PHYSICAL ACTIVITY AND DIETARY FAT AS DETERMINANTS OF BODY MASS INDEX IN A CROSS-SECTIONAL CORELATIONAL DESIGN

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Abstract

Overweight/obesity and related disease conditions will constitute a major threat to the economically productive adults and subsequently, will present a huge health-care burden on developing countries in the near future. Suspected determinants include physical activity and dietary fat. The main indicator of overweight/obesity is Body Mass Index (BMI . The purpose of this article is to present the prediction power of physical activity and dietary fat intake on BMI of lecturers within a higher learning institutionalized setting. The study adopted a cross-sectional correlational design. Proportionate and simple random sampling techniques were used to select a sample of 120 lecturers who participated in the study. Data collection was conducted through questionnaires, which had sections including physical activity checklist, 24-hour food recall, anthropometrics measurements mainly weight and height. Analysis of data involved the use of bivariate correlation and linear regression. A significant inverse association occurred between BMI and minutes spent in moderate intense physical activity per day ($r=-0.322$, $p<0.01$). Physical activity also predicted BMI ($R^2=0.096$, $F=13.616$, $\beta=-3.22$, $t=-3.69$, $N=120$, $P<0.01$). However, the association between Body Mass Index and dietary fat was not significant ($r=0.038$, $p>0.05$). In conclusion, physical activity was a significant predictor to BMI and on the contrary no significant impact was caused by dietary fat intake. Therefore, we still need further investigations on the effect of physical activity and dietary fat on BMI and risk factors associated poor diet should take priority.

Key words: Body Mass Index, physical activity, and dietary fat intake.

Introduction

Overweight/obesity has never been a problem in sub-Saharan Africa until in the recent past it is beginning to emerge as a medical problem in urban areas of many developing countries in Africa. In Kenya limited documented information exists to explain the situation in the country. However, a survey conducted by Central Bureau of Statistics *et al* (1) indicates that the prevalence of obesity among women in Nairobi Province is 39% of 721 women sampled for the study.

Scientific evidences have attempted to link physical activity and dietary fat intake with overweight/obesity in some studies. For example, a study by Klem *et al.* 1997 (2) of 629 and 155 overweight women and men respectively showed the subjects lost an average of 30 kg and maintained a required minimum weight loss of 13.6 kg for five years after engaging in physical activity. This implies that overweight individuals can reduce weight if they consistently perform manual activity or exercise for a predetermined period. On the other hand, experiments in laboratory animals have repeatedly shown that a strong positive relationship occur between dietary fat intake and body weight (3-4). However, Willett (5) in a review that focused on the relationship between dietary fat and weight reported that experimental studies lasting one year or longer did not show a link between dietary fat and weight in humans.

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Sempos et al (6) attempted to explain that failure to show linkage between dietary fat and weight may be due to methodological limitations and a better suggestion is to evaluate the relationship between dietary fat intake and overweight/obesity with a consideration given to information from observational epidemiology as well as experimental and clinical intervention studies.

In our study, we established the overall prevalence of overweight and obesity among University of Nairobi lecturers. Overweight limited to Body Mass Index (BMI) of 25 Kg/m^2 and above was 34.5%, while obesity limited to BMI of 30 Kg/m^2 and above was 8.6%. A more specific purpose of this article is to determine the effect of physical activity and dietary fat intake on Body Mass Index of the participants. Physical activity and dietary fat have reappeared in a number of studies as explanatory factors for the variations in Body Mass Index. Most of these studies are reviewed in the later sections under results and discussion.

Method

A cross-sectional analysis was undertaken among a sample of lecturers. Informed consents were obtained among all lecturers who participated in the study. The lecturers were accessed after obtaining a research permit from the Ministry of Education Science and Technology and documented permission from the University administration. One hundred and twenty (120) lecturers from four of the seven campuses of the University of Nairobi were involved in the study. The sample size was arrived at using Creative Research Systems (7) formula as follows: $SS=\{Z^2*(P)*(1-P)\} \div C^2$

$= 1.96^2*0.5*0.5\div 0.08^2 = 150$ lecturers

Where: SS=Sample size, Z=1.96 (precision for 95% level of confidence), P=0.5 (the worst percentage that can ever pick a choice), C=0.08 (confidence interval). However, from the sampling frame developed a finite population of 600 lecturers was obtained from which correction for finite population was carried out as follows: New SS = SS ÷ {1+ [SS-1] ÷Pop} (where: Pop=Population).

