

THE ASSOCIATION OF BODY FAT AND LEISURE TIME PHYSICAL ACTIVITY CALLED INTO QUESTION FOR ASIAN INDIANS

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Objective: Thrifty genotypes may predispose to type 2 diabetes and body fat (%BF) excess through a differentiated relationship between physical activity and body fat. We explored this hypothesis in Asian Indians, a population thought to be thrifty.

Methods: Three hundred and nine Guadeloupean adolescents responded to the modifiable activity questionnaire. Their body fat was assessed by bioimpedanceometry. We first studied the relationship between %BF and leisure time physical activity (LTPA). We then explored the associations of ethnicity with this relationship in a subgroup of 93 Asian Indians matched with 93 controls for age, sex, and LTPA class. The alpha risk retained was .05.

Results: The analyses showed that Asian Indians had higher %BF even when matched with controls for age, sex and LTPA quartile, and the relationship between LTPA and %BF observed in controls was not evidenced in Asian Indians.

Conclusions: The higher %BF in Asian Indians remained significant even when they were matched with controls for age, sex and LTPA quartile, and their LTPA was not associated – or was at least less robustly associated – with %BF. These findings are consistent with the hypothesis of thriftiness in Asian Indians, with the weaker relationship of high LTPA and low %BF a possible path to thriftiness. *Ethn Dis.* 2016;26(4):485-492; doi:10.18865/ed.26.4.485

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INTRODUCTION

Guadeloupe has seen a rapid progression in obesity from childhood onward. Its population is mainly composed of African descendants and a minority of Asian Indian descendants. Asian Indian Guadeloupeans have higher body fat than their local counterparts,^{1,2} as is the case elsewhere in the world.^{3,4} James Neel proposed that the disposition to fat excess in certain populations is the result of natural selection processes in our evolutionary past that led to better survival in environments regularly exposed to famine.⁵ Wells⁶ proposed that this selection was likely to have occurred after the advent of agriculture, as humans settled and became dependent on crops. Agriculture in India is highly dependent on the monsoon cycle, which abundantly waters the fields six months of the year. At periodic intervals, climatic shifts attributable to El Niño profoundly alter the rainfall, with drastic consequences like lethal fam-

ines. The tendency toward excessive body fat in Asian Indians thus might be, in part, genetically determined.

It has been proposed that storing fat while being physically active is epidemiologically less frequent⁷ and physiologically less easy⁸ than while being physically inactive. A tendency toward increased fat storage under genetic influence, associated with increased metabolic efficiency, would

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very likely have permitted better survival during famines by relatively unlinking the fat storage processes from physical activity energy expenditure so that thrifty humans could store fat while remaining active.

We conducted our research to answer the question, “Is the physical activity/body fat relationship different in Asian Indians and a control group?” If so, this would

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lend support to the hypothesis that the body fat stores of Asian Indians are less affected by physical activity than those of others.

METHODS

Sample

Three hundred and twenty-four students were recruited from Guadeloupean schools: 146 originating from India and 178 originating from elsewhere. Asian Indians declared that they and both parents had originated from India,^{9,10} while those in the control group declared that neither they nor either of their parents had originated from India.

Assessments

The leisure-time physical activity (LTPA) of the adolescents was estimated over a 7-day period with the modifiable activity questionnaire (MAQ) for adolescents; details of the MAQ are presented elsewhere.¹¹ This instrument was self-administered and supervised by trained interviewers in classrooms. The participants identified all activities they had performed in the 7 days preceding the study; they selected activities from a list of 40 activities that had been most reported by 380 students in a preliminary study of the same population. The advantage of this questionnaire is the high consistency of the items chosen with respect to the scanned population, a critical issue for studies of small populations on islands. This list included standard activities like walking, tennis, dancing, volleyball, handball, synchronized and lap swimming, and more specific activities like backpack-

ing, beach soccer, surfing, windsurfing and canoeing. The participants wrote down the day they performed each activity and its average duration.

