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THE EFFECT OF URBANISATION ON THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND OBESITY IN 10-15 YEAR OLD MALES IN THE NORTH-WEST PROVINCE OF SOUTH AFRICA: THUSA BANA STUDY

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ABSTRACT

The purpose of this study was firstly to investigate the relationship between physical activity and measures of obesity in 10–15 year old males in the North-West Province of South Africa. Secondly, the study aimed at determining the influence of age on the possible relationship between physical activity and obesity and thirdly, at determining the influence of urbanisation on the possible relationship between physical activity and obesity. A one-time cross sectional experimental design was used for this study. A total of 606, 10-15 year old males were recruited from 44 randomly selected schools in the North-West Province, which formed part of the THUSA BANA study during 2000 and 2001. Demographic data and physical activity participation were obtained through standardized questionnaires. Anthropometric measurements selected, were primarily those described in Norton and Olds (1996). Data analysis was performed using Statistica 2000 for Windows 1998. A one-way (ANOVA) and two-way analysis of variances together with Tukey post hoc HSD tests were used to indicate the differences between variables. The level of significance was set at $p<0.05$. Physical activity was not significantly associated with percentage body fat, body mass index or the sum of triceps and subscapular skinfolds in analysis of variances (ANOVA). Although there were no statistically significant differences between physical activity and the measures of obesity, the measures of obesity increased with a decrease in physical activity. In the application of the two-way analysis of variance, to determine the influence of age on the relationship between physical activity and obesity, some significant relationships were shown. The measures of obesity increased with an increase in age. There were also significant associations found in the application of the two-way analysis of variance, which determined the influence of urbanisation on the relationship between physical activity and obesity. The rural subjects had lower values of the indicators of obesity than the semi-urban and urban subjects, independent of their level of physical activity. This could indicate that socio-economic status and its influence on nutritional status, play an important role in the prevalence of obesity.

Key words: Anthropometry; Age; Obesity; Physical activity; South Africa.

INTRODUCTION

Obesity can be defined as an over-accumulation of adipose tissue because of a positive energy balance (Queen & Lang, 1993; McArdle *et al*., 1994). The accumulation of body fat is an indication that more energy has been stored than has been used (Bray, 1990; Epstein *et al*., 1996).

There are currently a worldwide increase in the prevalence of obesity especially in children and adolescents (Pronk & Boucher, 1999; Trent & Ludwig, 1999). Recent studies revealed that about 25% of American children are obese (Bar-Or *et al.,* 1998; Pronk & Boucher, 1999; Trent & Ludwig, 1999). Possible causes for this increased prevalence of obesity in children and adolescents are modernisation, rapid urbanisation in developing countries and unsafe environments which all lead to a more inactive lifestyle (WHO, 1998; Leupker, 1999; Van Mil *et al*., 1999). The onset of obesity in childhood leads to an increased likelihood of obesity later in life. Between 70-90% of obese children and adolescents become obese adults (Lechky, 1994; Bar-Or *et al*., 1998; Trent & Ludwig, 1999). Obesity is a chronic disease and is associated with a number of obesity-related diseases like: Coronary artery diseases, cancer, type II diabetes and psychological problems (Harlan, 1993; Rocchini, 1993; Williams *et al*., 1993; Bar-Or *et al*., 1998; Must & Strauss, 1999).

Seen in the light of the above it is clear that the increased prevalence of obesity in children is a problem worldwide. It is clear that there is a need for proper intervention methods to prevent and treat obesity in children. Physical activity has been proven to be an effective method in the prevention and treatment of obesity (WHO, 1998; Rippe & Hess, 1998; Sothern *et al*., 1999). Physical activity helps to prevent and treat obesity non-pharmacologically, by increasing the amount of energy expended, and increasing the resting metabolic rate (Goran *et al*., 1999).

