Effect of Total Calorie Consumed in Breakfast, Lunch, 
Evening Snacks and Dinner in Blood Biochemistry 
Profiles of Diabetics

Sutapa Mukherjee¹, Baishakhi Dey¹, Subhayan Das¹, Satyahari Dey², Analava Mitra¹,*

¹School of Medical Science and Technology, IIT Kharagpur, 721302, India
²Department of Biotechnology, IIT Kharagpur, 721302, India
*Corresponding author: analavamitra@gmail.com

Abstract  Diabetes is becoming one of the major killers of mankind after cancer and AIDS. Despite tremendous strides in modern medicine and availability of insulin therapy, restorations to normoglycemia without adverse consequences have not yet been achieved. Diabetes is found to be multi-factorial from the pathogenic point of view. Apart from conventional therapy, naturopathy and holistic approaches, dietary interventions have a profound role in the control of insulin resistant syndrome. Meeting adequate dietary requirements through a balanced diet with proper calorie intake are found effective to reduce the incidence of insulin resistance syndrome. Current research highlights on the proper distribution of calories through four times meal amongst rural and urban dwellers so as to achieve the maximum benefits of dietary interventions in the diabetics of Kharagpur 1 and 2 blocks. The RCT carried out on 200 volunteers showed that the diet consisting of 35% calorie in breakfast, 20% in lunch, 15% in evening snacks and 30% in dinner gave best results in improving the blood-gluco-lipid profile of the experimental group in contrast to control group who received 40% calories in breakfast, 30% in lunch and 30% in dinner. The research warrants further trials on large populations on long-term basis.

Keywords  Normoglycemia, Dietary Interventions, Balanced Diet, Insulin Resistance, Distribution of Calories, Blood-Gluco-Lipid Profile

1. Introduction

Diabetes mellitus or simply diabetes is a complex metabolic disorder of carbohydrate, protein and fat metabolism due to relative or absolute deficiencies in insulin secretion or in its action. In other words it is a disorder which is related to energy balance/ regulation in the body. The exact aetiopathogenesis of the disorder is unknown and the various causes linked with it include both nature and nurture. Dilman (1989) in his adaptational model links it with a failing rheostat model where hypothalamic legacy is considered to be predominant[1]. Hypothalamus due to repetitive attacks of stress and the subsequent hormonal changes as a result of stress undergoes repetitive adaptational changes. These causes changes in basal values of different hormones maintaining homeostasis.

Diet has a profound role in the control of insulin resistant syndrome [2-7]. Overeating is a noted cause of diabetes. It not only imparts excess calories but also more stress. Researchers are of different opinion in the specific role caused by differing food agents. Mitra and Bhattacharya (2007b) found while rural diet is composed of mainly carbohydrates which forms the principal component of diet and the rural diet is diabetogenic in nature, an increase in protein content in the diet would be easier to comply and more satiating. It caused reduction of abdominal fat in males[8]. This corroborates with the observations of Luscombe et al. (2002). Sanders et al. (1985) reported that with a low fat intake the difference in effects of omega-3 and omega-6 fatty acids are marginal[3,4]. Hence, the view expressed by Sanders et al. (1985) was contrary to the view expressed by Raheja et al. (1970) who links the diabetic explosion in India, to increase in consumption of omega-6 fatty acids which started from mid 70s in order to reduce blood cholesterol levels and subsequent coronary artery diseases[2,3]. Ghafoarunissa (1996) observed that in Indian rural diet, fat intake, particularly intake of omega-3 fatty acid is low and intake of fat is directly proportional to one’s income[5]. Both quality and quantity changes in different geographical areas in India depending on location and availability, culture, religion, ethnicity, economics, taboo and belief, personal factors etc. Majority of Indians are lacto-vegetarians. It is being observed that diet should be in optimum of all ingredients. Ornish (1996) had advocated a low fat diet to be beneficial for health but it has the disadvantage of low HDL level in blood[9]. It was observed that vegetarian diet has a role in reducing the incidence of Insulin Resistance [10-13]. Eating behavior is also important.
Eating behavior per day in Indian populace if analyzed shows different patterns. It varies from three time eaters (rural) to four timers (urban). Further, it should be optimally distributed considering breakfast, lunch, evening snacks and dinner. The present paper links to the most beneficial effects in the distribution of different partitions/day in a diabetic.

