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Research Article

Dietary and Lifestyle Impact on Different Biochemical and Hematological Parameters in Indian Children

Cristina Vassalle[1]*, Claudio Marabotti[2], Siddiqui Khawer Naveed[3], Roy Arun[3], Irene Traghella[1], Francesca Mastorci[6], Alberto Marabotti[4], Das Apabrita Ayan[5], Banerjee Tanima[5], Chakravarty Devasmita[5], Bandyopadhyay Arun[5], Kyriazoula Chatzianagnostou[1], Mirko Passera[6], Simona Storti[1] and Alessandro Pingitore[6]

[1]*Fondazione CNR-Regione Toscana G Monasterio, 56124 Pisa and 54100 Massa, Italy*

[2]*Cardiovascular Department, Ospedale della Bassa val di Cecina, Cecina, Italy*

[3]*Department of Cardiology, Ruby General Hospital, Kolkata, India*

[4]*University of Pisa, Italy*

[5]*Indian Institute of Chemical Biology, Kolkata*

[6]*Clinical Physiology Institute, National Research Council, Pisa, Italy*

***Corresponding Author:** Cristina Vassalle, Fondazione CNR-Regione Toscana G Monasterio, 56124 Pisa and 54100 Massa, Italy.

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Abstract

Objective: India is characterized by the simultaneous occurrence of under- and overnutrition. In children the adoption of inappropriate feeding practices drives both to immediate and longer-term health implications, and it is one of the predisposing factor to obesity risk and noncommunicable diseases (NCDs) in adulthood.

Aim: To assess differences in disease risk biomarkers between Indian children living in a Calcutta suburb slum respect to those belonging to the high social class, according to their dietary and lifestyle habits.

Methods: Lifestyle, dietary habit (13-item food-frequency questionnaire), physiological and laboratory general and cardiometabolic risk biomarkers [blood pressure, heart rate, uric acid-UA, urea, glycated haemoglobin, electrolytes, creatinine, lipid, thyroid and inflammatory profile, hemochrome, parathormone, vitamin D, liver enzymes] were assessed in 41 Indian children (4 - 10 yrs) of the low (LSC) and high social class.

Results: LSC-children had significantly lower UA, and significantly higher HDL, and inflammatory parameters, and consumed significantly less meal number, sugar, and dairy, snacks or street food.

Conclusions: Higher inflammation in LSC children as well as higher obesity risk in Indian children adopting a Western diet must be targeted in the context of socio-economic status towards better health for all children.

Keywords: *India; Children; Urban Slums; Primordial Disease Prevention; Nutritional Transition*

Introduction

In India, the National and Family Health Survey reported that a great percentage of children is still underweight [1]. Poor living conditions in early life may cause, in adulthood, subsequent high risk for chronic clinical conditions such as depression, hypertension, diabetes mellitus, and obesity, which in turn may drive to worse non communicable disease (NCDs) [2,3]. At the same time, a parallel process of demographic and epidemiological transition are currently occurring at high rate in India, in which a change from a condition of predominance of nutritional deficiencies and infectious diseases, to those classified as degenerative chronic disease (such as cardiovascular disease, cancer, and diabetes) is witnessed [4]. As developing country has become wealthier, an increasing number of Indians belonging to the upper class have abandoned their traditional eating habits and replaced them with a more Westernized diet, also associated with physical inactivity and other unhealthy lifestyle behaviors [5]. However, it must taken in account that in children, the adoption of inappropriate feeding practices, often typical of the Western diets, may drive both immediate and longer-term health implications, and it is one of the predisposing factor to subsequent obesity risk and NCDs in adulthood [6,7].