South Africa is currently experiencing rapid urbanisation, especially of Africans leaving underdeveloped rural areas to seek a better lifestyle in and around the cities. In 1993, 48% of the South African population was urbanized, compared to 53% in 1996 (Anon., 1998). Researchers suspect that childhood obesity is or may become a public health problem in South Africa because of the rapid urbanisation and westernisation (acculturation) processes taking place at the moment. Together with the increase in dietary intake that is associated with urbanisation (Popkin & Doak, 1998), there is also a decrease in participation in physical activity due to unsafe environments (Bar-Or *et al.,* 1998). Children is sitting in front of the television or computer and do not play outside anymore (Bar-Or *et al.,* 1998). We know far too little of the prevalence of obesity in this population to address it in responsible and appropriate intervention programmes, but early prevention in childhood will lessen the health and economic costs of this epidemic in adulthood (Underhay, 2000).

The purpose of this study is therefore to investigate the relationship between physical activity and obesity in 10-15 year old males in the North-West Province of South Africa. Secondly, the study aimed to determine the influence of age on the possible relationship between physical activity and obesity. Thirdly, the study aimed at determining the influence of urbanisation on the possible relationship between physical activity and obesity.

METHODS

Subjects

The subjects of this study consisted of 606 males between the age of 10 and 15 years. The subjects formed part of the THUSA BANA Study (THUSA: Transition and Health during Urbanisation in South Africa; BANA: Children) conducted during 2000 and 2001. The subjects were recruited from three different strata regarding urbanisation in the North-West Province of South-Africa. Schools were randomly selected from a list of all the schools in the province. Subjects between 10 and 15 years were also randomly selected from class lists. Informed consent was obtained from the subjects and their parents, and the study was approved by the Ethics Committee of the Potchefstroom University for CHE, South Africa. A cross-sectional experimental design was used for this study.

Anthropometry

Anthropometric measurements were done by qualified anthropometrists under guidance of a level III anthropometrist. The measurements were taken according to standard methods as described by Norton and Olds (1996). The relevant measures for this study were: body mass and stature; triceps and subscapular skinfolds; waist and gluteul girths. Stature (maximum stretch) was measured by means of a stadiometer to the nearest 0.1 cm and body mass was measured by means of an electronic scale (Precision Health scale) to the nearest 0.1 kg. Girths were measured with a flexible Lufkin steel tape to the nearest 0.1 cm and skinfolds were taken using a Harpenden skinfold caliper with a jaw pressure of 10 g/mm^2 and skinfolds were taken to the nearest 0.2 mm. In order to determine Body Mass Index, the following equation has been used:

$$\text{Body Mass Index (BMI)} = \frac{\text{Body mass (kg)}}{\text{Stature (m}^2\text{)}}$$

Percentage body fat was calculated according to the equation of Boileau (1985):

Males 6 - 11 years:
% Body fat = (sum of triceps & subscapular skinfolds) – 0.012 (sum of triceps and subscapular skinfolds)^2 – 3.4

Males 12 -14 years:
% Body fat = (sum of triceps & subscapular skinfolds) – 0.012 (sum of triceps and subscapular skinfolds)^2 – 4.4

Males 15 -18 years:
% Body fat = (sum of triceps & subscapular skinfolds) – 0.012 (sum of triceps and subscapular skinfolds)^2 – 5.4

Percentage body fat were divided into three groups according to the classification of obesity in children (Lohman, 1992).

Low body fat: <12%
Normal body fat: 12.1–24.9%
High body fat (overweight and obese): >25%

Demographic information

The questionnaires were designed or adapted for this study population and were validated with appropriate methods (Underhay, 2002). Questionnaires were issued during individual interviews and conducted by the researchers and specially trained African fieldworkers in the language of the subjects' choice.

The questionnaire on demographic information included questions on type of housing, access to electricity, water source, household income category and number and ages of people living in the house. Subjects were classified into three levels of urbanisation using criteria based mainly on where people lived and the quality of their housing.

Stratum I : Rural group
Subjects live on farms or in traditional tribal villages. Subjects mostly live in brick houses and mostly with piped water and electricity available.

Stratum II : Semi-urban / Informal housing
Subjects live in informal housing areas also known as 'squatter camps' found adjacent to all major towns and cities. Shared water supply and electricity are sometimes available. Most subjects living in these areas moved there recently (mostly from rural areas and farms) and therefore represent people in the most rapid phase of transition.

