Title: “BCC intervention reduces BMI at significant level – Community RCT study”

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ABSTRACT Title: “BCC intervention reduces BMI at significant level – Community RCT study”

Introduction: Diabetes mellitus, ‘Metabolic cum Vascular disorder” contributes 2% of all deaths in India. India is facing an epidemic of diabetes. BCC intervention helps to change lifestyle, modifying diet, BMI and reduces complications, mortality, costs which are major research gaps for diabetes in India.

Aims: To determine the Effectiveness of Behavioural change communication intervention in BMI among Type 2 Diabetic Mellitus patients.

Material and Methods: (CTRI/2019/09/021122, Reg 09/09/2019Trial Registered Prospectively)

Study Design: A True experimental Randomized Control Trial Research Design applied.

Study Population: Type 2 DM patients identified among all individuals between 20 years to 79 of the age of both sex and permanent residence of Kanyakumari District satisfying inclusion criteria.

Sampling: A multistage stratified, clustered sampling technique for selection of study samples from target population before Randomization into groups.

Tools: Modified Martha Mitchell Funnell Peer-based behavioral BCC intervention strategy tool applied. Data collection from 01/01/2021 to 30/06/2021 was done.

Sample Size: Open Epi: Sample Size for Clinical Trials, With 5% CI, 80% power, 10% Dropout rate, and past BCC studies reducing 15 % Percent of Exposed with Outcome, 284 samples selected by Kelsey method. Block Randomisation by Random Allocation software 15 blocks of 20 equal size and samples allocated randomly to study or control groups.

Statistical analysis used: Percentage, Chi-square test. Means, Paired T-test, Multiple linear regression analysis by SPSS version 26.0

Result: 284 Type 2 DM patients enrolled and finally 256 samples completed after 10% dropout. Out of 256 samples, 27.1 % were male and 72.9 % female. In paired T-test, At 6th month mean BMI were 21.97 & 23.78 and Paired mean differences were 2.425 & 0.164 in the study and control group. After multiple linear regression analyses, Type of House demographic factors was significantly associated with BMI.

Conclusions: BCC decreases BMI significantly in 6 months among Type2DM which is cost-effective for diabetes management.
MANUSCRIPT:

Title: “BCC intervention reduces BMI at significant level – Community RCT study”

Introduction: Type 2 diabetes (formerly called non-insulin-dependent, or adult-onset) results from the body’s ineffective use of insulin. In 2020, according to IDF, 463 million people have diabetes in the world and 88 million people in the Southeast Asia region. Of this 88 million people, 77 million belong to India. According to the IDF estimates, India has the second highest number of children with type 1 diabetes after the United States. It also contributes to the largest proportion of incident cases of type 1 diabetes in children in the SEA region. Per the World Health Organization, 2% of all deaths in India are due to diabetes.

Behaviour change communication is necessary as it ensures that the diabetic patient and their families have access to correct information about the disease, complications, treatment, advantages of lifestyle modification, available health care services. Information alone is insufficient to support behaviour change. Influencing healthy behaviours and creating a supportive social environment is also important. It requires desire for learning and participation of patient, family and community with a goal in mind to educate people about diabetes and how to take care and where to go, etc. Before individuals and communities change their behaviours, they must first understand basic facts about diabetes, change life style, know importance of modifying diet, regular exercise and be given access to services. In the next section, you will learn about goals, importance and principles of BCC in relation to diabetes mellitus. BCC is a necessary part of diabetes prevention, care and support programs, and providing link with other
health programmes. Behavior change messages emphasize information about the prevention of diabetes, treatment of diabetes, prevention of complications and their treatment. BCC involves diabetes education for the individual patient and also for the family and community. It is important to have some understanding of the factors that influence behaviour. Behaviour is influenced by three main factors i.e. beliefs, motivation and norms. Factors that influence change in behaviour are knowledge, attitude, and skill, support of family, friends and community, environment inside and outside family, health facilities available. All these help individual, family and community to change their behaviour. The relation between these aspects is indicated below. Factors influencing behaviour Factors influencing change Beliefs Knowledge, attitude, skills Motivation Support of family, friends, community Norms Environment, health facilities Change in behaviour of Individual, Family, Community. Hence my study in high prevalent south Indian population will help to identify the effectiveness of Community BCC intervention strategies which is an cost effective to reduce the burden of DM in India.

