JOURNAL OF CLINICAL AND BIOMEDICAL SCIENCES

RESEARCH ARTICLE

OPEN ACCESS

Received: 24-03-2024
Accepted: 28-05-2024
Published: 17.07.2024

Citation: Reddy MMKP, Srinivasa SV. Study on the Effect of Masticatory Frequency on One Hour Postprandial Blood Sugars in Normoglycemic and Dysglycemic Individuals. J Clin Biomed Sci 2024; 14(2): 38-43. https://doi.org/10.58739/jcbs/v14i2.24.20

* **Corresponding author**.

Manimohanhp@gmail.com

Funding: None

Competing Interests: None

Published By Sri Devaraj Urs Academy of Higher Education, Kolar, Karnataka

ISSN
Print: 2231-4180
Electronic: 2319-2453

Study on the Effect of Masticatory Frequency on One Hour Postprandial Blood Sugars in Normoglycemic and Dysglycemic Individuals

Reddy Mani Mohan K P[1]*, Srinivasa S V[2]

1 Postgraduate, Department of General Medicine, Sri Devraj Urs Academy of Higher Education and Research, Kolar, Karnataka, India
2 Professor & HOU, Department of General Medicine, Sri Devraj Urs Academy of Higher Education and Research, Kolar, Karnataka, India

Abstract

Background: The best method of prevention of diabetes includes early detection and dietary modifications through which the disease progression could be controlled in the modern era a novel yet sustained lifestyle modification is needed in preventing the progression of the disease. Mastication frequency has a role to play on glycaemic parameters in individuals, especially in the prandial phase. **Aims:** The study focuses on the effect of masticatory frequency on one hour post prandial sugars (since one hour post prandial blood sugars have a better prognostic value in predicting disease progression) in dysglycemic individuals as an attempt to prove the effectiveness of masticatory frequency as a dietary modification in dysglycemic. **Results:** A study group of 160 individuals divided into two groups of dysglycemic and normoglycemic. It is found that increased mastication frequency has a bearing on the post prandial sugars significantly in normoglycemic individuals. **Conclusion:** Thus can be used s a lifestyle modification in preventing the progression of the disease

Keywords: Lifestyle modification; Diabetic mellitus; Treatment; Dysglycemic; Normoglycemic; Postprandial blood sugar

1 Introduction

"Diabetes mellitus is a concretion of metabolic disorders characterised by persistent hyperglycaemia resulting from defects in insulin secretion, insulin action, or both" [1]. Though type 2 diabetes is present all over the world it is more, prevalent in developing and industrialised nations. Over the past few decades, the incidence of diabetes has been steadily increasing. "According to the International Diabetes Federation (IDF), there are currently over 500 million diabetics in the world, and by 2045, that figure is projected to rise by another 30%" [2].

Type 2 Diabetes develops as a composite of resistance to insulin in the peripheral tissues, increased glucose production, and impaired secretion of insulin, associated with a complex gene-environment, as opposed to Type 1 Diabetes, which is pancreatic B cell destruction and absolute insulin deficiency due to an autoimmune disorder that causes it. The various phenotypical characteristics of the patients by the bedside also reflect the variations in the aetiologies of these illnesses.

Type 2 Diabetes is often diagnosed in overweight middle-aged adults and frequently co-occurs with symptoms of the ”metabolic syndrome,” which includes hyperlipidaemia, abdominal obesity, and hypertension. It is estimated that diabetes will be responsible for close to 10% of all cause death worldwide (20-99 years old). In the last few years, diabetes and pre-diabetes have become more prevalent in India. According to the IDF 10^{TH} atlas, India ranks number two in the world after China with 74.2 million living with diabetes currently, is projected to see 124.9 million living with diabetes by 2045 in the 20-79 years of age. Also, India has the highest estimated number of prevalent type 1 diabetes cases in people under 20 years of age (2,29,400)[3].

One of the main components of diabetic treatment is lifestyle changes. Regular exercise and making wise dietary choices are the two factors that are most crucial in the treatment of diabetes mellitus. Since proper choice of food and regular exercise are difficult to sustain there is a need for lifestyle intervention which can be easily followed and habitually sustained. Hence, this study will be helpful in lifestyle intervention in the plan of treatment.

