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RESEARCH ARTICLE

Energy Intake, Physical Activity Level (PAL) and Energy Balance of Overweight Adults in Kochi, Kerala

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Abstract

At the other end of the malnutrition scale, overweight is one of today's most blatantly visible – yet most neglected – public health problems. Paradoxically coexisting with undernutrition, an escalating global epidemic of overweight and obesity – "globesity" – is taking over many parts of the world. If immediate action is not taken, millions will suffer from an array of serious health disorders (WHO, 2013). Obesity is a complex condition, one with serious social and psychological dimensions, that affects virtually all age and socioeconomic groups and threatens to overwhelm both developed and developing countries. Contrary to conventional wisdom, the obesity epidemic is not restricted to industrialized societies; in developing countries, it is estimated that over 115 million people suffer from obesity-related problems**.** Since overweight in adults is a public health concern, the search for effective anti-obesity measures has grown in recent years. The effectiveness of multidisciplinary approaches that combine physical activity and dietary strategies has now been recognized. However, the interaction between physical activity and energy consumption has received little consideration, although it could be a key target for controlling daily energy balance. The objective of the study was to elicit information on the energy balance of adults in terms of energy intake as 24 hour recall and energy expenditure as physical activity level (PAL). Adults (18-60 years) from Kochi corporation area in Ernakulam district of Kerala was selected for the conduct of the present study. Overweight subjects were classified by the BMI cutoffs recommended by WHO (2004) in which a high BMI 25 and above (Overweight) was followed for sample selection. A total of 140 adults including male and female were selected as study sample.

Background

Until recently, overweight was a public health problem only in Western countries. But over the past two decades, it has become truly a global problem—a "globesity epidemic," affecting countries rich and poor. An estimated 500 million adults worldwide are obese and 1.5 billion are overweight or obese. If recent trends continue unabated, nearly 60 percent of the world's population—3.3 billion people—could be overweight (2.2 billion) or obese (1.1 billion) by 2030. The prevalence of overweight has risen sharply over the last few decades in Kerala. Per cent of overweight or obese women in 1998-99 in Kerala was 17 per cent which has increased to 28 per cent in 2005–06 (Ajithkumar and Radhadevi, 2010). Given that human physiology has not changed and the genetic pool remains the same, the explanation for the increased prevalence of overweight must be found in reduced physical activity and altered eating habits. (Heini and Weinsier 1997; Hill and Peters, 1998; Kesavachandran et al. 2009 **;** FRAC, 2010; Johnson et al., 2011; WHO Media Center, 2012). But no published literature can be found from Kerala

to assess the interaction between physical activity and energy consumption among overweight adults which may be key target for controlling daily energy balance. Studies of such kind will be useful tools in planning and developing appropriate intervention methods. In this context, the present study has been conducted to assess the energy intake and physical activity level of the overweight subjects and have an insight in to the energy balance of them.

Methodology

A total of 140 adults in the age group of 18-60 years, including male and female, randomly selected from Kochi corporation in Kerala state,in India formed the study sample. Energy intake was calculated by using 24 hour dietary recall method. It was interpreted using nutritive value of Indian foods (ICMR, 1989). A set of standardized cups and spoons suited to local conditions were used. All the adult subjects were familiarized to standardized cups and spoons which helped them to recall the food intake for 24 hours. Considering the fact that physical activity and eating habits may vary on some days of the week, a period of two working days and one holiday was used while collecting information on energy intake and expenditure. BMR predictive equation applicable to Indians, derived by ICMR (1990) was used for predicting BMR (Kcal/24hr) in the present study is give below;

Male	18-29 yrs	14.5 x B.W (kg) + 645
	30-60 yrs	10.9 x B.W (kg) + 833
Female	18-29yrs	14.0 x B.W (kg) + 471
	3 0-60 yrs	8.3 x B.W (kg) + 788

Energy expenditure on physical activity was determined from physical activity level (PAL) where, the PAL was determined by a questionnaire containing daily activity record. For this, the number of minutes spent by the subject on each activity was recorded for a period of 24 hours. The PAL can be calculated by assigning physical activity ratios (PAR) given by FAO/WHO/UNU expert group (FAO/WHO/UNU, 2004) to these activities. PAR is the ratio that expresses the energy cost of an individual activity per min, as multiples of BMR.

$$\text{PAL} = \left(\sum PAR \times Ti/24\right)$$

Where PAR = Physical activity ratio for each activity

Ti = Time spent (hours in each activity)

Multiplication of the PAL value with Basal Metabolic Rate (BMR) will give an estimate value for the total daily energy expenditure (TDEE) and hence the following formula by FAO/WHO/ UNU (2004) was used :

TDEE = (PAL) x BMR

Energy balance was calculated using the formula:

Energy balance = Energy intake – Energy expenditure

The relationship between Body Mass Index and components of energy balance were studied using linear regression coefficient and Pearson's correlation coefficient among 420 subjects chosen with equal representation by gender, age and BMI categories i.e. <18.5(underweight), 18.5-24.9 (Normal weight) and 25 and above (Overweight). Data were entered and statistically analysed using SPSS version 17. All the entries were double checked for any possible key board error. Student't' test was applied to find the relationship between energy intake and expenditure.