**Aims:** To determine the Effectiveness of Behavioral change communication intervention in BMI among Type 2 Diabetic Mellitus patients.

**Material and Methods :**

**Ethical Clearance :** (CTRI/2019/09/021122 [Registered on: 09/09/2019] - Trial Registered Prospectively )

Approval has been obtained from Institutional Research Committee of Vinayaka Mission University on April 10th 2018. Approval for Ethical committee at Kanyakumari Govt Medical college, Kanyakumari District on April 12th 2018. Permission letter for Data Collection has been
given by The Director of Public Health and Preventive Medicine, Teynampet, Chennai on Jan 2021. Written informed consent has been obtained from study participants.

**Research Design:**

A Community Based Epidemiological Cross-Sectional Study including 20 years to 79 years of both sex to identify the prevalence of Type 2 DM. A True Experimental RCT Research Design, most powerful method available for testing hypothesis of cause and effect relationship among variables. It determine the effectiveness of BCC Strategies in BMI pattern at urban and rural south Indian population.

**Target population**

All individuals between 20 years to 79 of age of both sex and permanent residence of Kanyakumari District are involved in the study.

**Accessible population**

Individuals selected by cluster sampling technique between 20 years to 79 of age of both sex who are satisfying inclusion criteria and permanent residence of Kanyakumari District.

**Settings of the study:**

At KanyaKumari District which is the southernmost district situated at Tamilnadu state, South India was selected for the study.
Sampling: A multistage stratified, geographically clustered sampling approach using the 2011 census sampling frame will be used. In the Rural Area of Kanyakumari District, Stratified into regions containing contiguous Blocks. In each region, sub-stratification based on village population size & female literacy rate. In each stratum, villages selected by PPS method (50 villages selected/District). In each village, 56 Households—selected by systematic sampling (sample size in rural area 1150; 1150/50 = 23), 1 individual selected from each household using WHO kish table. In the Urban areas of Kanyakumari District, Stratified into regions containing contiguous Administrative Block. In each region, sub-stratification done based on town population size & female literacy rate. In each stratum, wards selected by PPS method (50 wards selected/District). In each ward All Census Enumeration Blocks (CEB) listed, 1 CEB selected from each ward by random selection. In each CEB, All households listed. 24 households—selected by systematic sampling (sample size in urban areas 650; 650/50 = 13). One individual will be selected from each house through WHO kish method.

Inclusion Criteria:

All adults (both men & women) aged between 20 years and 79 years. Usual resident of Kanyakumari District.

Exclusion Criteria:

Those who are seriously ill at the time of Data collection.

Not willing to provide written consent for the study.

Sample Size Calculation: The sample size was calculated separately for urban and rural using formula Sample size (n) = \( \frac{Z^2(p) (q)}{d^2} \). Assuming an expected prevalence of 14% in urban areas and 8% in rural areas, allowing a relative error of 20% on these, a non response rate of
20% and an alpha error of 5%, the sample size was estimated to be 650 in urban areas and 1150 in rural areas in each of the regions studied with a total of 1800 individuals.

OpenEpi: Sample Size for X-Sectional, Cohort, and Clinical Trials

Sample Size: X-Sectional, Cohort, & Randomized Clinical Trials

Two-sided significance level (1-alpha): 95
Power (1-beta, % chance of detecting): 80
Ratio of sample size, Unexposed/Exposed: 1
Percent of Unexposed with Outcome: 5
Percent of Exposed with Outcome: 15
Odds Ratio: 3.4
Risk/Prevalence Ratio: 3
Risk/Prevalence difference: 10

<table>
<thead>
<tr>
<th>Kelsey</th>
<th>Fleiss</th>
<th>Fleiss with CC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size - Exposed</td>
<td>142</td>
<td>141</td>
</tr>
<tr>
<td>Sample Size - Nonexposed</td>
<td>142</td>
<td>141</td>
</tr>
<tr>
<td>Total sample size:</td>
<td>284</td>
<td>282</td>
</tr>
</tbody>
</table>

References
Kelsey et al., Methods in Observational Epidemiology 2nd Edition, Table 12-15

A pilot study was conducted with a smaller sample size of 60 to assess the feasibility of the study. Main study was conducted with 284 samples (142 in experimental group, 142 in control group) for a period of 6 months. RA was done with 15 blocks of 20 random numbers in each block. 256 Diabetic samples were finally completed the study with 128 in the experimental group and remaining 128 in the control group after 10% dropouts.