Simple anthropometric indicators giving an estimate of stunting (height-for- age z score), underweight (weight-for-age z score), wasting (weight-for-height z score), mid-upper arm circumference, and functional tests (e.g. handgrip, blood pressure), are non-invasive and cheap, and remain the first choice where access to healthcare structures is difficult. Moreover, nutritional questionnaires and dietary indexes are also important for overall dietary assessment, giving information on variability in foods, quality of diets, and diet–disease relationships. However, blood tests are routinely done in worldwide healthcare settings, to help the determination of a risk/diseased or a healthy status. A panel of general blood tests commonly include metabolic parameters (e.g. glucose, lipid profile), nitrogen metabolites (e.g. urea, creatinine, uric acid), electrolytes and important enzymes (e.g. liver aminotransferases).

Aim of the Study

Aim of the present study was to assess differences between Indian children living in a slum in Calcutta suburb respect to those belonging to the high social class, regarding lifestyle and dietary habits, blood pressure and heart rate, and biochemical general, inflammatory and cardiometabolic risk biomarkers.

Material and Methods

Participants

The study was conducted in a tertiary care hospital in India in apparently healthy children aged 4 - 10 yr belonging to the low (n = 29, 12 females) and high (n = 12, 9 females) social class. None of the female reported menarche.

Low social class children living in a slums located in the suburbs of Kolkata City were enrolled in January 2016 at Department of Cardiology, Ruby General Hospital (West Bengal, India), where the non-governmental organization (Usthi Foundation), which give children access to healthcare and take care of their school attendance, cooperated with local physicians.

Children from high-social class were recruited from staff and doctor's children. Social status was estimated on the basis of their family income.

The study was approved by the local Ethics Committee: the investigation conformed to the principles outlined in the Declaration of Helsinki. All parents gave their informed consent before the study.

Dietary and lifestyle assessment

At enrolment participants' nutritional and lifestyle habits were assessed by using a semi-structured interview. In particular, for lifestyle habits, school frequency, hours of sleep per night, usual bedtime, smoke/alcohol assumption, menarche age, and job activity were evaluated.

For dietary intake food frequency per week (e.g. street food, cereals, legumes, eggs, meat) were estimated. Also, hygienic conditions at home (presence of bath, kitchen, and potable water availability) were considered.

Autonomic and biochemical measurements

Blood pressure and heart rate measurements were carried out by means of an automatic recorder (OMRON digital arm BP monitoring) allowing 3-minute intervals between single readings. Accordingly, blood pressure values, reported in the present study, represent the average of at least three recordings obtained from each child. Fasting blood samples were centrifuged at 2500g, for 10 minutes, and stored at -80°C until assayed. Biochemical analysis included the evaluation of the following biomarkers: uric acid (UA), urea, glycated hemoglobin (HbA1c), electrolytes, creatinine, lipid profile, and inflammatory parameters (C-reactive protein CRP, erythrocyte sedimentation rate

ESR), hematological parameters, thyroid-stimulating hormone (TSH), vitamin D (vitD), parathyroid hormone (PTH), serum glutamate pyruvate transaminase (SGPT, also known as alanine aminotransferase), serum glutamate oxaloacetate transaminase (SGOT, also known as aspartate aminotransferase), gamma-glutamyl transpeptidase (GGT). Standard automated laboratory methods were used to estimate biomarker concentration (INTEGRA 400, Roche, Cobas-E411, USA, Mindray BC5380, Germany)

Anthropometric measures

Anthropometric measurements (weight, height) were taken three times and averaged, and body mass index (BMI) calculated. Mid-Upper Arm Circumference (MUAC) was measured at the mid-point between the tip of the shoulder and the tip of the elbow.

Z scores (weight for age, WAZ; height for age, HAZ; BMI for age, BAZ) were calculated using the WHO Anthro software (WHO Anthro version 3.2.2, January 2011; http://www.who.int/childgrowth/software/en/).

