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Type 2 Diabetes and Prediabetes: Self- Care Prevention and Management in Rural Indian Population

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ABSTRACT:
Background: Various diabetic complications affecting multiple organs in humans remain one of the most common reasons for worry among the medical fraternity, making intervention necessary.
Aims: the present clinical trial was carried out to evaluate the prediabetes and diabetes prevalence and to assess the effect of non-drug diabetic self-management for improving the diabetic status and decreasing the risk factors of diabetes. To increase awareness for diabetes, a population-based approach was developed and used along with individualized lifestyle modifications on self-care and risks in Type 2 diabetics.
Materials and Methods: The study was conducted on 764 rural subjects determined the prevalence of prediabetes and diabetes from the collected data along with differences after intervention in diabetes type 2, normoglycemic, and subjects with deranged fasting glucose levels compared to baseline data. The statistical analysis of collected data was applied for result formulation.
Results: Before intervention and after intervention values for fasting glucose in diabetics were 238.7±12.6and 180.5±81.7respectively, with the p-value of <0.0001. Concerning BMI no change was seen with the p-value of 1.000. The caloric intake also improved with a p-value of 0.9428. Similar results were seen for systolic and diastolic blood pressure values. The waist-hip ratio showed a significant reduction post-intervention with the change in value to 0.90±0.08from 0.87±0.09 with a p-value of 0.1851. The diabetic knowledge value also improved considerably from 3.6±2.5 to 4.55±2.2 with a p-value of 0.1301
Conclusion: The present study concludes that the interventional program, physical activity, and diet counseling can help in effective controlling of the diabetic glucose levels and risk factors associated with diabetes. Hence, such a program can be implemented at a higher level especially in rural India to avoid risk and complications in diabetics. The
Keywords: Diabetes, Prediabetics, deranged fasting glucose, BMI, physical activity, nutrition counseling

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Keynote: Type 2 diabetes is a chronic disease with the continued increase in its prevalence, less accessibility to health care, and lack of awareness on diabetic complications additively pose a high burden on the Indian health-care sector and economy. One effective and economic strategy for managing and preventing type 2 diabetes is lifestyle modifications with diet interventions.

INTRODUCTION

India is heading towards being the Diabetes capital of the World with the increase in cases of adults as well as childhood diabetes causing high morbidity and mortality owing to its multi-organ complications. India has a huge population, with approximately 47 living with undiagnosed Diabetes.[1] Approximately 37 million Indians have prediabetes and approximately 73 million with diagnosed diabetes. A huge spike in diabetes cases in India has been seen since the early 1900s owing to an increase in a sedentary lifestyle, obesity, overweight, transitions in nutrition, epidemiology, and economy. Various diabetic complications affecting multiple organs in humans remain one of the most common reasons for worry among the medical fraternity, making intervention necessary.[2] This intervention for preventing, managing, and diagnosing diabetes as well as managing complications imparts a high burden on the economy especially on the poor Indian population. The goal for Indian health-care sectors by 2025 is to make diabetes diagnostics and drugs to approximately 80 of the population.[3]

Patients with Diabetes need to learn about self-care and management of diabetes to prevent long-term complications and have maintained optimum health, failure to which can lead to the development of life-threatening macrovascular and microvascular multi-organ complications. Subjects with diabetes and prediabetes need to learn and maintain these self-care and management strategies to achieve daily normal diabetes status.[4] Various such strategies include lifestyle modification including giving up the sedentary lifestyle habits with more physical activity and diet modifications, care to prevent diabetic foot, adequate intake of the prescribed drug at the correct time, regular monitoring of glucose levels, and quitting of adverse habits like alcohol and smoking.[5]

With an increased understanding of diabetes and prediabetes, there is a focus on individual patient care with an aim to the prevention of diabetes and its complications. Primary diabetic care aims at making diabetic acre accessible to all population and referral to a specialist when needed. As per WHO primary diabetic care should is focused on providing individualized care from qualified health-care providers. Providing this primary care seem very challenging to the Indian health-care system, hence needs to be worked upon and more share of the economy to be spent on this aspect, which can be challenging in developing low-income country.[6]

