Can Physical Activity and Dietary Fat Intake Influence Body Mass Index in a Cross-sectional Correlational Design?

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Abstract—The purpose of this study was to determine the influence of physical activity and dietary fat intake on Body Mass Index (BMI) of lecturers within a higher learning institutionalized setting. The study adopted a Cross-sectional Correlational Design and included 120 lecturers selected proportionately by simple random sampling techniques from a population of 600 lecturers. Data was collected using questionnaires, which had sections including physical activity checklist adopted from the international physical activity questionnaire (IPAQ), 24-hour food recall, anthropometric measurements mainly weight and height. Analysis involved the use of bivariate correlations and linear regression. A significant inverse association was registered between BMI and duration (in minutes) spent doing moderate intense physical activity per day (r=-0.322, p<0.01). Physical activity also predicted BMI (r^2=0.096, F=13.616, β=-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). Physical activity emerged as a more powerful determinant of BMI compared to dietary fat intake.

***Keywords*—**Physical activity, dietary fat intake, Body Mass Index, Kenya.

I. Introduction

OVERWEIGHT 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, a survey conducted by Central Bureau of Statistics *et al.,* [1] indicates that the prevalence of obesity especially among women in Nairobi Province is 39% of 721 women sampled for the assessment. This is already a bigger percentage and a health related threat worth giving special consideration.

Empirical evidence have attempted to link physical activity and dietary fat intake with overweight and obesity in some studies. For example, a study by Klem *et al.* [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 a strong direct relationship 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. Explanatory attempt by Sempos *et al.,* [6] argued 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 or obesity with a consideration given to information from both 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 study was to determine the associations as well as statistical effects of physical activity and dietary fat intake on Body Mass Index of the participants. Physical activity and dietary fat have appeared in a number of studies as explanatory factors for the variations in Body Mass Index. Most of these studies are reviewed in the subsequent sections under results and discussion.

II. Materials and Methods

A. Setting

This study was conducted within four campuses of The University of Nairobi. This is the largest and oldest University in Kenya located within Nairobi City in Kenya and has the largest number of lecturers. All the lecturers are allocated office spaces and therefore accessing them was possible with appointments. This included *Main campus*, in *Chiromo*, *Lower Kabete* and *Parklands*. The campuses were selected by simple random method.

B. Study Design, Sampling and Ethical Considerations

A Cross-sectional analysis was undertaken among a sample of lecturers. Data was collected for a period of month and

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analyzed. One hundred and twenty (120) lecturers from four of the seven campuses of the University of Nairobi had their questionnaires fully completed. The sample size was arrived at using Creative Research Systems' [7] formula which has been used by a number of authors [8] and has recently been quoted in one of the medical Journals [9]. The formula is 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.

However, we anticipated none responses and increased the sample size by 30 percent, hence, the working sample size at the time of data collection was 156 lecturers. Using simple random sampling technique, individual lecturers were selected to participate and appointments made at convenient times in their respective offices. We managed to interview 135 lecturers and out of these 120 complete questionnaires were selected proportionately across the campuses and the distributions were as follows: 60 lecturers were selected in *Main campus*, 35 in *Chiromo*, 15 in *Lower Kabete* and 10 in *Parklands*. These were the minimum expected sample size distribution based on our calculations and therefore response was 100 percent as planned.

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. Lecturers who agreed to participate were assured that the information obtained from them would be treated with confidence and all the questionnaires remained anonymous.

C. Data Collection Tools

Data were collected using a questionnaire. The questionnaire consisted of three sections; quantitative physical activity frequency checklist (modified from international physical activity questionnaire; IPAQ), a standard 24-hour food recall assessment form and Body Mass Index assessment questionnaire. The quantitative physical activity frequency checklist modified from the international physical activity questionnaire 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 were converted into equivalent minutes spent in moderate intensity physical activities per day. 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 [10]-[13].

Fat intake was computed from a 24-hour food recall using standard food tables developed by Latham *et al.,* [14] and validated for use again by K' Okul [15] 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 [16] 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.