Data collection: Data collection from 01/01/2021 to 30/06/2021 was done in the target population by cluster sampling. The tools used for data collection was WHO STEP wise
approach to chronic disease risk factor surveillance- Instrument v2.1. Behavioral Change Communication (BCC) tool has after tested for Internal Validity And Reliability.” Modified Martha Mitchell Funnell Peer-based behavioural strategies to improve chronic disease self-management and clinical outcomes” been used in this Study Group Of Diabetic patients.

Educational Intervention were used as tool. Weekly Face-to-face encounters (Each 30 minutes) at Baseline, 1, 2, 3, 4, 5 & 6 month has been given to all respondents on a one-on-one basis with health messages tailored for sex, age, and socioeconomic differences. Educational materials such as posters, banners, pamphlets, diabetes card, handholding activities on Glucometer and various vernacular IEC materials. Exercise: Participants in all studies were individually advised to increase physical activity. The weekly volumes of exercise prescribed ranged from 150 min/week at moderate intensity aerobic activity. Diet: An ideal diabetic diet takes into consideration the following factors: 1. Total calorie content and their derivation from proximate principles of diet 2. Glycaemic index 3. Fibre content 4. Consistency or physical form of food. Calorie content of foods has gained importance in planning diet, as high calorie consumption results in obesity, glucose intolerance, dyslipidemia and cardiovascular diseases. Recommendations of appropriate calories depend upon body weight. Calculation for Ideal Body Weight for an Individual (Height in cms – 100)x 0.9 and the next step in the calculation of appropriate calories depends upon the weight of the patient. Diabetics, who have ideal body weight, require 30 Kcal/Kg maintain their weight. Overweight diabetics, who should lose weight, require 20 Kcal/Kg of ideal body weight/day. Underweight, require 40 Kcal/Kg of ideal body weight/day to attain ideal body weight. An elderly person above 50 years of age may require 10% less calories for each decade. The daily meal plan should be consistent in terms of total calories and distribution of energy-yielding nutrients, viz. carbohydrates, fats and proteins. Distribution of Nutrients in the Diet (Total Calori sources=2000 calories), Carbohydrates 300 gms (60 to 65 % of total calories), Proteins 50 gms (
15 to 20% of total calories), Fats 30 gms (15 to 25% of total calories). Reduction of fat intake, commonly to <20–30% of total energy intake was advised to Diabetic patients. Specific increases in dietary fibre intake will be recommended, whereas an increased intake in fibre-rich foods such as fruits and vegetables will be advised. Healthy Life Style Practices including Alcohol withdrawal, Tobacco cessation, Decreased salt intake, Sedentary life style modification. Assessment of bcc strategy for BMI value were done at baseline and end of 6 month in study group and control group.

**Statistical analysis used:** Percentage, Chi square test, Mean, Comparison of Means across groups done by Paired T test, Multiple linear regression analysis done for association between demographic and dependent variable. SPSS version 26.0 were used for Statistical analysis.

**Results:** A total of 286 Type 2 DM patients were identified out of target 1800 Study samples by the multi stage cluster sampling technique at kanyakumari district. Among them, Urban samples has the prevalence of 136 out of 650 samples contributing Type 2 DM prevalence of 20.92% and Rural samples has prevalence of 150 out of 1150 samples results in 13.04%. In RCT BCC intervention study, Out of total sample size was 284, only 128 were in experimental group and 128 were in control group after 10% dropout.
Table 1 shows the gender of Diabetic patients in experimental and control group.