LTPA energy expenditure data are expressed in MET-hr/week according to the equation: $LTPA-EE = \sum [F_i \times (d_i/60) \times MET_i]$ where LTPA is the leisure-time physical activity in MET-hr/week, i is the leisure activity being considered, F is the number of times the leisure activity was reported during the week, MET is the standard metabolic equivalent of the leisure activity,¹² and d is the average duration of the leisure activity in minutes. We also studied the intensity of LTPA expressed as the average metabolic equivalent of LTPA, the intensity of the most intense LTPA, and the quantity of LTPA expressed as the average daily duration of LTPA. Subjects reporting LTPA-EE more than two standard deviations from the average of the sample were considered as misreporters. The stature (in meters) and body mass (in kilograms) were then measured. Body fat percentage (%BF) was estimated by bioelectrical impedance (Tanita BC 418 MA, Tanita Corporation) as the percentage of body fat in unshod, lightly-clothed participants with no jewelry or superfluous accessories.

Statistics

After excluding misreporters ($n=15$), the analyses were conducted in two successive steps.

First, we explored the effect of sex on the dependent variables with Student t tests in a group that included every non-Indian adolescent in the sample ($n=171$) and 10 randomly selected Asian Indians to achieve

a sample that was representative of the Guadeloupean adolescent population ($n=181$). We then identified the three quartiles of LTPA-EE in the group and determined the association of LTPA-EE with %BF by 1-way ANOVA with LTPA-EE classes as the independent variable. We then assessed the linear correlation between LTPA-EE and untransformed BF%. After nonlinear transformation of the data, the relationship was further explored by successively using quadratic, reciprocal, logarithmic, and power models. A linear regression analysis of %BF with LTPA-EE was also performed.

Student t tests then compared the %BF in every Asian Indian ($n=93$) and non-Indian ($n=93$) who could be matched (one-to-one) for age, sex, and LTPA-EE class. LTPA was matched regarding quartiles of LTPA-EE such that a 14-year-old boy in the control group who had reported LTPA-EE under the 1st quartile was matched with a 14-year-old Asian Indian boy who had also reported LTPA-EE under the 1st quartile. We then added LTPA-EE classes to ethnicity as a second independent variable through a 2-way analysis of variance to explore the impact of ethnicity on the relationship between LTPA and %BF.

Normality was explored by Shapiro-Wilk analyses, and acceptable skewness and kurtosis to perform parametric analyses were defined by indices within the range of $[-2;+2]$. The Levene test checked for heteroscedasticity. The Mann-Whitney test compared two independent heteroscedastic groups. The alpha risk retained throughout the study was .05.

RESULTS

Relationship between LTPA and %BF

The parameters studied in the subgroup representative of Guadeloupien adolescents are presented in Table 1 by sex. Males and females had comparable ages and body masses ($P=.802$ and $P=.368$, respectively).

Table 1. Age, anthropometry and physical activity variables by sex (n=181)

Variables	Whole sample (N=181)	Males (n=93)	Females (n=88)
Age, years	14.2 ± 1.5	14.2 ± 1.5	14.3 ± 1.5
Body mass, kg	60.3 ± 14.2	61.2 ± 14.3	59.3 ± 14.0
Stature, meter ^{a,b}	1.67 ± .11	1.7 ± .12	1.64 ± .08
LTPA-EE, in MET-hr/week ^a	48.6 ± 38.0	62.1 ± 37.37	34.3 ± 33.38
%BF, % ^a	21.3 ± 7.5	16.7 ± 5.46	26.0 ± 6.3

a. Significant effect of sex ($\alpha=.05$).

b. Heteroscedasticity was evidenced, leading to the use of the nonparametric Mann-Whitney U test.