The highest prevalence of diabetes is seen in the Indian population in the whole world. It is predicted that by 2030 there will be approximately 75 million diabetics with manifestations at a young age.A huge lot of the Indian population resides in the rural area making approximately 70%. The population residing in the rural areas has low resource medical settings and less availability to modern medical practice.[7] Also, as type 2 diabetes is a chronic disease with the continued increase in its prevalence, less accessibility to health care and lack of awareness on diabetic complications additively pose a high burden on the Indian health-care sector and economy. One effective and economic strategy for managing and preventing type 2 diabetes is lifestyle modifications with diet interventions. However, data regarding this intervention is scarce in the modern literature with only a few studies mentioning the positive impact of diet and lifestyle modification on improving diabetic status.[8] Hence, the present clinical trial was carried out to evaluate the prediabetes and diabetes prevalence and to assess the effect of non-drug diabetic self-management for improving the diabetic status and

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decreasing the risk factors of diabetes. To increase awareness for diabetes, a population-based approach was developed and used along with individualized lifestyle modifications on self-care and risks in Type 2 diabetics.

MATERIALS AND METHODS

The present study was based on a population-based approach which was carried out at Smt. MathurabaiBhausahebThorat Institute of Medical Sciences And Research Center [SMBT IMSRC], Nasik, Maharashtra, India; from December 2020 to April 2021. The study adopted on764 subjects of rural population.An attempt was done to involve the influential, public figure, and leaders by initial analysis in the village to explain the design of the study and motivate the subjects to participate in the study and keep trust in the protocol. Intervention and collection of data were done by individuals of expertise in the field. More than 40% of the village population had educational classification less than primary school and hence the oral interview method was considered most appropriate regarding data collection. The informed consent was collected from all study subjects and ethical clearance was taken from the Institutional Ethical committee.

Initially for the survey, all 764 individuals were interviewed where 102 individuals were less than 18 years (10-17) of age, and the remaining 662 were adults. A total of 604 individuals making 79% who completed the survey remaining 21% either denied the survey or migrated to other villages. The interviews and surveys were done by going home to home visits. The data were collected at two time periods including at the time of recruitment of study subjects which is considered baseline and after the intervention. The data collections were carried out by a person qualified to do so.

The data collected included the demographic parameters in the study subject. Capillary blood was used to determine the blood glucose level due to fear of venous blood withdrawal among the majority of study subjects owing to no pre-exposure and fear of the needle. Capillary blood determined the status of prediabetes and diabetes. The same glucometer was used to check the blood glucose levels (fasting). The subjects with not normal blood glucose levels were rechecked. American Diabetes association care standards were used to distinguish between the subjects with normal glucose levels (normoglycemic), subjects with impaired fasting glucose levels, and diabetics. Blood pressure was recorded for each subject using a sphygmomanometer after 10 minutes of rest in the left arm. Two readings were recorded and a third was taken if two had a difference of more than 4mm of mercury. Height and weight measurements were also taken along with hip and thigh circumference recordings. Die counseling was given after assessing the subject knowledge about food using a questionnaire and continuous diet intake assessment was also carried out. Obesity measures were taken based on waist to hip ratio.

Following measures were instilled in the study subjects: diet modification with more fibers and less fat and intake in portions along with the increase in physical activity. Personalized counseling was given to all individuals based on socioeconomic status, age, and sex. Detailed information was provided regarding diabetes and related complications with a focus on its prevention by lifestyle modification, reducing body fat, waist, and weight, diet modification, and stress reduction protocols. Individuals with only deranged fasting glucose levels were counseled separately.Weight reduction protocols were instilled only in overweight individuals. Diet counseling was personalized based on socioeconomic status. Intake of processed food and food rich in sugar was discouraged. Also, the subjects were informed about the importance of regulating and checking blood sugar levels.

The training was provided to the subjects by the persons qualified and trained to do so. The training was given for 3 months including detailed knowledge about prediabetes, diabetes,

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diet counseling, nutrition counseling, associated risk factors, and physical exercises. They were also trained about solving any query and question of the subjects related to diabetes.
The study determined the prevalence of prediabetes and diabetes from the collected data along with differences after intervention in diabetes type 2, normoglycemic, and subjects with deranged fasting glucose levels compared to baseline data. The statistical analysis of collected data was applied for result formulation.