<table>
<thead>
<tr>
<th>GENDER</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>%</td>
<td>F</td>
</tr>
<tr>
<td>Male</td>
<td>33</td>
<td>25.8</td>
<td>36</td>
</tr>
<tr>
<td>Female</td>
<td>95</td>
<td>74.2</td>
<td>92</td>
</tr>
<tr>
<td>Total</td>
<td>128</td>
<td>100</td>
<td>128</td>
</tr>
</tbody>
</table>

Chi² Value –0.179    df – 1    p –Value –0.389

Out of 256 Diabetic patients, 69 were males and 187 were females. In sex of the study participants in which 27.1% were male and 72.9% were female. Among these 69 male Diabetic patients, 47.8% were from the experimental group and 52.2% in the control group. Among these 187 female Diabetic patients, 50.8% were from the experimental group and 49.2% were from the control group. Regarding age category among Diabetic patients, 7.8% were 20 to 39 years category, 61.7% were 40 to 59 years category and 30.5% were 60 to 79 years category.
Category: 1. unemployed  2. employed  3. Homemaker  4. Retired Service

FIG 1: FREQUENCY DISTRIBUTION OF SAMPLES BASED ON THE EMPLOYMENT STATUS.

Regarding religion of 256 Diabetic patients, 48.85% were Hindu, 48.85% were Christian, and 2.3% were Muslim. Among marital status in Diabetic subjects, 1.6% were unmarried, 87.5% were married, 10.5% were widowed, and 0.4% were separated. Out of 256 Diabetic samples, 11.7% were unemployed, 53.5% were employed, 32.8% were Homemaker, and 1.9% were Retired from service. Among housing type, 66% were living in pucca housing type, 33.6% were living in semi-pucca housing type, 0.39% were living in kutcha house. Among educational status, 15 illiterate Diabetic samples, 40% were from the experimental group, and 60% were from the control group. Among 91 school completed Diabetic samples, 46.7% were from the experimental group, and 53.3% were from the control group. Among the 91
Graduates, 51.6% were from experimental group and 48.4% were from control group. Among the 28 Professional education completed Diabetic samples, 64.3% were from the experimental group and 35.7% were from the control group. Among place of residence, 52.34% were belongs to Rural population and 47.65% were belongs to Urban population and has equal distribution among study and control group respectively. Among samples, 0.78% were belongs to SC category, 0.39% were belongs to ST category, 81.6% were belongs to OBC category and 17.2% were belongs to Others category. With degree of freedom 1 and 95% of confidence interval, the table value of Chi Square is 3.841. Since the calculated Chi square Value were less than the table value and the calculated P value was more than the significance level of 0.05, there were no significant difference between all above demographic variables in the experimental and control groups.

**TABLE –2 : Distribution of Mean and SD of the physical parameter of Experimental and control group on Baseline and 6th month :**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Test</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>Pre Intervention</td>
<td>24.39</td>
<td>3.41</td>
</tr>
<tr>
<td>STUDY GROUP</td>
<td>Post Intervention on 6th Month</td>
<td>21.97</td>
<td>2.57</td>
</tr>
<tr>
<td>BMC</td>
<td>BASELINE</td>
<td>23.95</td>
<td>3.57</td>
</tr>
<tr>
<td>CONTROL GROUP</td>
<td>On 6th month</td>
<td>23.78</td>
<td>3.31</td>
</tr>
</tbody>
</table>

TABLE –2 With regard to BMI, the mean value and standard deviation on the postintervention 6th month were 21.97 & 3.41 respectively which were lower than the pre intervention mean
value and SD of 24.39 & 2.57. It shows the exact mean BMI decrease on 6th month after receiving BCC strategy were 2.42 from preintervention. With regard to BMI, the mean value and standard deviation on 6th month were 23.78 & 3.31 respectively which were lower than the baseline mean value and SD of 23.95 & 3.57. It shows the exact mean BMI decrease on 6th month who were not received bcc strategy were 0.17 from baseline in control group Diabetic samples.

Table 3: Comparison of mean preintervention Vs postintervention BMI -physical parameter among Diabetic samples in the experimental and the control group.