1.1 Aim

To study the effect of masticatory frequency on one-hour postprandial blood sugar levels in dysglycemic and normoglycemics individuals.

1.2 Objective

- To study the effect of masticatory frequency on one-hour postprandial blood sugar levels among dysglycemic individuals.
- To study the effect of masticatory frequency on one-hour postprandial blood sugar levels among normoglycemic individuals.
- To compare the effect of masticatory frequency on one hour postprandial blood sugar levels between dysglycemics and normoglycemic.

2 Materials and Methods

- **Study setting**: In the Out Patient and In Patient Departments of hospitals attached to R L JALAPPA hospital, SDUAHER, Kolar, India.
- **Study design**: Interventional study.
- **Study participants**: Individuals willing to be part of the study in the OPD and In- Patient of wards, by-standers of the patients of the hospitals mentioned above.
- **Study duration**: From December 2023 to March 2024
- **Sampling method**: Convenient sampling.
- **Sample size**:

Z1-α/2 =1.6 is a standard normal value at 5% level of significance. Z1-β = 0.84 is a standard normal value at 80% power. σ = pooled, SD = 22.62(2). d = clinically significant difference = 10.

Using formula n = 2[Z1-α/2+ Z1-β]2 x σ2 /d2 with 80% power and 5% confidence interval, the minimum number in each group is Total Sample Size = 160.

2.1 Inclusion Criteria

- Dysglycaemics: Fasting blood glucose >126mg/dl or/and Postprandial Blood Sugar >200 mg/dl.
- Normoglycaemics: Fasting Blood Sugar < 99 mg/dl and Postprandial Blood Sugar <140mg/dl.
- In persons with no previous history of diabetes
- Aged > 18 years, willing to give consent.

2.2 Exclusion Criteria

- Type one diabetes mellitus, recent surgery, acute severe illness, trauma, burns.
- Hepatobiliary and renal disorders, pregnancy, Edentulous patients.
- Type 2 diabetes mellitus patients whose treatment needs to be modified between day1 and day 2.
- Persons with previous history of diabetes on medication with blood sugar levels in normoglycemic levels.

2.3 Study Groups

- Group 1: Normoglycemic
- Group 2: Dysglycemic

2.4 Diagnosis

In a study by Suzuki H, et al. on the effects of thorough chewing on postprandial glycemia in non-obese Japanese subjects and observers, chewing 10 times and thorough chewing 30 times led to significantly lower blood glucose levels 90 min and 120 min after eating for the thorough chewing group, and total insulin secretion was significantly lower[4].

2.5 Methodology

After obtaining the approval from IEC and permission from the medical superintendent of the hospital, the out and in patients and their attenders were approached. They were given the required information about this study and their written informed consent was taken for participation. The consenting participants were divided into 2 study groups:

Table 1. Parameters

	Fasting	Postprandial	Hb1Ac
Normoglycemics	Less than 100 mg/dl	Less than 140 mg/dl	Less than 5.7%
Prediabetes	Prediabetes 100 mg/dl to 125 mg/dl	140 mg/dl to 199 mg/dl	5.7% to 6.4%
diabetes	Diabetes 126 mg/dl or higher	200 mg/dl or higher	6.5% or higher

Normoglycemic (Group 1) and Dysglycemic (Group 2) based on the recent blood sugars.

After division to each study subject a fixed caloric load (150 Cal in the form of 25 grams of raw groundnuts) was given on day 1 and day 2 at the same time. On day 1, the study subjects were asked to masticate at their normal frequency (around 10) which was counted. On day 2, the study subjects were asked to masticate at a frequency of 40 times per bolus before swallowing.

The caloric load was given in 3 boluses for the ease of administration. Blood glucose levels were measured on both days before the caloric load and 1 hour from the beginning of mastication. No changes in anti-diabetic treatment were made on the both the days of study. No food was taken for at least 2 hours before the start of the test on both the days and in the 1 hour between the meal and PPBS. The study subjects were told not to consume any meal or engage in any strenuous physical activity and to be preferably at rest.