RESULTS

The present clinical trial was carried out to evaluate the prediabetes and diabetes prevalence and to assess the effect of non-drug diabetic self-management for improving the diabetic status and decreasing the risk factors of diabetes. To increase awareness for diabetes, a population-based approach was developed and used along with individualized lifestyle modifications on self-care and risks in Type 2 diabetics.
The study included both males and females. Initially for the survey, all 764 individuals were interviewed where 102 individuals were less than 18 years (10-17) of age, and the remaining 662 were adults. A total of 604 individuals making 79% who completed the survey remaining 21% either denied the survey or migrated to other villages. The interviews and surveys were done by going home to home visits. The data were collected at two time periods including at the time of recruitment of study subjects which is considered baseline and after the intervention. The data collections were carried out by a person qualified to do so. The demographic characteristics of the study subjects are listed in table 1.
The study also assessed the alteration in various factors after intervention and counseling in the adult and youth study subjects with deranged fasting glucose and confirmed diabetics. These results are described in Table 2.
In minor subjects of less than 18 years of age, 22 subjects had deranged fasting glucose levels and no diabetic subjects as there. Before intervention and after intervention values for fasting glucose were 106.12±6.2 and 88.8±7.8 respectively, this difference shows a statistically significant reduction in the fasting glucose levels in subjects post-intervention with the p-value of <0.0001. The values for waist circumference and hip circumference before intervention were 24.5±3.4 and 29.5±4.2, whereas, post-intervention these values were decreased to 23.1±3.2 and 28.6±4.8 with the respective p-values of 0.1670 and 0.5117. Concerning BMI an increase post-intervention was seen with the value of 17.7±2.2 which was 16.0±1.7 before intervention with the p-value of 0.0064. The caloric intake also improved with a p-value of 0.9816. Similar results were seen for systolic and diastolic blood pressure values. The waist-hip ratio showed a significant reduction post-intervention with the change in value to 0.80±0.006 from 18.5±0.006 with a p-value of <0.0001.
In adult subjects of more than 18 years of age, 68 subjects had deranged fasting glucose levels and 29 diabetic subjects. Before intervention and after intervention values for fasting glucose in diabetics were 238.7±12.6and 180.5±81.7respectively, this difference shows a statistically significant reduction in the fasting glucose levels in subjects post-intervention with the p-value of <0.0001. The values for waist circumference and hip circumference before intervention were 33.5±4.1and 37.3±3.8, whereas, post-intervention these values were decreased to 31.4±4.6 and 36.1±5.1 with the respective p-values of 0.0718 and 0.3140. Concerning BMI no change was seen with the p-value of 1.000. The caloric intake also improved with a p-value of 0.9428. Similar results were seen for systolic and diastolic blood pressure values. The waist-hip ratio showed a significant reduction post-intervention with the change in value to 0.90±0.08from 0.87±0.09 with a p-value of 0.1851. The diabetic knowledge value also improved considerably from 3.6±2.5 to 4.55±2.2 with a p-value of 0.1301 (Table 2).

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The study also evaluated the mentioned variables among minors and adults on basis of their glycaemic values distinguishing them to normoglycemic, deranged fasting glucose, and diabetics, and the results are summarized in Table 3. The statistically significant difference in all the variables was seen on comparing the mentioned parameters in normoglycemic, subjects with deranged fasting glucose, and in diabetics.