<table>
<thead>
<tr>
<th>Group</th>
<th>Category</th>
<th>Mean</th>
<th>SD</th>
<th>Paired Difference</th>
<th>‘t’ - Value</th>
<th>p- Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>POST.BMI 6th MONTH</td>
<td>21.97</td>
<td>2.566</td>
<td>2.425</td>
<td>1.229</td>
<td>22.323</td>
</tr>
<tr>
<td></td>
<td>PRE.BMI - BASELINE</td>
<td>24.39</td>
<td>3.414</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>BMI ON 6th MONTH</td>
<td>23.78</td>
<td>3.310</td>
<td>0.164</td>
<td>1.137</td>
<td>1.635</td>
</tr>
<tr>
<td></td>
<td>PRE.BMI - BASELINE</td>
<td>23.94</td>
<td>3.570</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(P<0.01 very significant)

Table -3 reveals that the mean BMI decrease in the Diabetic samples on post - intervention 6th month were 21.97 & 23.78 in experimental and control group respectively. The corresponding ‘t’ values
was 22.323 in experimental group which were more than the table value of 2.9200 and t values was 1.635 in control group which were less than the table value of 2.9200. Hence the BMI decrease in the experimental group on post- intervention 6th month was statistically significant at 0.01 level and the BMI decrease in the control group on 6th month was not statistically significant at 0.01 level. This indicates that the paired difference of mean BMI decrease between experimental and control groups was true difference. It was due to the effect of BCC strategy intervention.

**Fig 2 : Box Plot Showing Change In BMI Between The Experimental And Control Groups:**

It also concluded the mean BMI decrease value 2.425 in the experimental group on 6th month is higher than the mean BMI decrease value 0.164 in the control group on 6th month.
Table 4: Demographic Factors with Post intervention BMI – Multiple Linear Regression Analysis:

<table>
<thead>
<tr>
<th>Demographic variable</th>
<th>B</th>
<th>Std. Error</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>24.897</td>
<td>2.663</td>
<td></td>
<td>9.348</td>
<td>.000</td>
</tr>
<tr>
<td>SEX (M / F)</td>
<td>-.327</td>
<td>.452</td>
<td>-.047</td>
<td>-.723</td>
<td>.471</td>
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<td>Religion</td>
<td>.081</td>
<td>.202</td>
<td>.026</td>
<td>.401</td>
<td>.689</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>.580</td>
<td>.460</td>
<td>.081</td>
<td>1.261</td>
<td>.209</td>
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<tr>
<td>URBAN/RURAL</td>
<td>-.225</td>
<td>.408</td>
<td>-.036</td>
<td>-.551</td>
<td>.582</td>
</tr>
<tr>
<td>AGE CATEORY</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1. 20 to 39 yrs</td>
<td>-.342</td>
<td>.352</td>
<td>-.064</td>
<td>-.972</td>
<td>.332</td>
</tr>
<tr>
<td>2. 40 to 59 yrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. 60 to 79 yrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td>-.141</td>
<td>.556</td>
<td>-.016</td>
<td>-.253</td>
<td>.800</td>
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<tr>
<td>Education status</td>
<td>.157</td>
<td>.267</td>
<td>.039</td>
<td>.587</td>
<td>.558</td>
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<tr>
<td>APL/BPL</td>
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<td>.435</td>
<td>.004</td>
<td>.059</td>
<td>.953</td>
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<tr>
<td>Employment Status</td>
<td>-.463</td>
<td>.296</td>
<td>-.102</td>
<td>-1.563</td>
<td>.119</td>
</tr>
<tr>
<td>Housing Type</td>
<td>-1.068</td>
<td>.431</td>
<td>-.167</td>
<td>-2.480</td>
<td>.014</td>
</tr>
</tbody>
</table>

Dependent Variable: 6 MONTH_BMI (P<0.05 significant)

This table 4 shows after Multiple Linear Regression Analysis Demographic variables with the Constant value of 24.897, standard error 2.663 and Beta value of 0.167 in Housing type shown p value 0.014 which was significant at 0.05 level and other demographic parameters were insignificant. Hence the Housing type only has significant association with the post intervention BMI level.
Discussion:

Type 2 diabetes usually begins in the middle age or after 40 years. It is not uncommon to come across the development of diabetes in third decade itself in our country. The path physiological basis is a combination of impaired beta cell function, with marked increase in peripheral insulin resistance at receptor/ post receptor levels and increased hepatic glucose output production. Their circulatory levels of insulin and C-peptide may be variable ranging from hyper to normo insulinemic into obese and non-obese types. Coma is rare in type 2 diabetes, but may result from extreme hyperglycemia and hyperosmolarity; ketoacidosis can occur in fulminating illnesses due to acute increase in insulin requirements but “spontaneous” ketosis does not occur. Lactic acidosis is rare.