2. Materials and Methods

2.1. Selection of Volunteers

450 volunteers residing in Kharagpur 1 and 2 blocks having Fasting Blood Glucose (FBS) level of 150-200 mg/dl were randomly selected (lottery) for the study as initial screening. 250 volunteers were excluded from them due to various reasons-failures to comply, denial of giving written consent, demanding money, left the place, underwent personal problems etc. Hence for final selection 200 volunteers were left with. These persons were subjected to the study as per ICMR protocol like they were being informed of the study, written consent taken and ethical committee approval obtained. These patients had developed diabetes within 2 years and free from any complications. They were not regularly taking any drug for hypertension, obesity, hepato-biliary disorders, cardiac complications or any other chronic disorders. The volunteers were living in different areas and naturally local agents were recruited by the research team to monitor. The volunteers underwent anthropometrical, biochemical and clinical assessments before and after the study. These volunteers were grouped into four different groups (lottery), one control (n=50) and three experimental (n=50×3), based on initial (pilot) study eating pattern. The experimental groups were divided according to identical/similar conditions of diet and life style in different areas and naturally local agents were recruited by the research team to maintain better compliance LAs at a maximum of 10 per fixed programmes. Approval of local administrative bodies like panchayets was also taken for the purpose. LAs recorded the raw food items consumed, dietary intake per day, life style patterns and deviations in daily life style. All deviations in standard procedure were noted during the study period of 6 months. LAs with the research team formulated the raw items to be consumed daily by different groups in different partitions-breakfast/lunch/dinner/others. The daily activities were also formulated and any deviation from it was requested to be reported to LAs.

2.2. Selection of Local Agents (LA)

The volunteers were distributed in different areas. Further, for better compliance LAs at a maximum of 10 per volunteers were recruited by the research team to maintain identical/similar conditions of diet and life style in different groups. LAs were provided with mobile number of volunteers were left with. These persons were subjected to the study as per ICMR protocol like they were being informed of the study, written consent taken and ethical committee approval obtained. These patients had developed diabetes within 2 years and free from any complications. They were not regularly taking any drug for hypertension, obesity, hepato-biliary disorders, cardiac complications or any other chronic disorders. The volunteers were living in different areas and naturally local agents were recruited by the research team to monitor. The volunteers underwent anthropometrical, biochemical and clinical assessments before and after the study. These volunteers were grouped into four different groups (lottery), one control (n=50) and three experimental (n=50×3), based on initial (pilot) study done. The experimental groups were divided according to three different types of eating patterns existing in the area while the control group followed the usual rural type of eating pattern.

- Control: Breakfast 40%, lunch 30% and dinner 30% (rural wide based both tribe and non-tribe)
- Group I: Breakfast 35%, lunch 40% and dinner 25% (rural, non-tribal)
- Group II: Breakfast 30%, lunch 40%, evening snacks 10% and dinner 20% (urbanized rural)
- Group III: Breakfast 35%, lunch 20%, Evening snacks 15% and dinner 30% (office workers)

2.3. Selection of Groups

The volunteers were distributed randomly in four groups as follows:

- Control: Breakfast 40%, lunch 30% and dinner 30% (rural wide based both tribe and non-tribe)
- Group I: Breakfast 35%, lunch 40% and dinner 25% (rural, non-tribal)
- Group II: Breakfast 30%, lunch 40%, evening snacks 10% and dinner 20% (urbanized rural)
- Group III: Breakfast 35%, lunch 20%, Evening snacks 15% and dinner 30% (office workers)

In each group the numbers of volunteers were 50. Each group was monitored by 2-3 LAs as per practicality and economic factors. They followed identical life style patterns. As the patients were from Bengali community the cooking patterns and raw items taken were more or less similar.

2.4. Collection of Blood Samples

12 hours fasting values are taken initially and at monthly intervals for six months. Measurement of total cholesterol (TC), high density lipoprotein cholesterol (HDLc), low density lipoprotein cholesterol (LDLc), very low density lipoprotein cholesterol (VLDLc), triglycerides (TG) and fasting blood sugar (FBS) was done by standard methods as depicted by Boehringer and by reagents supplied to meet the standard quality at monthly intervals by an indwelling catheter placed in the anti-cubital vein. Serum insulin level was measured at Spandan Diagnostics, Midnapore.

