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Relation between socioeconomic status and body composition in Burundi high school student

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Abstract
Introduction: A person's weak or physical strength is more dependent to the human life environment such as natural environment, socioeconomic environment, nutrition and how the body is physically maintained (physical fitness).
Aim: The present study aimed to compare physiological indicator of physical fitness among rural and urban living student and to establish the influence of socioeconomic indicators in the development of physical fitness among these two groups.
Method: Two different methods have been used in the present study: test method to obtain our participant fitness characteristics and documentation method to obtain our population socioeconomic indicators used to find out the relationship between those two groups (physical fitness and socioeconomic) indicators.
Results: Statistical results show that underweight, overweight, obese, body fat percentage as body composition indicators have a strong correlation to economy as indicator of socioeconomic status. No correlation has been obtained between these body composition indicators with health and education as indicators of socioeconomic status. Consider Blood lipids (total cholesterol, triglyceride, HDL-C, LDL-C) as physiological indicator, study results showed strong to very strong correlation between these indicators and economy. Statistical result showed a positive but a very weaken correlation between these blood lipids indicators and education and health as socioeconomic status indicators.
Conclusion: A strong interdependence between body compositions, physiological indicators of physical fitness and economic status has been observed among urban and rural living participant to the study.
- For some body composition indicators of physical fitness paired to education and health as socioeconomic component, no correlation has been obtained;
- Blood lipids as physiological indicators paired to health and education showed a very weaken correlation.

Keywords: Body composition; socioeconomic; relation; Burundi

Introduction
Body composition (BC) refers to the tissue components which make up the body and are usually used to refer to the relative percentage of fat and fat-free tissue. Fat-free mass (FFM), fat body mass or fat mass (FM) and the percent of body fat (%BF) are the most frequent components in the evaluation of body composition. The percent of body fat represents the percent of the total body mass which consists of fat. Fat-free mass refers to the mass of fat-free tissue and is known as lean body mass (Howley *et al*., 2007) [7]. The excessively increase of body fat conduce to others adverse health situations such as increased blood lipids, metabolic problems (Ferranti and Mozaffarian 2008) [8], cardiovascular problems (Rodrigues and colleague 2007) [9], increased body mass index and diverse grad of obesity (Lottenberg and colleague 2007) [10]. There are other anthropometric indicators which can be used to qualify someone's body composition. For example, height and weight are used to obtain BMI, and this indicator can be one among many others indicators of body composition. Muscular density can also explain one's body composition.
Many factors can positively or negatively influence body composition and as consequence, negatively or positively influence one's physical fitness and health. These factors are: sedentary lifestyle, aging, inadequate diet and socioeconomic situation to name few.

Edson and colleague 2009 [11] affirmed that physical activity can foster key changes in body composition and lean mass, thus becoming an important factor in controlling overweight/obesity among children and adolescents. And another study affirmed that the major predictor of body composition in developed countries is socioeconomic status which is measured through a combination of educational attainment, income, material possessions, and occupational type (McLaren, 2007; Sobal and Stunkard, 1989) [12, 13]. As countries become more developed, there is a greater tendency for a negative association between socioeconomic status and adiposity, one indicator of body composition; that is, adiposity measures are higher in poorer people (McLaren, 2007; Sobal and Stunkard, 1989) [12, 13]. In developed countries numerous researches regarding relation between socioeconomic status and body composition have been carried out. Results on this topic in developed countries are unequivocal.

Whether consider obesity, body fat percentage or blood lipids, this association is negative in developed countries (Jiménez *et al* 2010; Daniel *et al*. 2009; Matthis Morgenstern *et al*. 2009) [14, 6, 5].

Study analyzing socioeconomic influence on body composition in developing countries (Carlos A. Monteiro *et al*. 2004) [18] concluded that:

Obesity in the developing world can no longer be considered solely a disease of groups of higher socioeconomic status;

The burden of obesity in a particular developing country tends to shift towards the groups of lower socioeconomic status as that country's Gross National Product (GNP) increases;

The shift of obesity towards the poor apparently occurs at earlier stages of the economic development.

This study conclusion shows a same tendency in developed and in developing countries regarding association between socioeconomic and body composition: an inverse association.

There are several likely explanations for this inverse association. Lack of food and/or high energy expenditure patterns become less common in a society after a certain stage of economic growth has been reached, even among its poorer social segments.