Metabolic Syndrome

The clustering of insulin resistance, dysglycemia, dyslipidemia and hypertension was originally defined as syndrome X. Later central obesity was also added as a part of syndrome. The ATP-III criteria recognized the association between above factors of the metabolic syndrome and both pro-inflammatory and pro-thrombotic states. The New International Diabetes Federation (IDF) definition,

Total Calorie Intake

Calorie content of foods has gained importance in planning diet, as high calorie consumption results in obesity, glucose intolerance, dyslipidemia and cardiovascular diseases. Obesity is an important factor in terms of target cell resistance to insulin action. Attainment of ideal weight results in marked diminution in hyperglycemia and an increase in target cell response to insulin. The Body Mass Index (BMI) is calculated from the following formula and expressed as kg/m^2: BMI = Weight (Kgs)/ Height (M)^2, BMI <18.5 is under nutrition, 18.5 – 23 is normal range, 23- 25 is border line overweight, 25- 30 is overweight and >30 is obese. Note: Asians, the BMI range of 23- 24.9 has an equivalent risk of type2 DM,
hypertension and dyslipidemia as BMI of 25-29 in other Caucasians. According to the latest Asian date published the cut off values for waist circumference are 90 and 80 cm for men and women respectively and the corresponding waist to hip ratio are 0.88 and 0.81 respectively. Recommendations of appropriate calories depend upon body weight. (Height in cms – 100)x 0.9 , Calculation for Ideal Body Weight for an Individual . The next step in the calculation of appropriate calories depends upon then weight of the patient. Diabetics, who have ideal body weight, require 30 Kcal/Kg maintain their weight. Overweight diabetics, who should lose weight, require 20 Kcal/Kg of ideal body weight /day. Underweight, require 40 Kcal/Kg of ideal body weight/day to attain ideal body weight. An elderly person above 50 years of age may require 10% less calories for each decade. Calorie requirements for children are 1000 calories baseline plus 100 calories for girls and 125 calories for boys per year till the age of 12 years. Thus the calorie content of the diet for all diabetics should be set at a level which will permit them to maintain their desired body weight and in children and adolescents, allow for a normal rate of growth and development. The daily meal plan should be consistent in terms of total calories and distribution of energy-yielding nutrients, viz. carbohydrates, fats and proteins, Distribution of Nutrients in the Diet (Total Calori sources=2000. Carbohydrates 300 gms (60 to 65 % of total calories) , Proteins 50 gms( 15 to 20% of total calories) , Fats 30 gms (15 to 25 % of total calories ).Reduction of fat intake, commonly to <20–30% of total energy intake was advised to Diabetic patients. Specific increases in dietary fibre intake will be recommended, whereas an increased intake in fibre-rich foods such as fruits and vegetables will be advised. Healthy Life Style Practices including Alcohol withdrawal, Tobacco cessation, Decreased salt intake, Sedentary life style modification. The demands of diabetes and the integration of complex self-management regimens into daily life have been shown to produce more emotional
distress, and to leave people feeling overwhelmed, frustrated and discouraged. These demands also lead to reduced well-being, anxiety and depression. Weight loss can be attained with lifestyle programs that achieve a 500–750 kcal/day energy deficit or provide approximately 1,200–1,500 kcal/day for women and 1,500–1,800 kcal/day for men, adjusted for the individual’s baseline body weight. When provided by trained practitioners in medical care settings with close medical monitoring, short-term (3-month) high-intensity lifestyle interventions that use very low-calorie diets (defined as ≤800 kcal/day) and total meal replacements may achieve greater short-term weight loss (10–15%) than intensive behavioral lifestyle interventions that typically achieve 5% weight loss.

The mean BMI value of Diabetic samples on post 6th month of BCC strategy intervention were which 21.97 were lower than preintervention BMI value 24.39. When paired ‘t’ test was computed between pre intervention and post intervention BMI value on the 6th month of Diabetic samples is significant at 0.05 level. When compared them on 6th month BMI value were 21.97 and 23.78 in experiment and control group. The BMI decrease among experimental & control group on post- intervention 6th month was statistically significant at 0.01 level.