Results and discussion

Table: 1shows the mean and standard deviation of age and body measurements of the selected subjects.

Table: 1 Height, weight and BMI of the selected subjects.

Particulars	Male (n=70)	Female (n=70)
Age (yrs)	32.0±11.0	31.6±12.4
Height (cm)	165±8.5	155±5.8
Weight (kg)	76±14.7	66.1±10.4
BMI	27.9±4.5	27.4±4.1

The mean age of the male subjects was 32.0±11.0 years and that of the female subjects 31.6±12.4years. The mean height of the male subjects was 165±8.5cm. Female subjects were found to be shorter than male subjects, i.e. height was only 155±5.8 cm. Mean body weight of the male subjects was; 76kg and that of females was 66.1 kg.

To investigate the possible association between the energy consumed at different meals, the nutrient intake data of the overweight adults was assessed and the information is tabulated in Table 2.

Table 2 Energy intake (Kcal) at different meals

(N =140)

Meal	Male	Female
Breakfast	695	786
Lunch	758	746
Dinner	744	720
Others	648	632
Total	2845	2884

Total energy intake was 2845Kcal and 2884 Kcal for male and female subjects respectively. It was noticed that the energy obtained from in-between meals / snacks was almost equal to that of main meals. Consumption of fast foods, nonvegetarian foods with large portion sizes and snacks like banana fry and chips found to increase total energy intake of overweight subjects. In addition, consumption of oily parathas with non vegetarian foods often taken from hotels increase energy intake creating a positive energy balance. McCrory et al. (2002) Greenwood and Stanford (2008) and Martin et al. (2009) also opine that large portion sizes, fast foods and high fat snacks are positively associated with overweight and obesity.

The population's life style was categorized in to sedentary (PAL 1.4 - 1.69), active (PAL 1.7-1.99) and vigorous (PAL 2 - 2.40) according to the classification of FAO/WHO/UNU (2004). Table 3 shows the proportion the overweight population with sedentary, active and vigorous life style based on their PAL.

Table 3 Physical activity level (PAL) of the overweight subjects

(N=140)

Life style/PAL	Overweight			
	Male		Female	
	No.	%	No.	%
Sedentary (Light) 1. 4-1.69	70	100.0	58	82.9
Active (Moderate) 1. 7-1.99	0	0.00	12	17.1
Vigorous (Heavy) 2- 2.40	0	0.00	0	0.0
Mean PAL	1.34	100	1.57	100

The mean PAL showed a sedentary lifestyle for the subjects. In general female had higher PAL compared to their male counter parts. Based on PAL the entire male (100%) and 82.9 per cent females in overweight category were sedentary and 17.1 per cent female had active life style. The results indicated that recently physical activity level has become sedentary in Kerala.

The last three decades witnessed tremendous change in lifestyle. As industrialization and financial growth have occurred, there has been a shift in the types of activities that people perform in their daily routine, with television-watching and the usage of computer being at the forefront. A variety of domestic functions have been automated and each of these tasks has resulted in "labor saving" and more sedentary lifestyle. The availability of transport both personal and public has improved several folds and hence the energy expenditure in reaching places of study/work has become a fraction of what it was two decades ago. Unlike the developed country's population, people do not undertake intensive discretionary activities. This may be one of the major factors responsible for the reduction in physical activity level.

ICMR (2010) recommended that future research should be conducted in India on the PAL of a large number of adults. Such large data base will help in setting up equations for deriving PAL from height and weight data. Kesavachandran et al. (2009) stated that even though physical activity alone cannot maintain BMI and body fat per cent, it can reduce the risk of overweight and high body fat per cent in the population. The same trend has been observed in the present study also.

Energy balance is achieved when the energy from the intake of food and drinks equals the energy expended for metabolic processes and during physical activity. The amount of food eaten and the amount of physical activity undertaken determine the state of energy balance. In the present study the two major correlates of Body Mass Index (Energy intake and energy expenditure) were examined among overweight adults. Table 4 examines the mean estimates of energy balance of the selected subjects.