Demographic parameter	**Subgroup**	**Number(n=604)**	**Percentage%**
Age	10-18 years	86	14.23
	18-20 years	147	24.33
	21-60 years	248	41.05
	More than 60 years	123	20.36
Sex	Males	386	63.90
	Females	218	36.09
Education	Uneducated	179	29.63
	Primary school	206	34.10
	High school	131	2.68
	Graduation or above	88	14.56
Blood Glucose levels	Fasting	98.6±7.82	-
	Postprandial	129.42±9.28	-
Weight (in kg)	Underweight	98	16.22
BMI	Normal	296	49
	Overweight	136	23.01
	Obese	74	12.25
Blood pressure (in mmHg)	Systolic B.P	125±7.8	-
	Diastolic B.P	89±8.2	-
Smoking		289	47.84
Alcohol Consumption		210	34.76
Physical Activity	No activity	436	72.18
	Moderate	124	20.52
	Heavy	44	7.28
Socioeconomic status	Low	289	47.84
	Moderate	248	41.05
	High	67	11.09

Table 1: Demographic Characteristics of the study subjects

Parameter	**Before Intervention**		**Post- Intervention**		**p-value**	
	Deranged fasting glucose	**Diabetics**	**Deranged fasting glucose**	**Diabetics**	**Deranged fasting glucose**	**Diabetics**
Young Individuals (10-17 years) (n=86)	**22**	**0**	**22**	**0**	**22**	**0**
Fasting Blood	106.12±6.	-	88.8±7.8	-	<0.0001	-

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Glucose Levels	2					
BMI	16.0±1.7	-	17.7±2.2	-	0.0064	-
Hip Circumference	29.5±4.2	-	28.6±4.8	-	0.5117	-
Waist Circumference	24.5±3.4	-	23.1±3.2	-	0.1670	-
Hip waist ratio	18.5±0.006	-	0.80±0.006	-	<0.0001	-
Total Calorie Intake	1618.8±624.2	-	1621.9±548.9	-	0.9816	-
Systolic B.P	108.6±12.6	-	101.8±8.4	-	0.0412	-
Diastolic B.P	77.6±8.4	-	72.7±7.5	-	0.0490	-
Diabetes Knowledge Value (Score)	5.2±1.6	-	6.4±1.8	-	0.0243	-
Adults >18 years (n=518)	**68**	**29**	**68**	**29**	**68**	**29**
Fasting Blood Glucose Levels	108.4±8.2	238.7±12.6	96.5±15.5	180.5±81.7	<0.0001	0.0004
BMI	23.3±4.3	23.3±3.4	23.5±4.6	23.3±4.4	0.7938	1.0000
Hip Circumference	36.6±3.8	37.3±3.8	35.5±3.5	36.1±5.1	0.0814	0.3140
Waist Circumference	33.3±4.4	33.5±4.1	31.1±4.7	31.4±4.6	0.0056	0.0718
Hip waistRatio	0.90±0.06	0.90±0.08	0.87±0.07	0.87±0.09	0.0082	0.1851
Total Calorie Intake	1556.5±574.6	1464.4±498.8	1842.2±536.1	1473.3±439.7	0.0032	0.9428
Systolic B.P	129.8±15.4	132.9±18.6	123.3±12.5	129.5±19	0.0281	0.4939
Diastolic B.P	93.2±14.7	92.5±18.4	82.4±13.5	87.1±15.6	<0.0001	0.2331
Diabetes Knowledge Value (Score)	3.3±2.6	3.6±2.5	4.5±2.3	4.55±2.2	0.0051	0.1301

Table 2: Alteration in various Diabetic factors post-intervention

Parameter	**Normoglycemics**	**Deranged fasting glucose**	**Diabetics (n=0)**	**p-value**
Young Individuals (10-17 years) (n=86)	64	22	0	
BMI	16.55±2.47	17.7±2.2	-	0.0564
Hip Circumference	28.13±2.82	28.6±4.8	-	0.5801
Waist Circumference	22.9±2.33	23.1±3.2	-	0.7541
Hip waistRatio	0.81±0.04	0.80±0.006	-	0.3798

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Total Calorie Intake	1406.78±546.08	1621.9±548.9	-	0.1152
Systolic B.P	106.33±11.02	101.8±8.4	-	0.0824
Diastolic B.P	69.64±8.86	72.7±7.5	-	0.1508
Diabetes Knowledge Value (Score)	4.41±1.98	6.4±1.8	-	0.0001
Adults >18 years (n=518)	421	68	29	
BMI	20.24±3.59	23.5±4.6	23.3±4.4	0.065
Hip Circumference	32.60±3.06	35.5±3.5	36.1±5.1	<0.0001
Waist Circumference	27.27±4.02	31.1±4.7	31.4±4.6	0.037
Hip waistRatio	0.85±0.05	0.87±0.07	0.87±0.09	0.09
Total Calorie Intake	1649.7±583.3	1842.2±536.1	1473.3±439.7	0.005
Systolic B.P	117.05±18.37	123.3±12.5	129.5±19	0.206
Diastolic B.P	78.8±13.78	82.4±13.5	87.1±15.6	0.059
Diabetes Knowledge Value (Score)	3.76±2.42	4.5±2.3	4.55±2.2	0.008