=150÷ {1+ [150-1] ÷ 600

=120 lecturers.

The lecturers were proportionately distributed across the campuses and a simple random method used to select individual lecturers as follows: 60 lecturers were selected in Main campus, 35 in Chiromo, 15 in Lower Kabete and 10 in Parklands.

Data were collected using a questionnaire. The questionnaire consisted of three sections; quantitative physical activity frequency checklist (modified from international physical activity questionnaire), a standard 24-hour food recall assessment form and Body Mass Index assessment questionnaire. The quantitative physical activity frequency checklist had a list of common activities in urban areas categorized into ordinal discrete variables namely: light (<3.5kcal/min), moderate (3.5-7.0kcal/min) and high intensity (>7.0kcal/min) activities. For each case the respondent was required to tick (√) the activity he/she participated in the past one week indicating the time spent in minutes and the number of days spent per week. Time in minutes spent doing light and high intensity physical activities was converted to minutes spent in moderate intensity physical activities per day as an equivalent alternative. This conversion was based on the ratio that for every 60 minutes spent in light activity, only 30 minutes of moderate intense and 20 minutes for heavy intense is required as equivalent alternative. (8-11)

Fat intake was computed from a 24-hour food recall using standard food tables developed by Latham et al (12) and validated for use again by K' Okul (13) while Body Mass Index (BMI) which is measure of body fat was computed from weight and height measurements of each subject using a standardized bathroom scale and stadiometer respectively. BMI of participants were classified according to WHO (14) standards as follows: <18.5 kg/m^2 is underweight, 18.5-19.99 at risk to underweight, 20-24.99 kg/m^2 is normal, 25-29.99 kg/m^2 is overweight and ≥30 kg/m^2 is obese.

Results and Discussion

Physical activities were initially categorized as light, moderate, and high intensity. Specific types of activities were ranked according to the number of lecturers who participated in them (Table 1). Uniformity in activity levels among the study group was attained by converting minutes spent in all light activities to equivalent minutes spent in moderate activities per day in the ration 60:30 described earlier in the method section. From the findings of the study physical activity patterns were obtained using statistical group mean of 82.9 minutes as cut off level to come up with two sample groups i.e. active and less active. With the two groups in mind an individual could either be grouped as active or less active based on minutes spent in moderate activities per day and whether it was above or below the group mean respectively. Having the two sample groups identified the intended physical activity patterns.

Table 1. Physical activity Ranked by the number of lecturers involved

Physical activity category	Number of lecturers involved (N=120)	Rank
Light activities		
Lecturing (standing)	120 (100.00%)	1
Driving a car	100 (83.33%)	2
Walking slowly	85 (70.83%)	3
Ironing	23 (19.17%)	4
Sporadic jogging	21 (17.50%)	5
Vacuuming	17 (14.17%)	6
Conditioning exercise/warm up	17 (14.17%)	6
Cooking	14 (11.67%)	7
Gardening/pruning	14 (11.67%)	7
Cycling, very light effort	11 (9.17%)	8
Removing cobwebs	10 (8.33%)	9
Dusting furniture	9 (7.5%)	10
Washing	9 (7.5%)	10
Swimming (slow treading)	5 (4.17%)	11
Pool game	3 (2.50%)	12
Mopping	3 (2.50%)	12
Sweeping	1 (0.83%)	13
Golf (powered)	1 (0.83%)	13
Table tennis	1 (0.83%)	13
Moderate activities		
Climbing stairs	115 (95.83%)	1
Walking briskly	69 (57.5%)	2
Cycling, 5 to 9 kmph, level terrain	3 (2.50%)	3
Scrubbing floor	3 (2.50%)	3
Weight training	2 (1.67%)	4
Golf (pulling and carrying clubs)	2 (1.67%)	4

Table 1 shows that the first three leading activity in the category of light activities was lecturing while standing, followed by driving and walking slowly, in that order. Likewise, in the category of moderate physical activity, climbing stairs was the leading activity, followed by brisk walk. These leading activities were participated in by more than half of the lecturers (Source: Omondi et al, 2007).