Stratum III : Urban group
Subjects live in established urban townships (previously known as black locations), towns and cities. Water supply and electricity are available and people mostly live in westernised circumstances.

Physical Activity Questionnaire

The "Previous day physical activity recall" (PDPAR) questionnaire developed by Trost *et al*. (1999) was used in this study. Information regarding physical activity of the previous day was retrieved by this questionnaire. Subjects had to recall the activities of every 30 minute period they participated in the previous day and complete the activity questionnaire accordingly. The type and intensity of the activity was recorded on the questionnaire.

The intensity of the activities was divided into three different categories namely, high, moderate and low. A MET-value was used to express the intensity of the activity as a metabolic value (Trost *et al.*, 1999). One MET is equal to the energy expenditure associated with rest – 1 kcal/kg/hour or 3.5ml O_2/kg/min. To help explain this classification to children, pictures of low (<3 METS), moderate (>3 METS) and high (>6 METS) were used. MET-values of a specific physical activity was directly taken from the compendium of physical activities and energy expense list of the PDPAR (Ainsworth *et al.,* 1993; Weston *et al.,* 1997). A relative energy expenditure value was used to estimate the total daily energy expenditure by using the energy expense during specific periods of time. The 30 minute periods with a MET-value of 3 METS or more, as well as the 30 minute periods with a METS value of 6 METS and above, were added together. The activity level of subjects were classified in the following way: highly active when one or more of the 30 minute periods were coded as 6 METS, moderately active if two or more activities had a METS value higher than three and low active if two or less activities had a

METS value below 3 (Pate *et al.,* 1997). The PDPAR was tested and approved as being valid and reliable by Weston *et al.* (1997) and a number of researchers has used this questionnaire (Prista *et al*., 1997; Pate *et al*., 1997) with good results.

Statistical analysis

Statistical analysis was performed using Statistica 2000 (StatSoft., 1984-2000) for Windows 98. Descriptive statistics were calculated for the relevant variables. One-way analysis of variance (ANOVA) was computed to determine the relationship between physical activity and obesity. A two-way analysis of variance were computed to determine the relationship of physical activity and obesity respectively with urbanisation and age. For both the one-way and two-way analysis of variance the Tukey HSD post-hoc procedures for unknown number of subjects were applied.

RESULTS

Descriptive and comparative statistics for the 606, 10-15 year old males are provided in tables 1 and 2. The subjects were divided in five groups according to age. Statistics for the anthropometric variables are given in Table 1. Descriptive statistics regarding the physical activity and urbanisation status of the 10-15 year old males are given in Table 2.

TABLE 1. **DESCRIPTIVE STATISTICS OF ANTHROPOMETRIC VARIABLES IN 10–15 YEAR OLD MALES (N=606)**

Variable	Age	N	Mean	Min	Max	SD
Triceps Skinfold (mm)	10	87	9.98	4.4	35.0	5.74
	11	113	8.99	4.3	24.2	3.63
	12	135	10.48	4.1	31.8	5.68
	13	86	10.07	4.2	31.0	4.82
	14	82	9.64	4.4	60.0	7.03
	15	96	9.37	4.0	60.0	6.89
	Total group	605	9.79	4.0	60.0	5.67
Sub-scapular Skinfold (mm)	10	87	7.00	3.2	31.0	4.93
	11	113	6.42	3.4	26.1	2.94
	12	136	7.70	3.4	32.3	5.11
	13	86	7.80	3.4	24.8	4.02
	14	82	8.08	4.4	60.0	7.07
	15	96	8.91	3.4	60.0	7.42
	Total group	606	7.65	3.2	60.0	5.47
Sum of triceps and subscapular skinfolds	10	87	16.99	7.6	63.0	10.32
	11	113	15.42	7.7	49.7	6.21
	12	135	18.21	8.6	64.1	10.51
	13	86	17.87	8.8	47.4	8.39
	14	82	17.73	9.7	120.0	13.86
	15	96	18.28	8.1	120.0	13.97
	Total group	605	17.45	7.6	120.0	10.78