The lower level of education and health-related knowledge among the poor is coupled with a greater difficulty in acquiring the more expensive and less energy-dense foods (e.g. fruits, vegetables and whole-grain cereals) and there is a trend towards less leisure-time and fewer opportunities for recreational exercise (WHO 200). Again, with industrialization of developed and developing countries, refined and high energy foods are produced and putted on market. Low income families, with constrain in their food choices run to these refined and dense energy. Reason why obesity, abnormal blood lipid excessive body fat and other adverse characteristics of body composition are find in this category of people.

Furthermore, people with a high socioeconomic status may be the only ones able to resist to increasing obesogenic environments because they are more likely to have flexibility in their choice of diet and activity pattern than the poor who are more constrained in their choices (WHO 2003) [2].

In low income and very low income countries like Burundi less researches has been carried out on this topic. And existing general affirmation of positive association between socioeconomic status and body composition may not be true for all low and very low income countries.

The present study aimed to examine the relationship between socioeconomic status and selected indicators of body composition among high school students.

Research methods

Two different methods have been used in the present study: test method to obtain our participant body composition characteristics and documentation method to obtain our population socioeconomic indicators used to find out the relationship between those two groups (physical fitness and socioeconomic) indicators.

Study design and Population

Participant to the present study were students recruited according to their residential area. A part of students are from Bujumbura municipality (urban area with many schools and living standing relatively high) and Gitega Province (a semi urban area with many students from remote area). A total number of three hundred students have been recruited: 150 from urban area (85 males; 65 females) and 150 from remote area (92 male and 58 female). Recruited students were 21±2 years old and were all them in high school.

The present study was carried out in Burundi during the scholar year 2016/2017. From October 2016, testes have taken one mouth: two weeks for body composition indicators examination in Bujumbura urban area and two weeks for the same indicators examination in Gitega semi-urban area.

Variables tested

Body composition indicators measured were: BMI to determine the overweight or obesity situation, the body fat percentage and Waist circumference to determine abdominal obesity.

Test description and materials

- **Height and weight**: as measures of body size, were assessed with participants having bare feet and wearing light underclothes. Height was measured in the Frankfort plane to the nearest 1 mm and weight to the nearest 0.05 kg using a standard beam balance with a stadiometer (SECA 701 and SECA 861SECA, Hamburg, Germany). Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m2). The World Health Organization criteria (WHO 1997) was used: normal weight (18.5 < BMI, 25 kg/m2), overweight (25 < BMI, 30 kg/m2), or obese (BMI > 30 kg/m2).
- **Body fat percentage:** Skinfold thickness was measured at the non-dominant side of the body: triceps and subscapular using Holtain caliper. Body fat percentage was then calculated from triceps and subscapular skinfold thicknesses using Slaughter's equations. Below are Slaughter's equations.

Females

Females when triceps + subscapular ≤ 35 mm

Body fat % = 1.33 (triceps + subscapular) 0.013 (triceps +subscapular) 2 2.5

Females when triceps + subscapular > 35 mm

Body fat % = 0.546 (triceps + subscapular) + 9.7

Males

Males when triceps + subscapular ≤ 35 mm

Pre-puberal (Tanner stage 1)

Body Fat % = 1.21 (triceps + subscapular) 0.008 (triceps +subscapular) 2 1.7

Puberal (Tanner stage 2, 3, and 4)

Body Fat % = 1.21 (triceps +subscapular) 0.008 (triceps

+subscapular) 2 3.4
Post-puberal (Tanner stage 5)
Body Fat % = 1.21(triceps +subscapular) 0.008 (triceps +subscapular) 2 5.6
Males when triceps + subscapular > 35 mm
Body Fat % = 0.783 (triceps +subscapular) + 1.6

- **Waist circumference:** was measured with a non-elastic tape in a horizontal plane, at the level of the natural waist, which is the narrowest part of the torso from a front view. Participants stood erect with the abdomen relaxed, the arms at the sides and the feet together. The measurement was taken at the end of a gentle expiration without the tape compressing the skin. For some youth, especially for those who were obese, the measurement was performed in the midpoint between the superior iliac spine and the costal edge in the midaxillary line, because of identifying of their waist circumference was difficult. Abdominal obesity was defined3 using waist >94 cm for men and >80 cm for women (WHO 1997) [1].
- **Blood biochemical analysis:** All blood samples were taken after 12 hours fast between 7h00 and 9hoo AM. The preceding day was a resting day from any strenuous physical activity and participants were asked to rest at least eight hours during the previous night.

All blood samples were drawn from the antecubital vein and handled according to standardized laboratory practice: blood was directly centrifuged and the supernatant was gently removed and the rest serum was stored frozen at -800c until biochemically analyzed.
Total cholesterol, HDL-C and triglyceride were measured by using vitros DT60 dry chemistry system (ortho-clinical diagnostics, Inc, USA). LDL-C was estimated using the Freidewald equation: LDL-C= total cholesterol –HDL-C-(triglyceride/2.2). The biochemical analysis has been carried out in biochemical laboratory of Shanghai University of Sports in Chine.