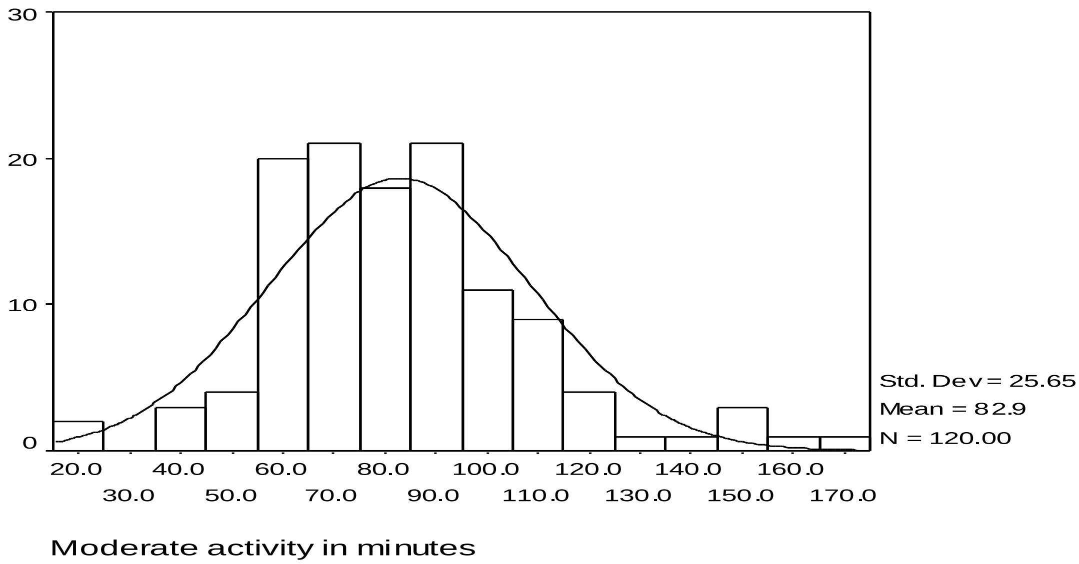

Figure 1. Distribution of Lecturers by Moderate Physical Activity in Minutes

Table 1. Total number and percentage of people reactive at different dilutions of sera by sex and age

Sex and age of people tested	No studied	No. (%) positive 32	64	128	256	512	1024	2048	4096	8192	
Sex Male	26	14(53.8)	1	-	1	4	1	2	3	2	-
Female	39	25(64.1)	2	4	4	2	1	2	5	4	1
Total	65	39(60)	3	4	5	6 2	-	4	8	6	1
Age <21	15	8(53.3)	2	-	1	2	1	-	1	2	-
(years) 22-43	36	24(66.7)	1	4	2	4	1	3	4	4	1
>44	14	7 (50)			2	-		1	3	-	-
Total	65	39 (60)	3	4	5	6	2	4	8	6	1

Table 2. Distribution of MDAT titers in Spot + and Spot - individuals

HIV-Spot Test	Number Tested	No. reactors(%)	32	64	128	256	512	1024	2048	4096	8192
Positive	19	10(52.6)	-	1	-	-	-	2	3	4	-
Negative	46	29(63)	3	3	5	6	2	2	5	2	1
Total	65	39(60)	3	4	5	6	2	4	8	6	1

Table 3. Association of Toxoplasma infection with feeding habit and cat ownership

Characteristic of the Interviewed Positive for MDAT	No. (%) (95% CI	Odds Ratio	p-value
Feeding Habit	16.9 (1.9-145.6)		0.002
Raw/undercooked mutton	38 (67.9)		
Well-served mutton	1 (11.1)		
Presence of cat in the house	5.3 (4.2-6.7)		0.002
Present	24 (80.0)		
Absent	15 (42.9)		

Figure 1 shows a statistical mean of 82.9(±25.65) minutes. It appears that majority of lecturers scored within the range of 82.9 ± 25.65 minutes of moderate activity per day. Lecturers that performed above the mean were labeled active (47.5%) while those who performed *below the mean were labeled less active (52.5%).*

The international recommendation for the adequacy of physical activity is at least 30 minutes of moderate intense for five or all days a week (10-11). In contrast, the study group approximately recorded a group mean of 82.9 minutes of moderate activity per day for all days of the week by average (Figure 1). This translated to the fact that majority of lecturers scored above the minimum international requirement and were therefore active by that standard. Nevertheless, it is logical to argue that this standard could be applicable in developed countries more so in America and European countries where these average measurements were obtained. The WHO (11) and USDHHS' (10) recommendations only provided the minimum requirement, but they were silent on the environmental coverage of the standard implying that the average minutes in moderate intensity physical activity per day in a given group may vary from population to population. To sum up this argument it is practically sound that in a population, some individuals may participate more in physical activities than others. The difference in the level of participation may have an impact on the overall health status.