Table 3: Comparison of normoglycemic, deranged fasting glucose, and diabetics among minors and adult study subjects

DISCUSSION

The study included both males and females. Initially for the survey, all 764 individuals were interviewed where 102 individuals were less than 18 years (10-17) of age, and the remaining 662 were adults. A total of 604 individuals making 79% who completed the survey remaining 21% either denied the survey or migrated to other villages. The interviews and surveys were done by going home to home visits. The data were collected at two time periods including at the time of recruitment of study subjects which is considered baseline and after the intervention. The data collections were carried out by a person qualified to do so. It was seen that the mean fasting glucose level in the study population was 98.6**±7.**82 and the postprandial value was129.42±9.28. Regarding weight 98 (16.22%) subjects were underweight, 296 (49%) had normal weight, 136 (23.01%) were overweight, and 74 (12.25%) were obese. 72.18%(n=436) had a sedentary lifestyle, 124 (20.52%) did moderate physical activity, and 44 (7.28%) did heavy activity. Concerning socio-economic status 47.84% (n=289) subjects had low socioeconomic status, 41.05% (n=248) had medium, and 11.09% (n=67) had low socioeconomic status. These results were in agreement with the studies by Ramachandran A et al[9] in 2004 and Ramachandran A et al[10] in 2006 where the authors reported similar results in terms of literacy, socioeconomic status, and physical activity.

In minor subjects of less than 18 years of age, 22 subjects had deranged fasting glucose levels and no diabetic subjects as there. Before intervention and after intervention values for fasting glucose were 106.12±6.2 and 88.8±7.8 respectively, this difference shows a statistically significant reduction in the fasting glucose levels in subjects post-intervention with the p-value of <0.0001. The values for waist circumference and hip circumference before intervention were 24.5±3.4 and 29.5±4.2, whereas, post-intervention these values were

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In adult subjects of more than 18 years of age, 68 subjects had deranged fasting glucose levels and 29 diabetic subjects. Before intervention and after intervention values for fasting glucose in diabetics were 238.7±12.6and 180.5±81.7respectively, this difference shows a statistically significant reduction in the fasting glucose levels in subjects post-intervention with the p-value of <0.0001. The values for waist circumference and hip circumference before intervention were 33.5±4.1and 37.3±3.8, whereas, post-intervention these values were decreased to 31.4±4.6 and 36.1±5.1 with the respective p-values of 0.0718 and 0.3140. Concerning BMI no change was seen with the p-value of 1.000. The caloric intake also improved with a p-value of 0.9428. Similar results were seen for systolic and diastolic blood pressure values. The waist-hip ratio showed a significant reduction post-intervention with the change in value to 0.90±0.08from 0.87±0.09 with a p-value of 0.1851. The diabetic knowledge value also improved considerably from 3.6±2.5 to 4.55±2.2 with a p-value of 0.1301. These findings were in agreement with the studies by JoshiPet al[13] in 2007 and Chow CK et al[14] in 2008 wherein adult subjects with type 2 diabetes similar results in terms of BMI, caloric intake, and glucose levels were seen.

CONCLUSION

The present study concludes that the interventional program, physical activity, and diet counseling can help in effective controlling of the diabetic glucose levels and risk factors associated with diabetes. Hence, such a program can be implemented at a higher level especially in rural India to avoid risk and complications in diabetics. The study focuses on applying for such programs at social levels as intervention, to attain desirable results in subjects with deranged fasting glucose levels and in diabetics. However, more such longitudinal studies with larger sample size, longer monitoring period, and different geographical areas are required to reach a definitive conclusion.

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