TABLE 1. **DESCRIPTIVE STATISTICS OF ANTHROPOMETRIC VARIABLES IN 10–15 YEAR OLD MALES (N=606)** ***(cont.)***

Variable	Age	N	Mean	Min	Max	SD
Percentage body fat (%)	10	87	14.81	6.2	34.5	6.34
	11	113	14.08	6.3	34.1	4.90
	12	135	14.90	6.3	33.5	6.98
	13	86	15.07	6.6	32.6	6.33
	14	82	14.23	6.6	45.0	5.92
	15	96	13.58	4.7	45.0	5.92
	Total group	604	14.47	4.7	45.0	6.15
Stature (cm)	10	87	135.05	117.8	167.0	7.50
	11	113	139.20	104.9	164.7	8.26
	12	136	143.99	117.3	166.6	8.05
	13	86	150.55	130.5	176.6	9.79
	14	82	156.60	115.6	180.5	10.86
	15	96	162.84	140.9	184.5	9.53
	Total group	606	147.37	104.9	184.5	13.04
Body mass (kg)	10	87	29.33	17.0	69.6	7.15
	11	113	31.17	23.0	58.0	6.19
	12	135	35.06	20.4	89.3	9.18
	13	86	39.11	23.7	73.6	9.33
	14	82	44.35	28.1	95.2	10.96
	15	96	49.34	28.2	100.5	11.53
	Total group	606	37.60	17.0	100.5	11.47
Body mass index (BMI)	10	87	15.94	12.25	31.86	2.75
	11	113	16.01	12.56	24.71	2.24
	12	136	16.72	12.78	32.17	3.04
	13	86	17.06	12.97	26.36	2.51
	14	82	17.98	14.13	33.65	3.47
	15	96	18.45	10.96	36.74	3.29
	Total group	606	16.98	10.96	36.74	3.05

In Table 1, the mean sum of triceps and subscapular skinfolds for the total group is 17.45±10.78, while the minimum is 7.6 mm and the maximum is 120 mm. The minimum value of 7.6 was measured at the 10-year old group, while the maximum of 120 mm was measured at the 14- and 15-year old groups.

Lohman (1992) reported that the sum of the triceps and subscapular skinfolds can be used with accuracy as a measure of percentage body fat using specific reference tables to derive percentage body fat from the sum of triceps and subscapular skinfolds (Lohman, 1992). The mean value of 17.45 is classified in the optimal percentage body fat category according to Lohman (1992). However, the maximum values of 120 mm, which were measured at the 14- and 15-year old groups are classified in the very high percentage body fat category (very obese category).

TABLE 2. **DESCRIPTIVE STATISTICS OF PHYSICAL ACTIVITY AND URBANISATION FOR 10–15 YEAR OLD MALES (N=604)**

Variable	**Age**	**Low active**	**Moderately active**	**Highly active**
Physical activity	10 (n= 88)	39	27	22
	11 (n=112)	48	47	17
	12 (n=137)	60	56	21
	13 (n= 86)	40	35	11
	14 (n= 83)	43	33	7
	15 (n= 96)	41	31	24
	Total group (N=604)	271 (45%)	229 (38%)	102 (17%)

Variable	**Age**	**Rural**	**Semi-urban**	**Urban**
Urbanisation	10 (n= 88)	37	11	40
	11 (n=114)	55	16	43
	12 (n=137)	51	32	53
	13 (n= 86)	36	15	35
	14 (n= 83)	18	10	55
	15 (n= 96)	22	20	54
	Total group (N=604)	219 (36%)	104 (18%)	280 (46%)

The mean percentage body fat for the total group is 14.47±6.15%, while the minimum is 4.7% and the maximum is 45.0%. The minimum percentage body fat of 4.7% was found at the 15-year old group and the maximum of 45% was found at the 14- and 15-year old groups. The mean percentage body fat of 14.47% is in the optimal range according to Lohman (1992). The maximum percentage body fat values of 45.0%, is very high and indicate that these individuals are very obese and at high risk for chronic diseases. According to the above classification of percentage body fat, the THUSA BANA male population had 40% (n=243) underweight subjects, 52% (n=315) normal weight subjects and 8% (n=46) obese subjects.