Used socioeconomic indicators
We used data already calculated by the Burundi Institute of Statistic Bureau (BISB), representing the socioeconomic performance in each province.
That institute has dispatched socioeconomic in three components (Economy, Education and Health). For the need of the study, we have restructured those data to obtain two values representing, one urban area and the other non-urban area.

Statistical analysis
In order to process and analyses the data, the SPSS (Statistical Package for the Social Sciences) software version 13 was used. The following descriptive statistics and analytical methods were applied: mean, and standard deviation.
Linear regression has also been performed to figure out the correlation and its consistency between socioeconomic and physical condition performance in Burundi Adolescent. Socioeconomic was taken as independent variable and body composition indicators as dependent variable in regression analysis.

Results

Table 1: Correlation between body composition and socioeconomic indicators

Body composition	Region	Economy	Education	Health
Male				
Underweight	Urban	0.702	0.001	0.026
	Rural	0.527	0.011	0.121
Overweight	Urban	0.789	0.000	0.000
	Rural	0.613	0.000	0.000
Obese	Urban	0.831	0.000	0.013
	Rural	0.561	0.000	0.000
Abdominal obese	Urban	0.121	0.000	0.000
	Rural	0.011	0.000	0.000
Body fat percentage (%)	Urban	0.712	0.372	0.139
	Rural	0.617	0.013	0.321
Female				
Underweight	Urban	0.691	0.017	0.056
	Rural	0.604	0.231	0.141
Overweight	Urban	0.701	0.000	0.009
	Rural	0.681	0.000	0.000
Obese	Urban	0.795	0.000	0.015
	Rural	0.653	0.000	0.000
Abdominal obese	Urban	0.213	0.000	0.000
	Rural	0.021	0.000	0.000
Body fat percentage (%)	Urban	0.821	0.003	0.134
	Rural	0.671	0.127	0.193

Table 2: Correlation between blood lipid and socioeconomic indicators

Blood lipids	Region	Economy	Education	Health
Male				
Total cholesterol	Urban	0.832	0.349	0.276
	Rural	0.628	0.289	0.159
Triglyceride	Urban	0.671	0.002	0.331
	Rural	0.532	0.019	0.230
HDL-C	Urban	0.724	0.218	0.009
	Rural	0432	0.312	0.286
LDL-C	Urban	0.504	0.192	0.239
	Rural	0.421	0.235	0.029
Female				
Total cholesterol	Urban	0.782	0.119	0.213
	Rural	0.693	0.211	0.194
Triglyceride	Urban	0.568	0.121	0.184
	Rural	0.421	0.109	0.211
HDL-C	Urban	0.709	0.119	0.301
	Rural	0.672	0.213	0.218
LDL-C	Urban	0.521	0.011	0.142
	Rural	0.438	0.122	0.113

Discussion

Take economy as socioeconomic indicator, the present study result's didn't show an inverse or a negative association between economy and selected body composition indicators. Except abdominal obese indicator, all other selected body composition indicators (underweight, overweight, obese, body fat percentage) have showed strong or close to strong relationship to economy as indicator of socioeconomic status. In fact, on these indicators, the « r» value obtained is close to 0.8 which is qualified as strong relation.

However, it was expected to find a positive linear relationship between overweight, obesity and body fat percentage and economic status among urban living only. But, linear regression has also shown a positive and strong relation between these indicators of fitness as well as in rural living participant. This was unexpected because urban living participants are supposed to have better nourishment and less workload than rural living participant to the study.

This correlation between these indicators of body composition and this socioeconomic component tells us that Burundi economic cannot itself only determine the difference on physical fitness. In other words, our economy is not strength enough to influence Burundi population physical fitness. In developed countries, where economy is well structured and developed enough, the difference in economic indicators among region can make differences in physical fitness development indicators.

In the literature, other researchers have arrived on similar results. In fact, in research carried out in Kenya, the number of household goods and assets found in the women's households was found to be significantly related with the mean BMI (P=0.020) and fat percentage (P=0.002), with increasing mean outcome variables as the number of items increased (REGINA.W. MBOCHI 2010). A significant relation was also established between that indicator of economic status with the mean waist circumference (P=0.477) in the same Kenyan study. Also, using food, heating and lighting, water, health, education and clothing as proxy indicator of economic status, a positive correlation has been established between physical fitness indicators (REGINA.W. MBOCHI 2010) [15].