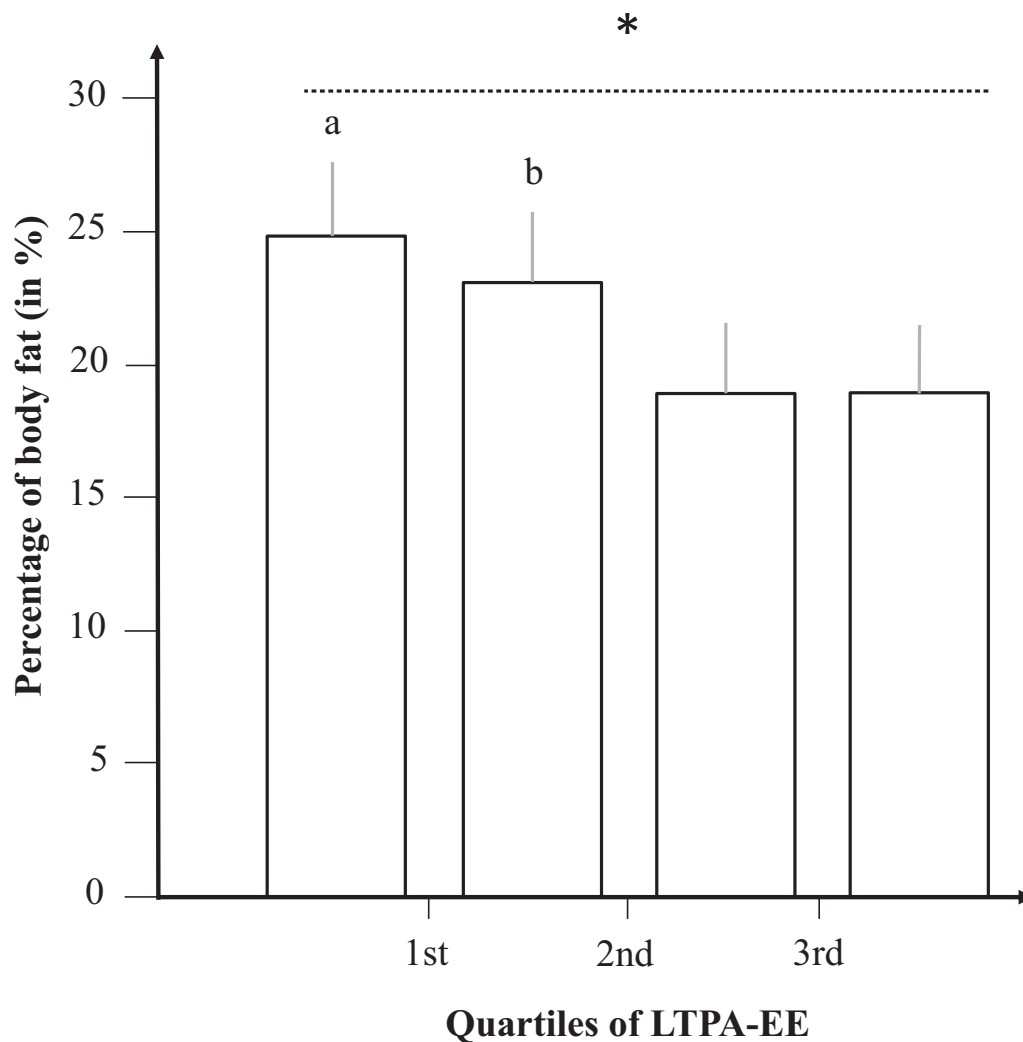


Figure 1. The percentage of body fat by quartiles of leisure-time physical activity energy expenditure in Guadeloupien adolescents (n=181).

*significant effect of LTPA-EE.

a. Adolescents under the 1st quartile of LTPA-EE are evidenced to have higher %BF than above the 2nd and the 3rd quartiles.

b. Adolescents under the 2nd quartile of LTPA-EE are evidenced to have higher %BF than above the 2nd and the 3rd quartiles.

$\alpha=.05$.

The post hoc effects of LTPA quartiles on %BF are evidenced by Fisher's least significant difference post hoc analyses.