Statistical analysis

Student's t test and χ^2 test for continuous and categorical variables, respectively, were used. Owing to skewness, log transformation of C reactive protein (CRP), gamma-glutamyl transferase (GGT), parathyroid hormone (PTH) was used. The relationship between two continuous parameters was performed by using simple regression analysis. Continuous variables with univariate association of $p \le 0.05$ were evaluated by a multivariate regression analysis to estimate independent factors in determining WAZ, HAZ, BAZ and MUAC values. Data are expressed as mean ± SD. Analyses were performed using StatView software (specify version). A p value ≤ 0.05 was considered statistically significant.

Results

Anthropometric characteristics and dietary and lifestyle habits according to social status

Demographic and physiologic characteristics of children enrolled in the study are reported in table 1. Children belonging to the low social class had lower Z-scores and MUAC with respect to high social class children (Table 2). In particular, girls in the high social class and boys in the low social class had respectively the highest and lower WAZ, HAZ and BAZ (Table 2).

	Low class	High class	p
Number	29	12	-
Males	13 (45)	4 (33)	ns
Age (years)	7.8 ± 1.5	8.3 ± 1.3	ns
Diastolic blood pressure (mmHg)	78 ± 8	76 ± 9	ns
Sistolic blood pressure (mmHg)	113 ± 11	110 ± 10	ns
Heart rate (bpm)	91 ± 14	101 ± 16	< 0.05

Table 1: *Demographic and physiological characteristics of children enrolled in the study.*
Data are expressed as mean ± SD or number (%).

	Low class		High class		
	Girls	Boys	Girls	Boys	p
WAZ	-0.9 ± 1.3	-1.8 ± 1.1	1.6 ± 1.1	0.4 ± 2.1	< 0.001
HAZ	-0.4 ± 1.0	-1.3 ± 0.9	0.9 ± 1.1	0.4 ± 1.8	< 0.001
BHZ	-1.0 ± 1.4	-1.5 ± 1.0	1.5 ± 1.0	0.2 ± 2.0	< 0.001
MUAC	16.7 ± 2.2	16.5 ± 1.9	21.0 ± 3.1	18.2 ± 5.9	< 0.01

Table 2: *Z-scores and mid-upper arm circumference according to social class and gender.*
WAZ: Weight for Age; HAZ: Height for Age; BAZ: BMI for Age; MUAC: Mid-Upper Arm Circumference.

No differences between children were found in lifestyle habits (Table 3). For dietary intake assessment, when stunting was defined as a low height-for-age for children (as a measure of past -chronic - child undernutrition) [8], 4 (13%) stunted children (with z-scores < -2.00) were found between children living into the slum. When underweight was defined as low weight-for-age (as an index of both past (chronic) and present (acute) undernutrition, 7), 9 (31%) children (with z-scores < -2.00) living into the slum were found to be underweight. Instead, in the HSC group, 6 children resulted overweight (50%), and 1 obese (8%). Moreover, children living in slums consumed a low number of meals ($p < 0.05$), reported no habitual sugar ($p = 0.06$), and dairy ($p < 0.01$) consumption, and no consumption of snacks and street food ($p < 0.001$). No difference for consumption of cereals, roots/tubers, legumes, meat, fish/seafood, oil/fats, fruits/vegetables, spices, and eggs was observed between the two groups of children (Table 3).

Lifestyle	Low class	High class	p
School frequency	29 (100)	12 (100)	ns
Sleep hours/night	9.4 ± 0.3	8.9 ± 0.4	ns
Usual bedtime	21 ± 1	22 ± 1	ns
Smoking habit/alcohol assumption	-	-	-
Job activity	-	-	-
Meal number/day	3	4	< 0.05
Diet consumption/week			
Street food	0 (0)	8 (67)	< 0.001
Cereals	29 (100)	12 (100)	ns
Legumes	28 (97)	12 (100)	ns
Dairy	14 (48)	12 (100)	ns
Eggs	28 (97)	12 (100)	ns
Meat	27 (93)	12 (100)	ns
Fish and seafood	25 (86)	9 (75)	ns
Oil/fat	12 (41)	7 (58)	ns
Sugar/Honey	22 (76)	12 (100)	0.06
Fruits and vegetables	29 (100)	12 (100)	ns
Tea	20 (69)	11 (92)	ns
Spices	29 (100)	12 (100)	ns
Hygienic conditions			
Bath	26 (90)	11 (92)	ns
Kitchen	29 (100)	12 (100)	ns
Potable water	13 (45)	6 (50)	ns