A study carried out in Cameroon on socio-economic status and adiposity has obtained comparable results to the present study (Leopold Fezeu *et al*. 2005) [16]. This Cameroon study has concluded that household amenities were the most important socioeconomic indicator for overweight, obesity and abdominal obesity in both genders. Occupational level was positively associated with obesity and abdominal obesity only in men, while there was no association between any marker of adiposity and educational level. Adiposity and abdominal obesity take place because an increase of lipids in the body and in this way may be one of many consequences of increased blood lipids.

Most of elements of body composition paired together with education and health as socioeconomic indicators, no correlation has been obtained.

Consider blood lipid as physiological indicator, study results showed strong to very strong correlation between these indicators and economy. This means that in Burundi, the more a family present better economic status, the more children are at risk to have increased blood lipid.

The plausible explanation of the increase of blood lipid risk in higher socio-economic groups include the greater capacity to obtain food, cultural values, that favour round body shapes and lower levels of physical activity (Leopold Fezeu *et al*., 2005) [16].

The Nutrition transition theory described by Popkin, (2002) [4], is seen to play an important role by bringing about changes in lifestyle and diet composition.

Results of the present study are contrarily to other research from Central Eastern Europe, Latin America and the Caribbean, Middle-East and North Africa, South Asia, South-east Asia and East Asia.

In fact, in these developing countries, there is an increased trend to elevate blood lipid and other cardio metabolic problems in lower socio-economic groups than in elevated socio-economic population. The explanation of this situation is that, lower level of education and health-related knowledge among the poor is coupled with a greater difficulty in acquiring the more expensive and less energy-dense foods (e.g. fruits, vegetables and whole-grain cereals) and there is a trend towards less leisure-time and fewer opportunities for recreational exercise (WHO 2000) [2].

Furthermore, people with a high socioeconomic status may be the only ones able to resist increasing obesogenic environments because they are more likely to have flexibility in their choice of diet and activity pattern than the poor who are more constrained in their choices (WHO 2003) [3]. A comparable cross-sectional survey undertaken in Brazil showed an inverse association between women's

socioeconomic status and obesity has resulted from both the continuous increase of the disease among the lower income groups and the recent decline in obesity observed among the higher income groups (Monteiro *et al*. 2004) [18].

For education and health as socioeconomic indicators, whether consider male participant or female participant to the study, statistical result showed a positive but a very weaken correlation between selected indicators of physical fitness and health. Similar correlation has been established between these selected indicators of physical fitness and education level.

To establish correlation between selected indicators of physical fitness and health as a socio-economic indicator we used alcohol consumption habit, tobacco smoking habit and access to health care facilities as component of health. For «Education as indicator of socio-economic indicator», non-education, primary education level, secondary education level and university educational level have been used in establishing its relation with selected indicators of physical fitness.

The present study result's is in somewhat contrary to a research conducted by in their study on lipid profile in a population of university students, they find a significant association between smoking and lipid profile.

The literature makes it clear that smoking leads to changes in the lipid profile, leading to significantly increases in triglycerides, VLDL and LDL-c, as well as a decrease in HDL-c (Elhashimi E *et al*. 2013) [22].

A sedentary lifestyle was also associated with HDL-c, and lower average cholesterol was found among those who did not engage in regular physical activity. It is known that physical exercise produces an increase in the metabolism of lipids and carbohydrates.

One of the most significant changes is the increase in HDL-c, considered to be the faction which has a protective effect on atherosclerotic disease. These findings, when confronted with the literature, corroborate the strong link between physical exercise and maintaining good health (Sacheck and colleague 2010) [21].

Alcohol consumption is another component of health. Correlation between this component of health and blood lipid among our participants has been established, but this correlation is weaken. Again, alcohol consumption is prohibited at school and this may be a reason the correlation obtained was not strength.

According to existing literature, Alcohol is a toxic substance that requires immediate breakdown upon ingestion. Affirmed that alcohol is metabolized through two main pathways: alcohol dehydrogenase (ADH) and hepatic microsomal ethanol oxidizing system (MEOS).

The ADH pathway produces acetaldehyde and NADH; acetaldehyde is further broken down into acetate, which can yield energy via the citric acid cycle. Excessive production of NADH and acetaldehyde are linked with metabolic disturbances such as lipid accumulation in the liver and decreased fat oxidation.

Conclusion

A strong interdependence between body compositions, physiological indicators of physical fitness and economic status has been observed among urban and rural living participant to the study;

- For some body composition indicators of physical fitness paired to education and health as socioeconomic component, no correlation has been obtained;
- Blood lipids as physiological indicators paired to health and education showed a very weaken correlation.

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