C. Data Analysis

Data were keyed into Statistical Package for the Social Sciences (SPSS) version 12.0 and analysis made using bivariate correlations and linear regression modeling techniques to find out the measurement relationships between dietary fat, physical activity and Body Mass Index. This was necessary for model comparisons. Two models were under investigations in this case. The first model focused on the relationship between physical activity and BMI and the structural nature of the model was as follows: BMI (Y) = *beta* (β) x Physical activity (X_1) + error $\{Y= \beta X_1 +e_1\}$. The second model focused on the relationship between dietary fat and BMI and the structural nature was as follows: BMI (Y) = *beta* (β) x Dietary fat (X_2) + error $\{Y= \beta X_2 +e_2\}$. These two models were later compared and are discussed in the subsequent sections.

III. 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 I). 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 ratio 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 (Fig. 1).

TABLE I
PHYSICAL ACTIVITIES RANKED BY NUMBER OF LECTURERS WHO PARTICPATED

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
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%)	9
Removing cobwebs	10 (8.33%)	10
Dusting furniture	9 (7.5%)	11
Washing	9 (7.5%)	11
Swimming (slow treading)	5 (4.17%)	13
Pool game	3 (2.50%)	14
Mopping	3 (2.50%)	14
Sweeping	1 (0.83%)	16
Golf (powered)	1 (0.83%)	16
Table tennis	1 (0.83%)	16
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%)	4
Weight training	2 (1.67%)	4
Golf (pulling and carrying clubs)	2 (1.67%)	6

Table I shows that the first three leading activities in the category of light activities were lecturing while standing, 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.,* [17]).

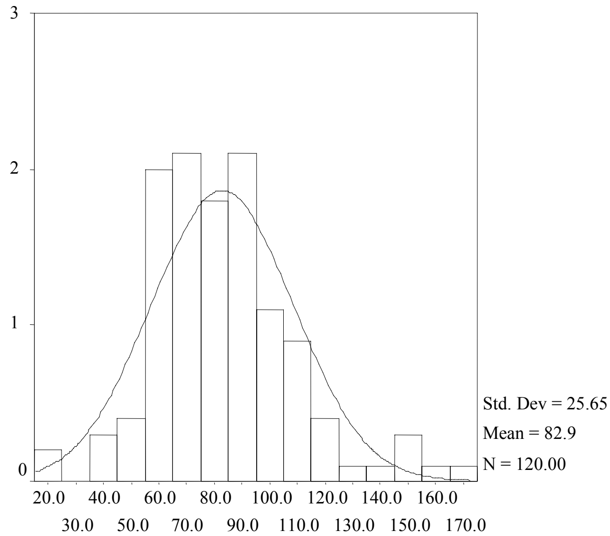

Fig. 1 Distribution of lecturers by moderate physical activity in minutes

The international recommendation for the adequacy of physical activity is at least 30 minutes of moderate intense for five or all days a week [12], [13]. 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 (Fig. 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 USDHHS' [12] and WHO [13] 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 consistently participate more in physical activities than others. The difference in the level of participation in physical activities may have varied impact on the overall health status of such individuals in pattern similar to their activity pattern.

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%. Further considering to the relationship between physical activity and BMI, revealed that physical activity had a strong inverse association with BMI measurements of the subject (r=-0.322) in addition to being a reasonable predictor (r^2=0.096, F=13.616, β=-3.22, t=-3.69, n=120, P<0.01). This 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.,* [18] 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 [17], 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 contrary, 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 the variability of BMI could was not significantly be affected by fat intake (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 [3], [4] 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 [19], [20] and may influence Body Mass Index especially when consumptions are consistently higher than normal for a long time.

Epidemiological evidence of the relationship between dietary fat and body weight is suggestive but not definitive [21]. 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 [18]. Yet, in our study we adopted a cross-sectional design but did not obtain a significant positive association between dietary fat intake and Body Mass Index. However, we cannot conclusively report that there is no relationship at all 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 [22] and by the daily variations in food intake of the same individual [23]

IV. CONCLUSION

Body Mass Index tended to increase significantly with a decrease in minutes spent in moderate intense physical activity. Moderate activity was also a reasonable predictor of BMI of participants ($P<0.01$). On the contrary, dietary fat intake had a positive association with BMI though insignificant. It 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 to intake of high fat diet is becoming a concern in developing countries as well particularly in urban settings. 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 using more concrete dietary assessment methods other than a 24-hour recall.

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