Hence there is true difference between the pre and post intervention BMI value of Diabetic Samples among the experimental and control group which was due to the effect of BCG strategy intervention. From the above findings, it is evident that BCC intervention decreased the BMI of Diabetic samples in the experimental group. The following studies supports the current findings. Trief et al (2016) US based rct study in which self management intervention delivered by dieticians at 4,8,12 months respectively to study group. Collaborative couples intervention resulted in lasting improvements in obesity and psychosocial variables. Goode et al (2015) Australia based rct study where counseling was given to increase physical
activity, diet, weight loss and followed up at baseline 6,12,18 months respectively. It concluded increased dose of intervention was associated in great weight loss. Effective behavior change techniques for physical activity and healthy eating in overweight and obese adults; systematic review and meta-regression analyses Gro Beate Samdal, Geir Egil Eide, Tom Barth concluded that there are similarities, but also differences in effective BCTs promoting change in healthy eating and physical activity and BCTs supporting maintenance of change. The results support the use of goal setting and self-monitoring of behavior when counseling overweight and obese adults. Body Mass Index and Incident Type 2 DM in Young Adults: A Retrospective Cohort Study Increasing obesity has contributed to the increasing incidence of T2D but not T1D among UK children and young adults, with a fourfold greater risk of developing T2D in obese individuals. Hansel et al (2017) France based RCT conducted study by web based support tool designed to improve lifestyle habits, diet, physical activity in study group and assessed at baseline and 4th month. Outcome showed significant improvement in weight and waist circumference in intervention group at 4 months. Wu, Y., Ding, et al (2014) Epidemiological studies have shown that body mass index (BMI) is a powerful predictor of type 2 diabetes. Field et al. reported that both men and women with BMI >35kg/m2 were approximately 20 times more likely to develop type 2 diabetes compared with controls. Weight Reduction for the Prevention and Therapy of Diabetes, Considering the impact of abdominal obesity on the development of diabetes and increasing the risk of coronary heart disease (CHD) in patients with existing type 2 diabetes, bodyweight reduction is the primary target in obese patients with or without type 2 diabetes. Both the Finnish Diabetes Prevention Study (DPS) and the US Diabetes Prevention Program (DPP) found a 58% reduction in the incidence of type 2 diabetes with intensive lifestyle modification (caloric restriction, low-fat
diet and increased physical activity) as a result of a 5–7% loss of initial bodyweight. In the DPP study, lifestyle intervention demonstrated even more favourable changes compared with metformin treatment in bodyweight

The obesity epidemic is associated with an epidemic of diabetes. Fat distribution and ectopic fat accumulation in skeletal muscles and liver are even more important than obesity per se. The term ‘diabesity’ has been coined to express that type 2 diabetes is obesity-dependent and that obesity is the main etiological cause of type 2 diabetes. Modifiable or lifestyle risk factors include increased body mass index (BMI), physical inactivity, poor nutrition, hypertension, smoking, and alcohol use, among others. Increased BMI is consistently shown to be one of the strongest risk factors for development of diabetes. In addition, distribution of body fat and specifically an increased waist-to-hip ratio, increase a person's risk for diabetes.

**Conclusion:**

The findings of this studies suggest that BCC interventions may have positive effects on Type 2 Diabetic patients which decreased BMI levels and results in appreciable glycemic control. The paired mean posttest 6th month BMI value in the experimental group Type 2 Diabetic patient is 2.425 level reduction compare to 0.164 level reduction in control group. It has confirmed that BCC intervention is cost effective in improving all physical among Diabetic individuals. Specific increases in dietary fibre intake, fibre-rich foods such as fruits and vegetables, BCC intervention provides Healthy Life Style Practices including Alcohol withdrawal, Tobacco cessation, Decreased salt intake, Sedentary life style modification which decrease BMI. Hence Health care providers should use the BCC intervention, which can be safely included in daily routine care.
References:


3. WHO STEPwise approach to chronic disease risk factor surveillance- Instrument v2.1


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