Body mass index (BMI) has a mean of 16.98±3.05 for the total group. The minimum BMI is 10.96 and the maximum is 36.74. Both the minimum and maximum BMI values were found in the 15-year old group. This finding is expected, because BMI increases with an increase in age (De Onis & Habicht, 1996; Luciano e*t al.*, 1997; Troiano & Flegal, 2000) and thus it was expected that the lowest value would be found in the 10-year old group. There are a number of reference data regarding BMI. Troiano and Flegal (2000) used National Health Examination Survey (NHES) II and III and National Health and Nutrition Examination Survey (NHANES) III as reference population. Mean BMI values for NHES II and III are between 17.1 and 22.3 and between 18.4 to 22.4 for NHANES III for 10–15 year old children. The mean BMI of 16.98 for the 10–15 year old males in the THUSA BANA study are thus a bit lower than that of the reference population used by Troiano and Flegal (2000).

For the purpose of this study the subjects were divided into three groups with regard to physical activity, namely: highly active, moderately active and low active (see physical activity questionnaire). As can be seen in Table 2, there were more low active subjects in each age group than there were moderate and high active subjects. Subjects were also divided into three groups regarding urbanisation, namely: rural, semi-urban and urban.

TABLE 3. **THE RELATIONSHIP BETWEEN OBESITY AND PHYSICAL ACTIVITY AMONG 10–15 YEAR OLD MALES: THUSA BANA STUDY (N=602)**

	Physical activity									
	Low			Moderate			High			
Variable	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**F- value**
Body Mass Index (BMI)	274	17.23	3.32	227	16.68	2.74	101	16.80	2.92	F(2.559) = 1.59
Sum of triceps + subscapular skinfolds	274	17.92	11.33	227	16.66	10.16	101	17.97	10.71	F(2.559) = 0.98
Percentage (%) body fat	274	14.80	6.51	227	13.98	5.79	101	14.78	5.92	F(2.559) = 1.23

According to the one-way analysis of variances and the Tukey HSD post hoc test there were no significant differences between the three indicators of obesity (percentage body fat, sum of triceps and subscapular skinfolds and body mass index) and physical activity. According to the results in Table 3, there was no statistically significant relationship between any of the indicators of obesity and physical activity. The mean BMI and percentage body fat values of the low active group were higher than that of the moderately active as well as the highly active groups. Although there were no statistically significant differences present, there was a tendency of the indicators of obesity (percentage body fat, sum of triceps and subscapular skinfolds and body mass index) to increase with a decrease in physical activity. It is interesting however, that the moderately active group had the lowest values for all the indicators of obesity, and not the highly active group, as was expected.

Table 4 shows the results of the two-way analysis of variance which investigated the influence of age on the possible relationship between physical activity and the three indicators of obesity. The only statistically significant differences ($p<0.05$) between the different age groups occurred were detectedin the BMI, where the 10 year old, low active group (a) (see Table 4) significantly differed from the low active 14- (e) and 15-(f) year old low active groups. The low active 11-year old group (b) also differed significantly from the 14- (e) and 15-(f) year old low active groups. The low active 11-year group (b) also differed significantly from the moderately active 10- (g) and 11- (h) year old groups. The low active 15-year old group (f) also differed significantly from the moderately active 10- (g) and 11- (h) year old groups.