Table 4. Energy Balance of the selected adults (N=140)

Particulars	Male	Female
Energy intake(Kcal)	2844	2883
Energy expenditure(Kcal)	2327	2552
Energy balance(Kcal)	+517	+331
t - value	9.433**	3.622**

**Significant at one per cent level

Overweight subjects exhibited a positive energy balance. Statistical analysis using‘t’ test showed significant difference between intake and expenditure among both male and female overweight subjects (positive balance).

A study by Jonville et al. (2009) on energy expenditure and dietary intake in overweight versus non-overweight adults in Caribea showed that both energy expenditure and intake were higher in the overweight men and women as compared with their normal-weight counterparts. It should also be noted that a higher body mass requires a higher energy consumption in the order of 15 to 25 kcal/kg. According to Shetty (2002) in India decline in time dedicated to productive work has been accompanied by a reduction in energy spent at work resulting from increased mechanisation of occupational work. Concurrent to this, decrease in the energy expenditure on occupational activities, universal use of motor cars, mechanisation of most manual jobs outside the occupational sphere and increasing leisure time have aggravated this trend.

The relationship between Body Mass Index and components of energy balance were studied using linear regression coefficient and Pearson’s correlation coefficient. The results thus obtained are given in Table 5.

Table 5. Correlation of BMI with components of energy balance

(N==420)

Variables	Regression coefficient		Pearson’s correlation coefficient	R-square change
	Constant (b0)	Variables (b1)		
Energy intake	12.188	0.005	0.794**	0.631
Physical activity level (PAL)	-	-	-0.111	-
Total daily energy expenditure(TDEE)	8.957	0.006	0.468	0.219
Energy balance	16.961	0.004	0.720**	0.519

**Correlation significant at the 0.01 level (2-tailed)

The results showed that energy intake was significantly and positively correlated with BMI (r= 0.794; P < 0.01) as per the Pearson’s correlation coefficient given in the table. Further a linear regression analysis showed that one unit increase in energy intake, increased BMI by 0. 005 and variation in BMI due to energy intake is 63.1 per cent (R^2= 0.631; p < 0.01). Even though total daily energy expenditure is decreasing in the modern society, it is difficult for most people to restrict intake to meet decline in energy requirements, and more and more people are becoming obese. Thus, increasing physical activity may be the strategy of choice for public health efforts to prevent obesity. According to Mc Crory et al. (2002) Hill et al. (2000) and Jeffery and Harnack (2007) adult weight gain may largely be attributed to over consumption of energy, than what is actually required.

According to Shetty (2002) data from India show that a gradual reduction in cereal grain consumption between 1975 and 1995 that has not affected the average energy intake. Misra et al. (2011) reviewed secular trends in food groups and nutrient intake and revealed that nutrition transition over the past 30 years (1973-2004), has resulted in 7 per cent decrease in energy derived from carbohydrate and 6 per cent increase in energy derived from fats.

In the present study, as per Pearson’s correlation coefficient, physical activity level (PAL) and TDEE had no significant relationship with BMI. The mean PAL showed sedentary lifestyle for all BMI groups except underweight female. PAL did not show a trend of increase with increase in BMI.

Energy balance found to have strong and positive relationship with BMI(R=O.720, P < 0.01). Regression coefficient indicated linear increase in BMI due to energy balance was 0.004. Variability in BMI due to energy balance was 51.9per cent (R^2 = 0. 591, P < 0.01). The present study underscores the observation of WHO Media Center (2012) and Swinburn et al. (2011) that the fundamental cause of BMI is an energy imbalance between calories consumed and calories expended. The factors responsible for the epidemic of obesity in Nauru, the country

having highest per cent of overweight population are also reported to be dramatic decrease in physical activity and a dependence on a Western diet (Curtis, 2004).

People must have been on excessive intake, relative to their energy needs during the dynamic phase of weight gain. But it seems reasonable to conclude that the low levels of physical activity now prevalent in Kochi, as revealed from the mean PAL values of the selected subjects that has not been matched by an equivalent reduction in energy intake. This must play an important, perhaps dominant, role in the development of overweight. However, it should be mentioned that public health strategies must be targeted both in reduction of total energy and the fat content of diet and improving the physical activity, if they are to have any chance of reversing the current trends in overweight and obesity and thereby avoiding the associated health consequences. Veerman et al. (2007) opines that to stop the increase in obesity prevalence, energy expenditure should increase, energy intake should decrease, or a combination of both.

Therefore to support healthy longevity, one should put a stop to the pandemic of sedentarism. Staying physically fit throughout life coupled with increasing intake of coarse cereals, pulses, fruits and vegetables to the optimal level and decreasing the intake of meat products and salt may well be one of the easiest, cheapest, and most effective ways to avoid overweight and related consequences.

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