In this study overweight limited to Body Mass Index (BMI) of 25 Kg/m^2 and above was 34.5%, while obesity limited to BMI of 30 Kg/m^2 and above was 8.6%. Considering the relationship between physical activity and BMI, physical activity had a strong inverse association with BMI measurements of the subject (r=-0.322) in addition to being a powerful predictor (R^2=0.096, F=13.616, β=-3.22, t=-3.69, N=120, P<0.01). The result implied that when physical activity is focused on independent of other factors, there is a strong likelihood that in a population where individuals display varied BMI, the relationship with physical activity would be such that if BMI increases, the duration spent in physical activity decreases. Likewise, Paeratakul et al (15) noticed a significant inverse relationship between physical activity and BMI in both men and women in a cross-sectional analysis. This means that a part from time series studies where both the exposed and non-exposed are followed for a long period to monitor changes overtime (16), to some extent a cross-sectional design is also a valid methodological approach in epidemiological investigations to determine the influence of exposure factors on a given ill health condition particularly when time is a limitation.

On the other hand, the average fat intakes across Body Mass Index indicated higher consumption of daily fat by overweight participants (78.81 g/day) compared to normal weight participants (68.75g/day). Although there was a positive correlation between dietary fat and Body Mass Index (r=0.038), coefficient of determination (r^2) revealed that that the variability of BMI could only be explained by a negative fat intake percent (-0.7%) though insignificantly (r^2=-0.007, F=0.169, N=120 p>0.05). Additionally, dietary fat did not predict BMI (β=0.081, t=0.411, p>0.05). This was contrary to the findings of other studies where experiments in laboratory animals have repeatedly shown that there is a strong positive relationship between dietary fat intake and body weight (4,17) which is generally attributed to the more efficient metabolism of fat compared to other nutrients (4) and to the hyperphagic effect of a high-fat diet. A similar observation is expected in humans since dietary fat is also stored as body fat more efficiently than other macronutrients (3,18) and may influence Body Mass Index especially when consumptions are consistently higher that normal for a long time.

Epidemiological evidence of the relationship between dietary fat and body weight is suggestive but not definitive (19). In general, cross-sectional studies provide consistent evidence of the positive relationship between dietary fat and body weight as opposed to longitudinal studies that have shown inconsistent results (15). Yet, in our study we adopted a cross-sectional design and finally did not obtain a significant positive association between dietary fat intake and Body Mass Index. On the basis of this, we cannot conclusively report that there is no relationship due to several factors, which may have come in, such as genetics and metabolic factors, physical activity, and behavioral factors such as dieting in response to weight gain. Effective control of these confounding factors may perhaps give concrete outcome. Furthermore, epidemiological studies of diet and body weight are complicated by the difficulty in measuring dietary intake of a free-living population, resulting in measurement errors in dietary data. These errors may be caused, for example, by under-reporting of intake by some overweight individuals (20) and by the daily variations in food intake of the same individual (21).

Conclusions and recommendations

Body Mass Index tended to increase significantly with a decrease in minutes spent in moderate intense physical activity. Moderate activity was also a powerful predictor of BMI of participants (P<0.01). On the contrary, dietary fat intake had positive association with BMI though insignificant and also failed to predict BMI (p>0.05). In as much as the study did not show a more concrete relationship between dietary fat and Body Mass Index there is need to understand that long term overnutrition-related overweight in developing countries is a serious concern. The current trend indicates that overweight will constitute a major threat to the economically productive adults and subsequently, will present a huge health-care burden on these countries in the near future. We therefore suggest further investigations on the relationship between diets in general and overweight, more concrete dietary assessment methods other than a 24-hour recall need be used.