TABLE 4. **AGE AND THE RELATIONSHIP BETWEEN OBESITY AND PHYSICAL ACTIVITY AMONG 10–15 YEAR OLD MALES (N=602)**

		Age Group								
Variable	**Physical activity**	**10**			**11**			**12**		
		N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Body Mass Index (BMI)	Low	43	e,f a)16.31	3.64	47	e,f b)16.10	2.16	60	c)16.87	3.59
	Moderate	27	e,f g)15.65	1.92	47	e,f h)16.09	2.18	55	i)16.60	2.59
	High	22	m)16.09	2.39	17	n)15.64	2.59	20	o)16.67	2.49
Sum of triceps + subscapular skinfolds	Low	43	a)18.19	13.46	47	b)15.25	5.47	60	c)18.50	10.20
	Moderate	27	g)15.13	5.33	47	h)15.40	5.74	55	i)17.79	10.86
	High	22	m)18.20	9.27	17	n)15.88	9.09	20	o)18.48	10.94
Percentage body fat	Low	43	a)15.06	7.19	47	b)13.98	4.49	60	c)15.29	7.37
	Moderate	27	g)13.95	4.65	47	h)14.16	4.97	55	i)14.43	6.63
	High	22	m)16.20	7.14	17	n)14.07	5.82	20	o)15.08	6.98
Variable	**Physical activity**	**13**			**14**			**15**		
		N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Body Mass Index (BMI)	Low	40	d)16.99	2.42	43	a,b,g,h e)18.60	4.14	41	a,b,g,h f)18.83	2.45
	Moderate	35	j)16.99	2.35	32	k)17.49	2.52	31	l)18.16	2.52
	High	11	p)17.52	3.41	7	q)16.44	1.84	24	r)18.19	3.52
Sum of triceps + subscapular skinfolds	Low	40	d)18.40	9.32	43	e)19.38	18.2	41	f)17.84	7.35
	Moderate	35	j)17.03	7.57	32	k)16.27	2.21	31	l)17.84	6.59
	High	11	p)18.59	7.75	7	g)14.24	6.59	24	r)19.60	15.0
Percentage body fat	Low	40	d)15.37	7.14	43	e)14.79	6.69	41	f)14.22	5.76
	Moderate	35	j)14.47	5.64	32	k)13.88	5.33	31	l)12.51	5.33
	High	11	p)15.89	5.58	7	g)12.33	2.24	24	r)13.85	4.65

N = number of subjects SD = Standard deviation
Significant difference ($p<0.05$) between groups is indicated by a, b,c, d, e, f, g, h and i above the group mean.

There were no statistically significant differences between the sum of the triceps and subscapular skinfolds and the different age and activity groups (see Table 4). It is interesting to note that the highly active 11-, 12-, 13-, and 15-year old groups had, unexpected, higher sum of skinfolds values than the low and moderately active groups. There was, however an increase in the sum of triceps and subscapular skinfolds with an increase in age, independent of activity level.

According to Table 4 there were also no significant differences between percentage body fat of the different age and activity groups. It is interesting that the moderately active groups had lower percentage body fat values than the low active and high active groups, irrespective of age. Another interesting phenomenon was that the 10- and 13-year old high active groups had the highest percentage body fat values. Therefore, age had no influence on the non-significant relation between physical activity and the indicators of obesity in this study. However, there was tendency that body mass index increased with an increase in age, whereas percentage body fat and the sum of the triceps and subscapular skinfolds increased with an increase in age from 10–13 years and thereafter decreased. There also was a decrease in skinfold thickness with an increase in age, which could possibly be attributed to physiological changes in boys, due to puberty.

TABLE 5. **THE INFLUENCE OF URBANISATION ON THE RELATIONSHIP BETWEEN OBESITY AND PHYSICAL ACTIVITY AMONG 10–15 YEAR OLD MALES: THUSA BANA STUDY (N=601)**

		Urbanisation								
Variable	**Physical activity**	**Rural**			**Semi-urban**			**Urban**		
		N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Body Mass Index (BMI)	Low	113	g a)16.69	3.07	46	b)16.53	2.01	115	a c)18.05	3.79
	Moderate	86	d)16.65	2.48	38	e)16.68	2.56	103	f)16.93	3.01
	High	17	g)16.25	2.87	21	h)16.65	3.63	62	i)17.06	2.69
Sum of triceps + subscapular skinfolds	Low	113	a)17.39	10.29	46	b)15.94	7.97	115	c)19.22	13.22
	Moderate	86	d)15.51	6.41	38	e)16.26	7.52	103	f)17.76	13.10
	High	17	g)15.09	7.05	21	h)20.15	16.53	62	i)18.13	8.97
Percentage body fat	Low	113	a)14.51	6.56	46	b)13.36	5.23	115	c)15.67	6.84
	Moderate	86	d)13.49	5.40	38	e)13.84	5.53	103	f)14.45	6.19
	High	17	g)12.96	5.19	21	h)14.90	5.70	62	i)15.29	6.17