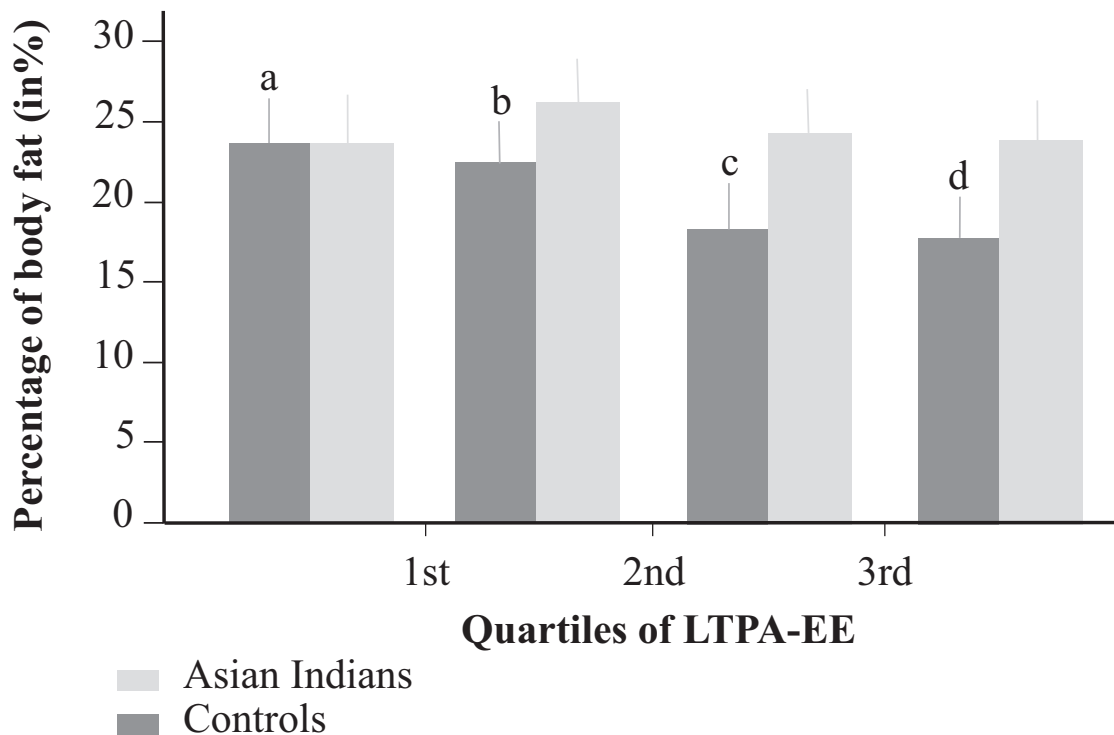


Figure 2. The percentage of body fat by ethnicity and quartile of leisure-time physical activity energy expenditure in Guadeloupean adolescents (n=186).

a. Controls under the 1st quartile of LTPA-EE have higher %BF than control subjects between the 2nd and the 3rd quartiles and control subjects above the 3rd quartile.
 b. Controls between the 1st and 2nd quartiles of LTPA-EE have higher %BF than control subjects between the 2nd and 3rd quartiles and control subjects above the 3rd quartile.

c. Controls between the 2nd and 3rd quartiles have lower %BF than each of the Asian Indian LTPA-EE groups.

d. Controls above the 3rd quartile have lower %BF than each of the Asian Indian LTPA-EE groups.

$\alpha=.05$.

The post hoc effects of LTPA quartiles and ethnicity on %BF are evidenced by Fisher's least significant difference post hoc analyses.

Males were taller ($P<.0001$), reported higher LTPA-EE ($P<.0001$), and showed lower %BF ($P<.0001$). The linear relationship between %BF and LTPA-EE was moderate ($r=-.28$, $P<.0001$). This relationship was not modified by any of the data transformations ($r=-.28$, $P<.05$) except for the power model, which yielded a slightly greater coefficient of correlation ($r=-.30$, $P<.05$). The linear regression analysis ($P<.0005$) produced a y-intercept of 23.92 and a slope of -0.05 for the above-mentioned .28

coefficient of correlation. The 1-way ANOVA showed that the quartiles of LTPA-EE (15.6, 39 and 73 MET-hr/week) were associated with %BF ($P<.0005$) as presented in Figure 1.

