewise, the study suggests an increased risk of undernutrition among boys from peri-urban areas due to the higher prevalence of stunting. Results may have been affected by the small study population from the two participating schools. Hence further research involving a larger sample size is warranted to yield results that can be considered more representative of the entire population.

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References

[1] N. Tathiah, I. Moodley, V. Mubaiwa, and L. Denny, South Africa's nutritional transition: Overweight, obesity, underweight and stunting in female primary school learners in rural KwaZulu-Natal, South Africa, S Afr Med J, vol. 103(10), pp. 718-723, 2013.

[2] H. F. Delisle, Poverty: the double burden of malnutrition in mothers and the intergenerational impact, Ann N Y Acad Sci, vol. 1136, pp. 172-84, 2008.

[3] P. Shetty, Nutrition transition and its health outcomes, Indian Journal of Pediatrics, vol. 80(1), pp. 21–27, 2013.

[4] K. Lock, R. D. Smith, A. D. Dangour, M. Keogh-Brown, G. Pigatto, C. Hawkes, R. M. Fisberg, and Z. Chalabi, Health, agricultural, and economic effects of adoption of healthy diet recommendations, Lancet, vol. 376(9753), pp. 1699-709, 2010.

[5] N. P. Steyn, D. Labadarios, and J. H. Nel, Factors which influence the consumption of street foods and fast foods in South Africa, Nutrition Journal, vol. 10(104), 2011.

[6] R. Uauy, M. L. Garmendia, and C. Corvalán, Addressing the double burden of malnutrition with a common agenda, Nestle Nutr Inst Workshop Ser, vol. 78, pp. 39-52, 2014.

[7] V. S. Leal, P. I. C. de Lira, R. C. E. de Menezes, J. S. Oliveira, L. A. de Souza, S. L. de Andrade, and M. B. Filho, Factors associated with the decline in stunting among children and adolescents in Pernambuco, Northeastern Brazil, Rev Saúde Pública, vol. 46(2), 2012.

[8] Z.A. Bhutta, and R. A. Salam, Global nutrition epidemiology and trends, Ann Nutr Metab, vol. 61, pp. 19-27, 2013.

[9] L. H. Dekker, M. Mora-Plazas, C. Marín, A. Baylin, and E. Villamor, Stunting associated with poor socioeconomic and maternal nutrition status and respiratory morbidity in Colombian schoolchildren, Food Nutr Bull, vol 31(2), pp. 242-250, 2010.

[10] K. Kahn, Population health in South Africa: Dynamics over the past two decades, Journal of Public Health Policy, vol. 32: 30–36, 2011.

[11] D. Stupar, W. B. Eide, L. Bourne, M. Hendricks, P. O. Iversen, and M. Wandel, The nutrition transition and the human right to adequate food for adolescents in the Cape Town metropolitan area: Implications for nutrition policy, Food Policy, vol. 37, pp. 199–206, 2012.

[12] N. J. Temple, and N. P. Steyn, The cost of a healthy diet: A South African perspective, Nutrition, vol. 27, pp. 505–508, 2011.

[13] P. Amuna, and F. B. Zotor, Epidemiological and nutrition transition in developing countries: impact on human health and development, Proceedings of the Nutrition Society, vol. 67, pp. 82–90, 2008.

[14] R. Kruger, H. S. Kruger, and U. E. MacIntyre, The determinants of overweight and obesity among 10- to 15-year-old schoolchildren in the North West Province, South Africa – the THUSA BANA (Transition and Health during Urbanisation of South Africans; BANA, children) study, Public Health Nutrition, vol. 9(3), pp. 351–358, 2005.

[15] A. Boutayeb, and S. Boutayeb, The burden of non-communicable diseases in developing countries, International Journal for Equity in Health, vol. 4(2), 2005.

[16] World Health Organisation, Global status report on non-communicable diseases. http://www.who.int/nmh/publications/ncd_report_full_en.pdf. Accessed January 13th 2014, 2010.

[17] R. Kanter, and B. Caballero, Global Gender Disparities in Obesity: A Review, Adv Nutr Int Rev J, vol. 3(4), pp. 491–8, 2012.

[18] R. E. Black, C. G. Victoria, S. P. Walker, Z. Bhutta, P. Christian, M. de Onis, M. Ezzati, S. Grantham-McGregor, J. Katz, R. Martorell, and R. Uauy, Maternal and child undernutrition and overweight in low-income and middle-income countries, Lancet, vol. 382, pp. 427–51, 2013.

[19] B. M. Popkin, L. S. Adair, and S. Wen Ng, The global nutrition transition: the pandemic of obesity in developing countries, Nutrition Reviews, vol. 70(1), pp. 3–21, 2012.

[20] S. Willan, A Review of Teenage Pregnancy in South Africa – Experiences of Schooling, and Knowledge and Access to Sexual & Reproductive Health Services. Partners in Sexual Health. http://www.rmchsa.org/wp-content/uploads/2013/08/Teenage-Pregnancy-in-South-Africa-2013.pdf Accessed January 13th 2014, 2013.