N = number of subjects SD = Standard deviation

The results of the two-way analysis of variance which investigated the influence of urbanisation on the possible relationship between physical activity and the indicators of obesity are shown in Table 5 and Figures 1, 2 and 3. The only significant difference ($p<0.05$)

between the different groups of urbanisation occurred at BMI, where the low active rural group (a) differed significantly from the low active urban group (g). The high active group had lower values of BMI and in some cases of sum of the skinfolds and percentage body fat, than the moderately active and low active groups, independent of their urbanisation group.

Urbanisation had no statistically significant influence on the non-significant relation between physical activity and the indicators of obesity (BMI, sum of triceps and subscapular skinfolds and percentage body fat). There was however a tendency that, the urban groups had higher values for the indicators of obesity than the urban and rural groups, independent of activity level, but there was no significant differences.

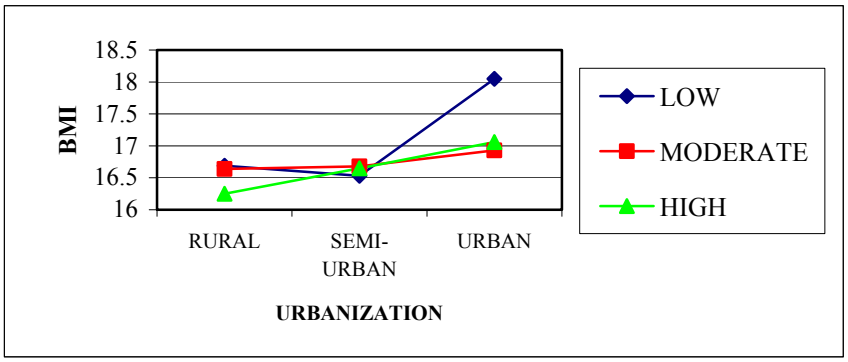

FIGURE 1. **THE INFLUENCE OF URBANISATION ON THE RELATIONSHIP BETWEEN BMI AND PHYSICAL ACTIVITY AMONG 10–15 YEAR OLD MALES: THUSA BANA STUDY**

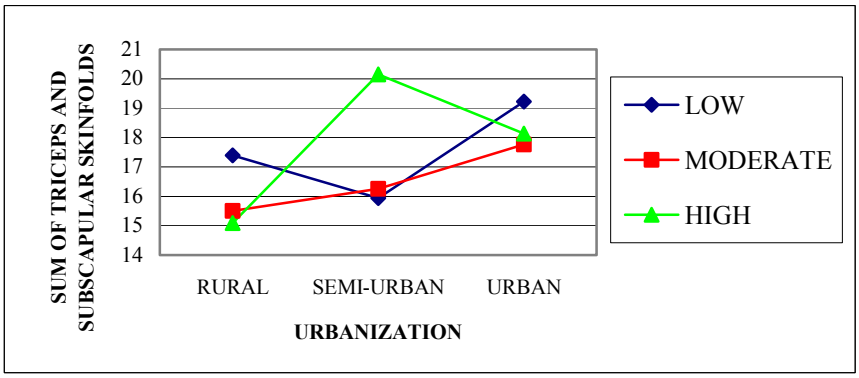

FIGURE 2. **THE INFLUENCE OF URBANISATION ON THE RELATIONSHIP BETWEEN THE SUM OF TRICEPS AND SUBSCAPULAR SKINFOLDS AND PHYSICAL ACTIVITY AMONG 10–15 YEAR OLD MALES: THUSA BANA STUDY**