During the period of fasting, patients were allowed to take water at regular half hourly intervals, if required. Finally, all the data was collected and analysed statistically. Patients with no previous history of diabetes and with blood sugars within normal limits of ADA association were considered normoglycemic. Patients with previous history of diabetics on medication and patients with blood glucose levels in the pre-diabetic range were considered as dysglycemic.

3 Results

In the present study a total of 160 individuals were considered. The mean age of the study participants in Normoglycemics (Group 1) and Dysglycemics (Group 2) was 32.3±7.5 years and 49.3±8.3 years respectively.

From Table 2 it was observed that majority of the study participants 70 (87.5%) were of age less 40 years. It may also be noted that 9 (11.2%) and 1 (1.2%) were in the age group of 41-50 years and 51-60 years respectively.

From Table 3 it was observed that majority of the study participants 28 (35%) were in the age group of 41-50 years followed by 27 (33.8%) in the age group of 51-60 years. It was noted that 15 (18.8%) and 10 (12.5%) were in the age group of 31-40 years and 61-70 years respectively.

In the present study, it was noted that in Group 1, 40 (50%) were males and 40 (50%) were females also it was observed that in Group 2, 42 (52.5%) and 38 (47.5%) were males and females respectively.

Table 2. Age and gender wise distribution of the study participants (Group 1)

Group 1 Age		Gender		Total
		Male	Female	
≤30	Count	18	20	38
	%	22.50%	25.00%	47.50%
31-40	Count	16	16	32
	%	20.00%	20.00%	40.00%
41-50	Count	6	3	9
	%	7.50%	3.80%	11.20%
51-60	Count	0	1	1
	%	0.00%	1.20%	1.20%
Total	Count	40	40	80
	%	50.00%	50.00%	100.00%

Table 3. Age and gender wise distribution of the study participants in Group 2

Group 2 Age		Gender		Total
		Male	Female	
31-40	Count	10	5	15
	%	12.50%	6.20%	18.80%
41-50	Count	15	13	28
	%	18.80%	16.20%	35.00%
51-60	Count	12	15	27
	%	15.00%	18.80%	33.80%
61-70	Count	5	5	10
	%	6.20%	6.20%	12.50%
Total	Count	42	38	80
	%	52.50%	47.50%	100.00%

From Table 4 it was observed that in Group 1 the mean sugar levels on day 1 (pre and post) is 111.00±11.94 and 132.36±12.56 respectively. The mean difference and percentage change in the sugar levels are noted to be 21.36 and 19.2 % respectively.

From Table 5 it was observed that in Group 1 the mean sugar levels on day 2 (pre and post) is 112.45± 9.1 and 122.06±10.18 Respectively. The mean difference and percentage change in the sugar levels were noted to be 9.61 and 4.5 % respectively.

It was observed that in Group 2 the mean sugar levels on day 1 (pre and post) is 177.32±12.61 and 216±15.04 respectively. The mean difference and percentage change in

Table 4. Table depicting sugar levels of study participants onday 1 in Group 1

Group 1	Number	Mean	Standard deviation	Mean difference	Standard deviation of difference	Change %
Day 1 (Pre)	80	111	11.94	21.36	4.282	19.2
Day 1 (Post)	80	132.36	12.56			

Table 5. Table depicting sugar levels of study participants on day 2 in Group 1

Group 1	Number	Mean	Standard deviation	Mean difference	Standard deviation of difference	Change %
Day 2 (Pre)	80	112.45	9.119	9.61	4.586	8.5
Day 2 (Post)	80	122.06	10.181			

Table 6. Table depicting sugar levels among study participants on day 1 (Group 2)

Group 2	Number	Mean	Standard deviation	Mean difference	Standard deviation of difference	Change %
Day 1 (Pre)	80	177.32	12.63	39.31	8.22	22
Day 1 (Post)	80	216.63	15.04			

the sugar levels were noted to be 39.31 and 22.2% respectively (Table 6).

It was observed that in Group 2 the mean sugar levels on day 2 (pre and post) is 177.26 ± 12.61 and 211.613 ± 15.04 respectively. The mean difference and percentage change in the sugar levels were noted to be 34.35 and 19.27% (Table 7).

Independent sample test of the effect of masticatory frequency by comparing the drop in blood sugars among normoglycemic and a statistically significant drop was seen with increased mastication ($p < 0.0001$). Independent sample test of the effect of masticatory frequency by comparing the drop in blood sugars among dysglycemics, and a statistically significant drop was seen with increased mastication ($p < 0.0001$).