Table 3: *Lifestyle habits and dietary intake of children enrolled in the study. Data are expressed and mean±SD or number (%).*

Biochemical markers according to social status

As concerns biochemical markers, low social class children presented lower UA ($p < 0.001$), and higher HDL ($p < 0.05$) levels (Table 4). They also showed higher creatinine ($p \leq 0.001$) and potassium ($p < 0.001$), and lower sodium ($p < 0.05$) and chloride ($p < 0.001$) (Table 4). Moreover, inflammatory parameters were higher in low social class children (ESR, neutrophil to lymphocyte ratio) (Table 4). No differences in the other analytes or parameters were observed (Table 4).

	Low social class (Mean ± Std dev)	High social class (Mean ± SD)	p-value
ESR (mm/h)	24.9 ± 8.7	20 ± 4.5	0.08
Hemoglobin (g/dL)	12.7 ± 0.9	12.9 ± 1.1	ns
WBC (x10^9/L)	10 ± 2.5	9 ± 3	ns
N/L	2.6 ± 1.4	1.7 ± 0.6	0.03
Platelets (x10^9/L)	2.7 ± 0.7	3 ± 0.9	ns
Uric acid (mg/dL)	3.5 ± 0.6	4.3 ± 0.6	< 0.001
Urea (mg/dL)	19.4 ± 3.6	18.7 ± 7.8	ns
HbA1c (%)	5.4 ± 0.3	5.3 ± 0.3	ns
Sodium (meq/L)	137.5 ± 1.5	138.8 ± 1.9	< 0.05
Potassium (meq/L)	4.7 ± 0.4	4.2 ± 0.2	< 0.0001
Chloride (meq/L)	98.8 ± 2.3	104.3 ± 1.1	< 0.0001
Creatinine (mg/dL)	0.6 ± 0.1	0.5 ± 0.2	< 0.01
SGPT (IU/L)	22.6 ± 5.6	28.5 ± 16.7	ns
SGOT (IU/L)	31.1 ± 5.4	28.2 ± 5.5	ns
γ-GT (IU/L)	11.2 ± 2.5	10.9 ± 4.4	ns
CRP (mg/dL)	1.3 ± 0.5	1.5 ± 1.4	ns
Total cholesterol (mg/dL)	158.6 ± 26	159.1 ± 25	ns
HDL (mg/dL)	58.8 ± 9	50.6 ± 15	< 0.05
LDL (mg/dL)	73.8 ± 24	79 ± 24	ns
VLDL (mg/dL)	26 ± 3.4	18 ± 4.2	ns
Triglycerides (mg/dL)	131.1 ± 16.6	126 ± 20	ns
TSH (mU/L)	3.8 ± 2	3.7 ± 2	ns
Vitamin D3 (ng/mL)	16 ± 4.8	13.6 ± 12	ns
PTH (pg/mL)	43.4 ± 13	43 ± 19	ns

Table 4: *Biochemical parameters in LSC and HSC Indian Children.*

ESR: Erythrocyte Sedimentation Rate; WBC: White Blood Cells; N/L: Neutrophils to Lymphocytes Ratio; HbA1c: Glycated Hemoglobin; SGPT: Serum Glutamic Pyruvic Transaminase; SGOT: Serum Glutamic Oxaloacetic Transaminase; γ-GT: Gamma Glutamyl Transferase; CRP: C-Reactive Protein; HDL: High-Density Lipoprotein; LDL: Low Density Lipoprotein; VLDL: Very Low Density Lipoprotein; TSH: Thyroid-Stimulating Hormone; PTH: Parathyroid Hormone.