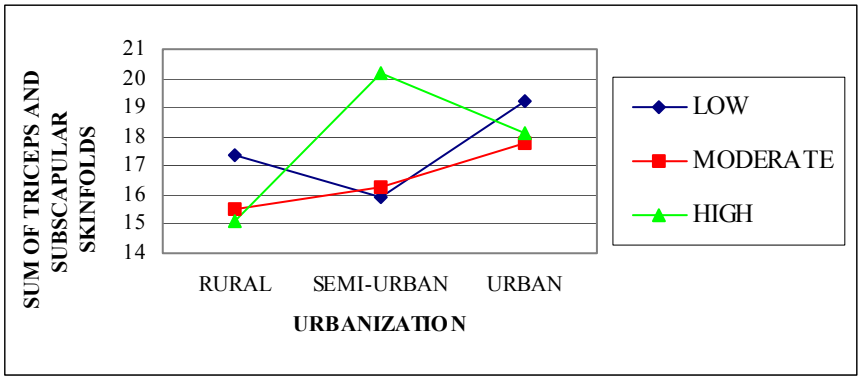

FIGURE 3. **THE INFLUENCE OF URBANISATION ON THE RELATIONSHIP BETWEEN PERCENTAGE BODY FAT AND PHYSICAL ACTIVITY**

DISCUSSION

According to Sothern *et al*. (1999) physical activity is an effective method in the prevention and treatment of obesity. According to this study it appears that there is only a decrease in the indicators of obesity (body mass index, percentage body fat and triceps and subscapular skinfolds) with an increase in physical activity from low active to moderately active. This relationship however, is not statistically significant. This results are contradictory with already existing research. Kemper *et al*. (1999) found that percentage body fat decreased with an increase in physical activity and visa versa.

According to this study, age has no statistically significant influence on the relationship between physical activity and the indicators of obesity. There was a tendency for body mass index to increase with an increase in age from 10 to 15 years. This could be because of growth and the accompanied increase in muscle mass in relation to body stature during this phase of adolescence. Guillaume (1999) and Troiano and Flegal (2000) which used the NHES II, NHES III and NHANES III as reference data also reported an increase in body mass index with an increase in age. This however was not the case with percentage body fat and the sum of the triceps and subscapular skinfolds, which increased with an increase in age, until 13 years and thereafter showed a decrease in values with an increase age until 15 years. These results are opposing to results by Lohman (1992) who found a direct increase in sum of triceps and subscapular skinfolds with an increase in age in adolescent boys in developed countries.

Figures 1, 2 and 3 show the influence of urbanisation on the relationship between physical activity and the sum of triceps and subscapular skinfolds, body mass index and percentage body fat as indicators of obesity. No statistical significant difference could be found between the variables, but there was a tendency for higher body mass index, sum of the triceps and subscapular skinfolds and percentage body fat values in the urban group than in the semi-urban and rural groups. The rural group had the most low active subjects, while the urban group had the most high active subjects, which is unlike expected. This could possibly be explained by the

fact that no organized physical activity exist in the rural communities. Although this children live in rural areas, they don't have to walk as far to school and to fetch water as in the past. Urban children however are exposed to organized sport activities and thus have a higher physical activity level. Another interesting phenomenon is that only at the rural group, the relationship between physical activity and the indices of obesity was like expected (a decrease in measures of obesity with and increase in physical activity). This could indicate that other factors than physical activity, like diet play an important role in the development of obesity in semi-urban and urban children.

Possible reasons for the lower values in the three indicators of obesity, in the rural and semi-urban groups could be that low socio-economic status which is associated with the rural and semi-urban subjects in this study could have an influence on the nutritional status of the subjects. The urbanisation of traditional rural people have generally been associated with a nutritional transition characterized by increased intakes of energy, fat and processed foods, resulting in enhanced rates of obesity (Vorster *et al.*, 2000). The differences between the rural, semi-urban and urban THUSA BANA subjects could therefore possibly be attributed to the effect of urbanisation has on the changing of diet towards a more western diet. Most of the urban subjects has spent most of their lives in urban areas and followed a typical western lifestyle. Other factors, such as diet, probably played a more important role than physical activity in the development of overweight.

CONCLUSION

Based on the results of this study, it is concluded that there are no significant relationship between physical activity and the indicators of obesity in 10–15 year old males. There were also no significant differences as far as the influence of age and urbanisation on the relationship between physical activity and the indicators of obesity is concerned.

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