Association of Ethnicity with the %BF-LTPA Relationship

We found that %BF was higher in the Asian Indians (23.6%, CI95% 22.3;25.0) than in those in the control group (20.2%, CI95% 18.9;21.6), with a mean difference of 3.4% (CI95% 2.4;4.4) (Levene

$p=0.871$) and $P<.05$. The values of %BF by quartile of LTPA-EE and ethnicity are presented in Figure 2. Two-way ANOVA revealed the principal effects of ethnicity and LTPA-EE quartiles on %BF with $P<.001$ and $P<.05$, respectively, and no interaction effect ($P=.139$) (Levene $P=.315$). Although no interaction effect of ethnicity and LTPA-EE quartiles was demonstrated, we conducted Fisher's least significant difference post-hoc analyses to explore the principal effect of ethnicity on %BF

(Figure 2). We observed that the %BF in control group participants was lower for those between the 2nd and 3rd LTPA-EE quartiles and for those above the 3rd quartile than for those under the 1st or between the 1st and 2nd quartiles of LTPA-EE ($P < .05$ for all). These differences in %BF with increasing LTPA-EE were not observed in Asian Indians. Some differences in %BF between Asian Indians and control group participants were evidenced, with control participants between the 2nd and 3rd LTPA-EE quartiles and above the 3rd quartile having lower %BF than Asian Indian subjects from all LTPA-EE classes ($P < .05$ for all).

DISCUSSION

The relationship between LTPA-EE and %BF that was observed in the ethnically representative adolescent group was modulated by ethnicity. Asian Indians did not benefit from LTPA to the same extent as those in the control group regarding their body fat percentage, as this last did not significantly differ between the lowest and highest levels of LTPA, contrary to control participants.

Relationship between LTPA and %BF

Body fat is associated with increased exercise difficulty in youth.^{13,14} The fattest participants would thus have been expected to perform less physical activity during leisure time. However, this hypothesis seems unlikely to explain the differences in LTPA because it has been observed that obese children and ad-

olescents do not have differentiated maximal oxygen consumption capacities but are burdened by the metabolic cost of their excess mass.^{15,16} Moreover, the number of obese adolescents in our present study was low. Another hypothesis is that the fattest participants modify LTPA because of psychosocial determinants.¹⁷ Body composition is not psychosocially neutral but has instead been reported to modulate social relationships¹⁸ and human behavior.¹⁹ Weiss and her colleagues¹⁷ observed that BMI was a predictor of LTPA decline over a 4-year follow-up of adults aged 18 to 65 years. They suggested that the relationship between physical activity and BMI might be bi-directional, especially because the fattest participants would encounter intolerance in physical activity settings. Obese participants might also see their weight as a barrier to being physically active.²⁰ Other research suggested that this phenomenon may not be mediated by overweight but by the perception of overweight in adults²¹ and adolescents,²² at least in women.

Although the influence of body fat on LTPA is theoretically possible, the influence of physical activity on body composition and obesity from childhood has been more fully documented.²³ As physical activity contributes to the energy balance between intakes and expenditures, its lack may promote fat storage, as observed in sedentarization.²⁴

It is interesting to note that the linear component of the relationship between LTPA and body fat was moderate. This supports the notion that, although physical activity reduces body fat, other factors

are more important. The literature proposes that age, sex, sexual maturation and ethnicity are independent factors of body fat. Indeed, the tendency of Asian Indians to have greater body fat than Caucasians in adulthood and non-Asian Indian Guadeloupians in adolescence has previously been observed.

Association of Ethnicity with the %BF-LTPA Relationship

Although Asian Indians were matched for age, sex and LTPA with those in the second control group, they were fatter than their counterparts. This suggests that the difference in body composition observed both here and previously² cannot be totally explained by differences in the physical activity reported by

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adults and adolescents.^{9,10} Dietary differences could be involved but the only available data to date have shown no difference in energy intake or macronutrient intake in healthy adult workers⁹ in Guadeloupe. The 2-way analysis of variance supported the notion that the relationship between LTPA and %BF is modu-

lated by ethnicity, as the Asian Indians did not seem to benefit from LTPA to the same extent as control participants. The difference in %BF observed in this group between the highest quartile of LTPA-EE and the lowest was not statistically significant, in contrast to that of the controls. Nevertheless, although the least and most active Indians showed no difference in %BF, mean %BF did decrease from the lowest quartile of LTPA-EE distribution to the highest in the Asian Indian group. It would thus be risky, especially because of the potentially high beta risk, to assume that increased LTPA-EE is not negatively associated with %BF in Asian Indians of Guadeloupe, but it might also be considered that this association is likely to be weaker than in control participants.