Interestingly, all LSC children had CRP levels above 0.6 mg/dl (age-reference limit adopted). Moreover, for it concerns 25(OH)D levels, only one male children in the HSC showed sufficient levels (above 30 ng/mL).

Correlation of WAZ, HAZ, BAZ and MUAC in the overall population

WAZ: Inversely correlated with creatinine ($r = -0.36$, $p < 0.05$), vitamin D ($r = -0.33$, $p \leq 0.05$), M/L ($r = -0.3$, $p \leq 0.05$), and directly with UA ($r = 0.51$, $p < 0.001$), chloride ($r = 0.43$, $p < 0.01$), SGPT ($r = 0.5$, $p < 0.001$), hematocrit ($r = 0.32$, $p < 0.05$). WAZ was significantly higher in children consuming street food ($p < 0.01$), and dairy ($p < 0.05$), and negatively correlated with sleep hours ($p < 0.001$).

Multiple regression analysis identified creatinine (T value -2.1, $p < 0.05$), and sleep hours (T value -3, $p < 0.01$) as independent variables for WAZ.

HAZ: Inversely correlated with creatinine ($r = -0.31$, $p \le 0.05$), N/L ($r = -0.35$, $p < 0.05$), M/L ($r = -0.36$, $p < 0.05$), SGOT ($r = -0.37$, $p < 0.01$), and directly with UA ($r = 0.37$, $p < 0.05$), chloride ($r = 0.43$, $p < 0.01$), PTH ($r = 0.42$, $p < 0.01$). HAZ was significantly higher in children consuming street food ($p < 0.05$), and dairy ($p < 0.05$), and negatively correlated with sleep hours ($p < 0.05$).

Creatinine (T value -2.3, $p < 0.05$) and PTH (T value 2.7, $p \le 0.01$) remained as independent correlates of HAZ after multivariate adjustment.

BAZ: Inversely correlated with creatinine ($r = 0.35$, $p < 0.05$), vitD ($r = -0.36$, $p < 0.05$), HDL ($r = -0.4$, $p < 0.05$), and directly with UA ($r = 0.52$, $p < 0.001$), chloride ($r = 0.4$, $p \le 0.01$), SGPT ($r = 0.55$, $p < 0.001$). BAZ was significantly higher in children consuming street food ($p < 0.01$), dairy ($p < 0.05$), and negatively correlated with sleep hours ($p < 0.001$).

At the multivariate regression analysis, HDL (T value -2, $p \le 0.05$), creatinine (T value -2.1, $p < 0.05$), SGPT (T value 2.4, $p < 0.05$), sleep hours (T value -3.5, $p \le 0.001$) remained the only independent determinant for BAZ.

MUAC: Directly correlated with UA ($r = 0.47$, $p < 0.01$), chloride ($r = 0.35$, $p < 0.05$), SGPT ($r = 0.57$, $p < 0.001$), Hbg ($r = 0.37$, $p < 0.05$), GGT ($r = 0.41$, $p < 0.01$), GFR ($r = 0.32$, $p < 0.05$), and inversely with HDL ($r = -0.34$, $p < 0.05$), and vitamin D ($r = -0.48$, $p < 0.01$). MUAC was significantly higher in children consuming street food ($p < 0.01$), dairy ($p < 0.05$), and negatively correlated with sleep hours ($p < 0.001$).

At the multivariate analysis sleep hours remained as the only significant determinant for MUAC (T value -3.1, $p < 0.01$).

Discussion

In the present study, we evidenced that a significant percentage of Indian children living in a slums is stunted/underweight, and has higher levels of inflammatory markers respect to those belonging to the high social class. On the contrary, high social class children, which adopted a Western dietary pattern, had higher percentage of overweight and higher levels of biochemical parameters, representing conventional risk factors for NCDs, which correlates to nutritional indices. Moreover, sleep quality intended as hours of sleep per night per hours, emerges as an important determinant for nutritional indices, suggesting that also inadequate sleep may contribute to cardio-metabolic risk in children independently from their socio-economic status.