4 Discussion

"Mastication which has an effect on the cephalic phase of the insulin response, is initiated by vagal stimulation and other neuronal hormones like gastrin releasing polypeptide, vasoactive intestinal polypeptide (VIP) and gastric hormones like glucagon like peptide and gastric inhibitory polypeptide, play a role in the cephalic role of insulin secretion." [4]

4.1 Changes in Normoglycemic Group

When 25 grams of raw ground nuts were given on day one as 3 divided boluses. The average pre-prandial and postprandial blood sugar levels in normoglycemic group on day one when asked to masticate at their own frequency was 111 mg/dl and 132 mg/dl respectively with a mean masticatory frequency of 23.45 and an average mean increase in postprandial blood sugars of 21.3 mg/dl (percentage change of 19.52%) postprandially.

The average pre- and postprandial blood sugar levels in normoglycemic group with a fixed masticatory frequency of 40 on day two was 112.45 and 122.62 mg/dl respectively and with an average mean increase in postprandial blood glucose of 9.61 mg/dl (percentage change of 8.5%) postprandially. It is seen that the mean difference in the prandial increment between day 1 and day 2, among the normoglycemic population is 11.7 mg/dl with a percentage change of 11.02%.

4.2 Changes in Dysglycemic Group

The average pre-prandial and postprandial blood sugar levels in dysglycemic group on day one when asked to masticate at their own frequency was 177.32 mg/dl and 216.63 mg/dl respectively with mean a masticatory frequency of 23.2 and an average increase in postprandial blood sugars of 39.31 mg/dl (percentage change of 22%) postprandially.

The average pre-prandial and postprandial blood sugar levels in dysglycemic group with fixed masticatory frequency of 40 on day two was 177.26 mg/dl and 211.613 mg/dl with an average increase in postprandial sugars 21.3 mg/dl (percentage change of 19.2%) postprandially.

And the mean difference in postprandial increment between day 1 and day 2 between the pre- and the postprandial sugars among the dysglycemic population is 4.96 mg/dl with a percentage change of 2.73%.

Our study demonstrates that through increased masticatory frequency there was a significant reduction in one hour postprandial blood sugars both in normoglycemic group (with an average fall in blood sugar levels of 11.76 mg/dl) and dysglycemic group (with an average fall in blood sugars of 4.76 mg/dl).

It was observed that among dysglycemic population in spite of increased masticatory frequency few participants had

Table 7. Table depicting sugar levels among study participants on day 2 (Group 2)

Group 2	Number	Mean	Standard deviation	Mean difference	Standard deviation of difference	Change %
Day 2 (Pre)	80	177.263	12.61	34.35	7.86	19.27
Day 2 (Post)	80	211.613	15.04			

Table 8. Changes in Normoglycemics

Group 1	Mean difference	Standard deviation of difference	Change %
Day 1 (Pre-Post)	21.36	4.282	19.52
Day 2 (Pre-Post)	9.61	4.586	8.5

Table 9. Changes in Dysglycemics

Group 2	Mean difference	Standard deviation of difference	Change %
Day 1 (Pre-Post)	39.31	8.22	22
Day 2 (Pre-Post)	34.35	7.86	19.27

Table 10. Difference in pre-prandial and hour blood sugar between group

	Normoglycemic		Dysglycemic	
Masticatory Frequency	**Mean**	**SD**	**Mean**	**SD**
Low (<40)	21.363	4.282	39.31	8.221
High (>40)	9.6	4.5856	34.35	7.866

increase in postprandial blood sugars (20% of participants) hence implies the possible presence of other factors that may affect the impact of mastication as an intervention in diabetic population.

On contrary there was consistent fall in blood sugar levels among the normoglycemic as compared with the dysglycemic population indicating improvement of masticatory frequency a definitive useful tool among the normoglycemic in preventing the progression of the disease and also reducing the postprandial burden in dysglycemic population.