2.5. Equipments Used

In order to observe the effect of composite on the Type 2 Diabetes patients blood samples were tested for FBS, TC, HDLC by using Photometer 4010 of Boehringer, Germany. VLDLC is being computed as 1/5th of TG value and LDLC is being computed by the difference TC - (VLDLC + HDLC). Serum insulin values were measured by ELISA method at Spandan Diagnostics using Biorad, Coda Automated EIA Analyzer. For gravimetric measurements of raw items common balance (Addy & Co) was used. Standard charts of calorie content of different food items were also used to calculate the approximate calories [14,15].

2.6. Statistical Analysis

Let μ₀ be the average blood level of the desired parameter
of the control group. The goal is to test whether \( \mu \), the average blood level of the desired parameter of the experimental group is less than \( \mu_0 \) or not, that is to test

\[
H_0 : \mu = \mu_0
\]

Against

\[
H_1 : \mu < \mu_0.
\]

Let \( \bar{X}_0 \) be the sample mean of the control group and \( \bar{X} \) be that of the experimental group. In order to test \( (H_0,H_1) \), our test statistic is

\[
t = \frac{\bar{X} - \bar{X}_0}{s \sqrt{\frac{2}{n}}},
\]

where \( s = \sqrt{\frac{s_1^2 + s_2^2}{2}} \), \( s_1^2 \) and \( s_2^2 \) being the sample variances of the control group and the experimental group respectively. It is to be noted here that the above formula has been simplified from the standard one when the sample sizes \( n_1 \) and \( n_2 \) are the same. It is to be noted that the sample size being very large, the above test statistic \( t \) could be well approximated by normal distribution and the p-value for different parameters be calculated, on using the same kind of test statistic with the help of normal probability table.

### 3. Results and Discussion

Clinical, anthropometrical and biochemical evaluations of the volunteers before the study were as follows:

- **Age**: 47.5±8.1 years (Mean ± SD)
- **Sex**: Males 95, Females 105
- **Weight**: 56.6±2.6 kg
- **Body Mass Index (BMI)**: 21.8±2.4

At the end of the study, it was found that the changes were observed in respect to volunteers’ weight and BMI. Volunteers’ weights and BMI were 57.3±2.5 kg, 22.7±2.5 respectively resulted statistically insignificant changes.

Table 1 showed anthropometrical, clinical and biochemical evaluations of volunteers and the results were described in respect of \( M_0 \) (i.e. at the start of the experiment) and \( M_6 \) (i.e. at the end of the experiment).

Figure 1 shows the changes in the BBP of interest, i.e., TC, HDLC, LDLC, VLDLC, TG and FBS. Analyzing the result, it is evident that the changes in lipid profile (lowering of TC, VLDL, LDL, TG) and FBS in Group II and III were statistically significant (\( p=0.04 \) in Group II and \( p=0.035 \) in Group III) in comparison to the control group while in Group I the changes in the BBP values were insignificant. It may be mentioned here that beneficial changes in lipid profile indicates lowering of TC, VLDLC and LDLC, TG and FBS and increase in HDLC. The HDLC changes were statistically insignificant during the experiment in the groups.

### 4. Conclusion

Dietary interventions as well as proper distribution of calories is an effective non pharmacologic approach to combat type 2 diabetes[16,17]. Hence, the present study indicates that diet consisting of 35% calorie in breakfast, 20% in lunch, 15% in evening snacks and 30% in dinner may be the best to lower down the adversities in BBP and consequent complications in type 2 Diabetes. However, the study lacks the evidence-based conclusive results due to financial constrains which hindered the researchers to establish the study clinically effective (based on large number population and for a longer period of time).

<table>
<thead>
<tr>
<th>Table 1. Anthropometrical, biochemical and clinical data in both experimental and control groups of human volunteers (mean± SD).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experimental group</strong></td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
</tr>
<tr>
<td><strong>Males</strong></td>
</tr>
<tr>
<td><strong>Females</strong></td>
</tr>
<tr>
<td><strong>Body Mass Index (BMI)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Systolic Blood Pressure (SBP) (mm of Hg)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Diastolic blood pressure (DBP) (mm of Hg)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Serum GPT (IU/l)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Blood Urea (mg/dl)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Serum creatinine (mg/dl)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Serum uric acid (mg/dl)</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Serum GOT (IU/l)</strong></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Values at the start and end of the experiment were denoted by \( M_0 \) and \( M_6 \) respectively.
Effect of Total Calorie Consumed in Breakfast, Lunch, Evening Snacks and Dinner in Blood Biochemistry Profiles of Diabetics

Figure 1. Changes in BBP values in all the groups in comparison to control group for 6 months

REFERENCES