Malnutrition is a big public health problem in India, where nearly 60 million children are estimated to be underweight [9]. In particular, this problem is diffuse especially among the poor and vulnerable social classes, and it sets in mostly during the first years of life. Parameters related to nutrition and growth are determinants of their successive survival, cognitive development, and lifelong health. Restricted growth in young children is a risk factor for mortality from infectious diseases and for poor physical and cognitive development throughout life [10,11].

Recent research suggests that social and economic status (SES) exposures during childhood are powerful predictors of health in adulthood, suggesting how physiological, behavioral, or psychological pathways can link the childhood SES experience to adult health [12].

In this context, social background and nutritional differences significantly affect inflammatory parameters in adolescent worldwide [13,14]. However, there is a lot of heterogeneity according to social class. In particular, at the same time India is a country in rapid nutritional and demographic transition, in which life expectancy is increasing and we witness change from undernutrition to overweight and obesity. A study conducted in 45 villages in East and West Godavari in Andhra Pradesh on sample size of 180.162 subjects, showed that the peak prevalence of many non-communicable diseases occurs at a younger age than in developed countries, recommending the challenge to implement appropriate prevention strategies [15]. Thus, subjects belonging to high social class are experiencing an epidemic of obesity-hyperglycemia, largely due to demographic and lifestyle changes, which is reflected in a growing burden of NCDs [16]. A review on school Indian children, including 11 studies, estimated a prevalence of overweight and obesity among 8.5 - 29.0% and 1.5 - 7.4% respectively [17]. We found more than half children belonging to HSC group with overweight/obesity and adverse Western feeding habits. Interestingly, we previously observed that UA (a main blood antioxidant, but also a cardiovascular risk factor if present at high levels) progressively growth from underweight to normal weight and overweight/obese Indian children ($p < 0.01$) [18]. Moreover, as food intake and fructose content may significantly affect the development of hyperuricemia, the adoption of Western diet (high fats and fructose content), street-food consuming (high content in saturated fats and poor in fibers, vitamins and antioxidants) and sedentary habit may favor UA elevation [19]. Accordingly, Indian children in the high social class, which habitually consume street food, presented higher UA levels respect to those who do not consume this kind of food [18]. Thus, early identification of overweight during childhood, which is of considerable clinical and public health relevance, may be particularly important among Indian children. By contrast, higher inflammatory parameters in low social class children, possibly associated to multiple factors linked to socio-economic disadvantage, such as the result of high levels of infection exposure, inappropriate infant, child feeding, lacking care practices, can also represent an important link in the pathophysiology of NCDs later in adulthood. Interestingly, sleep duration, which is a known risk factor for obesity and metabolic risk both in adults and children of other ethnic groups, emerges as a determinant of nutritional indices, independent on Indian children social status [19-21]. The high prevalence of hypovitaminosis D, likely also related to skin colour, suggest the need of supplementation and physiological level restoring in all children, beyond their belonging to different social classes.

One limitation for the present study is the limited number of children enrolled, although the great number of biomarkers considered, and significance of the differences observed reinforce our results. Accordingly, the multifactorial nature of child stunting and underweight offers many entry points for clinical and educational solutions and suggests that the impact of any intervention remains influenced by the combined effects of all variables within the determinants of health.

In conclusion, the co-existence of undernutrition and overnutrition in the Indian children population level poses a unique public health challenge. Interventional strategies for primary prevention of NCD risk in adulthood, possibly starting at a very young age, and focused on increased physical activity and healthy lifestyle behaviors (e.g. sleep hours) and food options, must be optimized in the socio-economic context of children. In this setting, the identification and use of simple and valid biochemical markers may be helpful to track these changes so as to understand and prevent late-life health outcomes, pursuing better health for all children.