Our study had a higher sample size of 160 as compared to the earlier is studies of H. Suzuki et al.[4] (N=26), Vinayak et al.[5] (N=)100. The results were in congruence with both the studies among normoglycemic population where increased mastication frequency/ thorough mastication has role in reducing the blood sugars postprandially among normoglycemic individuals, however in the above studies blood sugar levels were measured after hours postprandially. Among the dysglycemic population our study observed a statistically significant drop in among the dysglycemic subjects postprandially after one hour, where such findings were not observed in either of the studies[5,6] in which the postprandial sugars were checked after 2 hours. In a study by Jia li et al., on obese and thin individuals with a test meal of 2200 calories it was observed that on increasing the frequency of mastication from 15 to 40, resulted in elevated postprandial glucagon like peptide-1 and reduced energy uptake (by 11.9%). Highlighting the usefulness of increased mastication in combating obesity.[7]

In a cross-sectional studies of Yamazaki T et al., done on a study group of 6,827 it was suggested that increased masticatory frequency and slow chewing of food aids in preventing the occurrence of diabetes among Japanese population as it was observed in the study that people living with diabetes had a lower masticatory compared to the normoglycemic population.[8]

In the studies of Cassady BA et al., done on 13 patients using almonds it is observed that hunger was suppressed after 40 chews compared to after 10 and 25 chews hours after the consumption of the food, emphasizing the role of mastication.[9]

5 Conclusion

- As per our study, increased masticatory frequency could be used as an intervention in reducing the burden of one hour postprandial blood sugars.
- As per our study increased masticatory frequency can be used as a definitive lifestyle utility in preventing the development of complications/progression of the disease.

References

1) Association AD. Diagnosis and Classification of Diabetes Mellitus . *Diabetes Care*. 2014;37(Supplement_1):S81–S90. Available from: https://doi.org/10.2337/dc14-S081.
2) Association AD. Standards of Medical Care in Diabetes—2010. *Diabetes Care* . 2010;33(Supplement_1):S11–S61. Available from: https://doi.org/10.2337/dc10-S011.
3) Animaw W, Seyoum Y. Increasing prevalence of diabetes mellitus in a developing country and its related factors. *PLoS One*. 2017;12(11):1–11. Available from: https://doi.org/10.1371/journal.pone.0187670.
4) Suzuki H, Fukushima M, Okamoto S, Takahashi O, Shimbo T, Kurose T, et al. Effects of thorough mastication on postprandial plasma glucose concentrations in nonobese Japanese subjects. *Metabolism*. 2005;54(12):1593–1599. Available from: https://doi.org/10.1016/j.metabol.2005.06.006.
5) Sonoki K, Iwase M, Takata Y, Nakamoto T, Masaki C, Hosokawa R, et al. Effects of thirty-times chewing per bite on secretion of glucagon-like peptide-1 in healthy volunteers and type 2 diabetic patients. *Endocrine Journal*. 2013;60(3):311–319. Available from: https://doi.org/10.1507/endocrj.ej12-0310.
6) Shirali A, Thomas NK, Shirali PA, Harishchandra P, Joseph N, Rathi P. Influence of mastication rate on prandial glycemia among prediabetics: An observation. *Indian Journal of Public Health Research & Development*. 2019;10(12):14–19. Available from: https://doi.org/10.37506/v10/i12/2019/ijphrd/192186.
7) Jie L, Na Z, Lizhen H, Ze L, Rui L, Cong L, et al. Improvement in chewing activity reduces energy intake in one meal and modulates plasma gut hormone concentrations in obese and lean young Chinese men. *The American Journal of Clinical Nutrition*. 2011;94(3):709–716. Available from: https://doi.org/10.3945/ajcn.111.015164.
8) Yamazaki T, Yamori M, Asai K, Nakano-Araki I, Yamaguchi A, Takahashi K, et al. Mastication and Risk for Diabetes in a Japanese Population: A Cross-Sectional Study. *PLoS One*. 2013;8(6):1–8. Available from: https://doi.org/10.1371/journal.pone.0064113.
9) Cassady BA, Hollis JH, Fulford AD, Considine RV, Mattes RD. Mastication of almonds: effects of lipid bioaccessibility, appetite, and hormone response. *American Journal of Clinical Nutrition*. 2009;89(3):794–800. Available from: https://doi.org/10.3945/ajcn.2008.26669.