References

1. **Central Bureau of Statistics, Ministry of Health, Kenya Medical Research Institute, National Council of Population Development and Centre for Disease Control, 2003. *Kenya Demographic Health Survey 2003 results*. CBS, MOH, KMRI, NCPD, CDC, Nairobi.**
2. **Klem, M.L., Wing, R.R., Mc Guire, M.T., Seagle, H.M. and Hill, J.O., 1997. A descriptive study of individuals successful at long-term maintenance of substantial weight loss. *American Journal of Clinical Nutrition, 66*, 239-46.**
3. **Flatt, J.P., 1987. The difference in the storage capacities for carbohydrate and for fat, and its implications in the regulation of body weight. *Ann NY Academic Science*, 499: 104-123.**

4. Schemmel, R., Mickelsen, O. and Motawi, K., 1972. Conversion of dietary to body energy in rats as affected by strain, sex and ration. *Journal of Nutrition;* 102: 1187-1197.
5. Willett, W., 2002. Dietary fat plays a major role in obesity. O*besity Review*, 3; 59-68.
6. Sempos, C.T. Liu, K. and Ernst, N.D., 1999. Food and nutrient exposures: What to consider when evaluating epidemiologic evidence. *American Journal of Clinical Nutrition*, 89 (3): 179-182.
7. Creative Research Systems (2003). The survey system: Sample size calculator. *Creative Research systems*, (707): 765-1001.
8. Ainsworth, B.E., Haskell, WL., William, L., Whitt, M.C., Irwin, M.L., Melinda, L., Swartz, A.M., Ann, M., Strath, S.J., O'brien, W.L., Bassett, D.R. J.R., Schmitz, K.H., Emplaincout, P.O., Patricia, O., Jacobs., DR. J.R., and Leon, A.S., 2000. Compendium of physical activities: an update of activity codes and MET intensities. [Electronic version] *Medicine and Science in Sports and Exercise*, 32 (9): 498-516.
9. Ainsworth, B.E., Haskell, W.L., William, L., Whitt, M.C., Irwin, M.L., Melinda, L., Swartz, A.M., Ann, M., Strath, S.J., O'brien, W.L., Bassett, D.R. J.R., Schmitz, K.H., Emplaincout, P.O., Patricia, O., Jacobs, D.R. J.R and Leon, A.S., 1993. Compendium of physical activity classification of energy cost of human physical activity. [Electronic version] *Medicine and Science in Sports and Exercise;* 25 (1): 71-80.
10. United States Department Health and Human Services., 2002. Physical activity fundamental to preventing disease. Rockville, MD Inc. Washington.
11. WHO (2003). Global strategy on diet, physical activity and health. *African Regional Consultation Meeting Report Harare, Zimbabwe,* 28-20 March.
12. Latham, M.C., 1979. Human nutrition in tropical Africa: A textbook for health workers with special reference to community health problems in East Africa. New York; NY: Cornel University.
13. K' Okul, N.O.R., 1991. Maternal and child health in Kenya: A study of poverty, disease and malnutrition in Samia. Published by The Finish Society for Development Studies in cooperation with The Scandinavian Institute of African studies, Nairobi.
14. World Health Organization (WHO), 2000. Obesity: Preventing and managing the global epidemic. *WHO technical report series 894. WHO Geneva*.
15. Paeratakul, S., Popkin, B.M., Keyou, G. Adair, L.S. and Stevens, J., 1998. Changes in diet and physical activity affect the Body Mass Index of Chinese adults. *International Journal of Obesity*, 22, 424-431.
16.* Omondi, O.D., Othuon, O.A.L. and Mbagaya, G.M., 2007. Physical activity patterns, dietary intake and health status among University of Nairobi lecturers. *South African Journal for research in sport, physical education and recreation. 29(2): 87-98.
17. Salmon, D.M.W. and Flatt, J.P., 1985. Effect of dietary fat content on the incidence of obesity among ad libitum fed mice. *International Journal of Obesity*, 9: 443-449.
18. Berry, E.M., Hirsch, J. and Most, J. and Thorton, J., 1986. The role of dietary fat in human obesity. *International Journal of Obesity*, 10: 123-131.
19. Lissner, L. and Heitmann, B.L, 1995. Dietary fat and obesity: Evidence from epidemiology. *European Journal of Clinical Nutrition*, 49: 79-90.
20. Braitman., L.E., Adlin, E.V and Stanton, J.L., 1985. Obesity and caloric intake: the National Health and Nutrition Examination Survey of 1971-1975 (HANES I). *Journal of Chronic Diseases*, 38:727-732.
21. Willett, W.C., 1990. *Nutritional epidemiology*. Oxford University Press: New York.
22. Hayes, L. and Unwin, N., 2001. *Addressing the emerging pandemic of diabetes and cardiovascular disease in sub-Saharan Africa.* WHO Report of Workshop in Nairobi, Kenya.
23. World Health Organization, 1990. Diet, nutrition, and the prevention of chronic diseases: *Report of a WHO Study Group*. *WHO Technical Report Series* 797: Geneva.