[21] N. Peer, C. Lombard, K. Steyn, N. Gwebushe, and N. Levitt, Differing Patterns of Overweight and Obesity among Black Men and Women in Cape Town: The CRIBSA Study. PLoS ONE; 9(9). Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4164661/, 2014.

[22] N. Phaswana-Mafuya, K. Peltzer, W. Chirinda, A. Musekiwa, and Z. Kose, Sociodemographic predictors of multiple non-communicable disease risk factors among older adults in South Africa, Glob Health Action, 2013; Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3776324/.

[23] E. W. Kimani-Murage, K. Kahn, J. M. Pettifor, S. M. Tollman, D. B. Dunger, X. F. Gómez-Olivé, and S. A. Norris, The prevalence of stunting, overweight and obesity, and metabolic disease risk in rural South African children, BioMed Central Public Health, vol. 10(158) http://www.biomedcentral.com/1471-2458/10/158 -Accessed February 10th 2014, 2010.

[24] E. Kimani-Murage, Exploring the paradox double burden of malnutrition in rural South Africa, Glob Health Action, vol. 6(19249), pp. 193-205, 2013.

[25] B. M. Mayosi, A. J. Flisher, U. G. Lalloo, F. Sitas, S. M. Tollman, and D. Bradshaw, The burden of non-communicable diseases in South Africa, Lancet, vol. 374, pp. 934–947, 2009.

[26] J. L. Baker, L. W. Olsen, and T. I. Sorensen, Childhood body-mass index and the risk of coronary heart disease in adulthood, New England Journal of Medicine, vol. 357(23), pp. 2329–2337, 2007.

[27] Grace College Outreach Programme, http://www.grace-college.co.za/about-us/outreach/masihambisane Accessed November 4th 2013.

[28] UNICEF, Nutrition training: Adolescents. http://www.unicef.org/nutrition/training/3.3/6.html Accessed September 9th 2013.

[29] Y. Youfa Wang, and H. J. Chen, Use of Percentiles and Z -Scores in Anthropometry. In: Preedy VR (Ed) Handbook of Anthropometry: Physical Measures of Human Form in Health and Disease, Springer Science+Business Media, 2012 DOI 10.1007/978-1-4419-1788-1_2.

[30] E. Craig, R. Bland, J. Ndirangu, and J. J. Reilly, Use of mid-upper arm circumference for determining overweight and overfatness in children and adolescents, Arch Dis Child, vol. 99(8), pp. 763, 2014.

[31] M. M. Mazcoglu, N. Hatipoglu, A. Ozturk, B. Cicek, H. B. Ustunbas, and S. Kurtoglu, Waist Circumference and Mid-Upper Arm Circumference in Evaluation of Obesity in Children Aged Between 6 and 17 Years, J Clin Res Pediatr Endocrinol, vol. 2(4), pp. 144–50, 2010.

[32] V. Swami, D. A. Frederick, T. Aavik, L. Alcalay, J. Allik, D. Anderson, S. Andrianto, A. Arora, A. Brännström, J. Cunningham, D. Danel, K. Doroszewicz, G. B. Forbes, A. Furnham, C. U. Greven, J. Halberstadt, S. Hao, T. Haubner, C. S. Hwang, M. Inman, J. L. Jaafar, J. Johansson, J. Jung, A. Keser, U. Kretzschmar, L. Lachenicht, Li. NP, K. Locke, J. E. Lönnqvist, C. Lopez, L. Loutzenhiser, N. C. Maisel, M. P. McCabe, D. R. McCreary, W. F. McKibbin, A. Mussap, F. Neto, C. Nowell, L. P. Alampay, S. K. Pillai, A. Pokrajac-Bulian, R. T. Proyer, K. Quintelier, L. A. Ricciardelli, M. Rozmus-Wrzesinska, T. Ruch, W. Russo, A. Schütz, T. K. Shackelford, S. Shashidharan, F. Simonetti, D. Sinniah, M. Swami, G. Vandermassen, M. van Duynslaeger, M. Verkasalo, M. Voracek, C. K. Yee, E. X. Zhang, X. Zhang, and I. Zivcic-Becirevic, The Attractive Female Body Weight and Female Body Dissatisfaction in 26 Countries Across 10 World Regions: Results of the International Body Project I, Pers Soc Psychol Bull, vol. 36(3), pp. 309–25, 2010.

[33] L. Malete, K. Motlhoiwa, S. Shaibu, B. H. Wrotniak, S. D. Maruapula, and J. Jackson, Body Image Dissatisfaction Is Increased in Male and Overweight/Obese Adolescents in Botswana, J Obes, Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3619546/,2013.

[34] C. C. Jinabhai, M. Taylor, P. Reddy, D. Monyeki, N. Kamabaran, R. Omardien, and K. R. Sullivan, Sex differences in under and over nutrition among school-going Black teenagers in South Africa: an uneven nutrition trajectory, Tropical Medicine and International Health, vol. 12(8), pp. 944–952, 2007.

[35] O. Y. Addo, and J. H. Himes, Reference curves for triceps and subscapular skinfold thicknesses in US children and adolescents, Am J Clin Nutr, Mar 1 vol. 91(3), pp. 635–642, 2010.