The differentiated association of LTPA with %BF in Asian Indians supports the Wells hypothesis that Asian Indians are thrifty genotype carriers and are thus likely to be a medium of thriftiness. Metabolic efficiency can be considered as the energy intake per unit of body mass or body surface area necessary to maintain body weight. Earlier data²⁵ suggested that genes can modulate this parameter. Thus, greater metabolic efficiency in Asian Indians, as suggested recently,²⁶ would explain why they store more energy from food intake despite physical activity. This particularly fits with their documented predisposition to type 2 diabetes.^{27,28} James Neel proposed that fat storage capacity was an advantage throughout human phylogenesis but became deleterious with epidemiological transitions, being the origin of the

recent progression of obesity and diabetes in some populations.²⁷ Yet this is not sufficient to explain why the difference in body fat between ethnicities increased for each increasing quartile of LTPA, as evidenced by the *t* test. It has been suggested²⁹ that the plasticity of metabolic efficiency and energy balance might be controlled by the brain which, informed by the metabolic sensors (insulin, glucose, leptin, etc.), modulates energy intake, expenditure and storage. Differentiated mechanisms of regulation in Asian Indians might explain why the association between energy stores and physical activity is weaker.

A potential limitation of this study is the relatively small sample size, which, due to increased beta risk, might explain the lack of difference between the %BF of Asian Indians in low and high LTPA-EE classes. We therefore note here that the sample sizes were the same and the variances were very close for control group participants and Asian Indians. Thus, although we cannot conclude from this study that %BF and LTPA-EE are unrelated in Asian Indians, the study does provide evidence that this relationship is weaker. This raises the issue of an explanatory hypothesis, which is perhaps the second limitation of this work. We did not control the parameters that may modulate and explain the differentiated relationship between LTPA-EE and %BF in Asian Indians. Future research should explore the implications of diet (appetite, digestion, absorption, adipogenesis or diuresis), metabolic efficiency and myogenesis. Another potential limitation of this study is the use of the modifiable ac-

tivity questionnaire. Although this tool has been used in adolescents from different origins³⁰ and in French adults,³¹ its reliability in the ethnic groups we explored has not yet been documented. However, the validity of our comparison should be questioned only if the bias of validity is differential, which we have no reason to suspect. Last, we explored LTPA throughout adolescence and not only >15 years and thus used the 7-day version of the questionnaire, rather than the 1-year version, as memory skills are known to improve with age up to mid-adolescence.³² This limits the possibility of comparing our LTPA results with most of the studies that used the MAQ in adolescents.

CONCLUSIONS

This study reports that the Asian Indian minority might benefit less than others from physical activity regarding body fat. This reasonably raises the hypothesis that one or more factors modulate the impact of physical activity in this group, and we suggest that ethnic differences in metabolic efficiency and metabolic efficiency plasticity might be involved, consistent with the thrifty genotype hypothesis. It would be interesting to prospectively explore the impact of different quantities of physical activity training on the body composition of Asian Indians.

ACKNOWLEDGMENTS

ETHICAL STANDARDS

Our research was approved by the French West Indies University institutional review board (IRB) and all procedures were in ac-

cordance with the ethical standards of the IRB and the Helsinki Declaration of 1975, as revised in 2000. Written informed consent was obtained from all adolescents and one of their parents.

CONFLICT OF INTEREST

No conflicts of interest to report.

AUTHOR CONTRIBUTIONS

Research concept and design: Sinnapah, Antoine-Jonville, Hue; Acquisition of data: Sinnapah, Antoine-Jonville, Hue; Data analysis and interpretation: Sinnapah, Antoine-Jonville, Hue; Manuscript draft: Sinnapah, Antoine-Jonville, Hue; Statistical expertise: Sinnapah, Antoine-Jonville, Hue; Supervision: Sinnapah, Antoine-Jonville, Hue; Administrative: Sinnapah, Antoine-Jonville, Hue

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