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Bibliography

1. NFHS-4, National and Family Health Survey (2015-2016).

2. Mendenhall E., *et al*. "Non-communicable disease syndemics: poverty, depression, and diabetes among low-income populations". *Lancet* 389.10072 (2017): 951-963.

3. Vassalle C., *et al*. "Antioxidants in the diet and cognitive function: which role for the Mediterranean life-style?" *Journal of Prevention of Alzheimer's Disease* 4.1 (2017): 58-64.

4. Yadav S and Arokiasamy P. "Understanding epidemiological transition in India". *Global Health Action* 7 (2014): 23248.

5. Shrivastava U., *et al*. "Obesity, Diabetes and Cardiovascular Diseases in India: Public Health Challenges". *Current Diabetes Reviews* 13.1 (2016): 65-80.

6. Bhargava M., *et al*. "Overweight and Obesity in School Children of a Hill State in North India: Is the Dichotomy Urban-Rural or Socio-Economic? Results from a Cross-Sectional Survey". *PLoS One* 11.5 (2016): e0156283.

7. Misra A., *et al*. "Nutrition transition in India: secular trends in dietary intake and their relationship to diet-related non-communicable diseases". *Journal of Diabetes* 3.4 (2011): 278-292.

8. Srivastava A., *et al*. "Nutritional status of school-age children - A scenario of urban slums in India". *Archives of Public Health* 70.1 (2012): 8.

9. Bryce J., *et al*. "Maternal and child undernutrition, effective action at national level". *Lancet* 371.9611 (2008): 510-526.

10. Black RE., *et al*. "Maternal and child undernutrition: global and regional exposures and health consequences". *Lancet* 371.9608 (2008): 243-260.

11. Grantham-McGregor S., *et al*. "Developmental potential in the first 5 years for children in developing countries". *Lancet* 369.9555 (2007): 60-70.

12. Galobardes B., *et al*. "Is the association between childhood socioeconomic circumstances and cause-specific mortality established? Update of a systematic review". *Journal of Epidemiology and Community Health* 62.5 (2008): 387-390.

13. Chen E., *et al*. "Role models and the psychological characteristics that buffer low-socioeconomic-status youth from cardiovascular risk". *Child Development* 84.4 (2013): 1241-1252.

14. Kruger HS., *et al*. "Stunting, adiposity, and low-grade inflammation in African adolescents from a township high school". *Nutrition* 26.1 (2010): 90-99.

15. Joshi R., *et al*. "Chronic diseases now a leading cause of death in rural India--mortality data from the Andhra Pradesh Rural Health Initiative". *International Journal of Epidemiology* 35.6 (2006): 1522-1529.

16. Ganie MA., *et al*. "Prevalence, risk factors and consequences of overweight and obesity among schoolchildren: a cross-sectional study in Kashmir, India". *Journal of Pediatric Endocrinology and Metabolism* 30.2 (2017): 203-209.

17. Srihari G., *et al*. "Nutritional status of affluent Indian school children: what and how much do we know?" *Indian Pediatrics* 44.3 (2007): 204-213.

18. Mastorci F., *et al*. "Undernutrition and Overnutrition Burden for Diseases in Developing Countries: The Role of Oxidative Stress Biomarkers to Assess Disease Risk and Interventional Strategies". *Antioxidants (Basel)* 6.2 (2017): E41.

19. Vassalle C., *et al*. "Uric Acid for Cardiovascular Risk: Dr. Jekyll or Mr. Hide?" *Diseases* 4 (2016): E12.

20. Sayin FK and Buyukinan M. "Sleep Duration and Media Time Have a Major Impact on Insulin Resistance and Metabolic Risk Factors in Obese Children and Adolescents". *Childhood Obesity* 12.4 (2016): 272-278.

21. Aziz M., *et al*. "The Association of Sleep Duration and Morbid Obesity in a Working Population: The Baptist Health South Florida Employee Study". *Metabolic Syndrome and Related Disorders* 15.2 (2016): 59-62.

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