

Original Research Article

Predictors of poor glycemic control in type 2 diabetic patients in South Indian population

Pushpita De¹, Shaheen Banu^{2*}, Diviya Muthukumar³

¹Nutritionist, ²Consultant Diabetologist, Ideal Diabetes Care Center, Bangalore, Karnataka, India

³Senior Lecturer, Hindu Mission College of Nursing, Chennai, Tamil Nadu, India

Received: 27 October 2017

Accepted: 30 November 2017

*Correspondence:

Dr. Shaheen Banu,

E-mail: drshaheenshaikh@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: The aim of this study is to shed light on the patients' knowledge, expectations and attitudes with regards to glucose control, and to understand the barriers to achieving good glucose control among south Indian patients with type 2 diabetes.

Methods: A cross-sectional study was conducted among 76 type 2 diabetic patients in this study. Patients' information such as sociodemographic characteristics, family history of diabetes, diabetes duration, medication adherence, dietary pattern, physical activity was obtained through interview. Anthropometric details were noted during the interview. All available last readings for fasting blood sugar, post prandial blood sugar and glycosylated hemoglobin were abstracted from patients' records.

Results: A total of 76 patients were enrolled in the study. The overall mean (SD) duration of the disease was 9±7.02 years. 63% had HbA1c ≥7%, which is categorized as a poor glycemic control. 43% of the subjects had poor glucose control who did not follow healthy eating plans. 84% of the patients did participate in physical exercise but did not follow as recommended. 67% of the patients have poor knowledge about glucose control.

Conclusions: The main results indicate that glycemic control in type 2 diabetes is generally poor. Longer duration of diabetes and not adherent to diabetes self-care management behaviors were associated with poor glycemic control. Therefore, a balanced approach to improve awareness about diabetes and its control both among patients and the medical fraternity is urgent need of the hour in India.

Keywords: Diabetes, Good glycemic control, Physical activity, Waist circumference

INTRODUCTION

Diabetes has emerged as a major health care problem in India. According to the Diabetes Atlas published by the International Diabetes Federation (IDF), there are an estimated 40 million persons with diabetes in India in 2007 and this number is predicted to rise to almost 70 million people by 2025 by which time every fifth diabetic subject in the world would be an Indian.¹

Number of deaths in adult due to diabetes is estimated to be 3.96 million per year and mortality rate of diabetes in all ages is 6.8%, at global level.² Not only is there a huge number of people with diabetes in India but awareness levels are also low.

In spite of well-defined treatment for type 2 diabetes, in majority of the people, disease is poorly controlled with existing therapies.^{3,4}

Studies like UKPDS and DCCT have proven that poor glycemic control (HbA1C>7%) is associated with increased risk for micro vascular complications.^{5,6} An Indian study showed that the prevalence of diabetes is high in urban India. There is a large pool of subjects with impaired glucose tolerance at a high risk of conversion to diabetes.⁷

A major concern in the management of diabetes is the occurrence of complications, many of which are irreversible. Due to its complications such as degeneration of the retina leading to blindness, kidney disease, coronary heart disease, stroke, amputation of the limbs, problems during pregnancy, and congenital malformations; diabetes causes an enormous burden to health care services and costs. Type 2 diabetes develops as a combination of genetic susceptibility and environmental factors, and its rate increases steeply with age.⁸

Predictors of poor glycemic control can be deduced from the relationships between the following: glycemic control and socio-demographic characteristics (gender, age, income, occupational status and educational level), glycemic control and the level of physical activity, glycemic control and obesity, glycemic control and dietary intake, and glycemic control and diabetic profile (age at diagnosis, duration of diabetes, type of treatment, complication and family history).⁹

Glycemic control is considered as the main therapeutic goal for prevention of organ damage and other complications of diabetes. Several large clinical trials have demonstrated that tight blood glucose control correlates with reduction of micro vascular complications of diabetes.¹⁰ Therefore, achieving glycemic control is a critical metabolic goal because hyperglycemia contributes to the progression of diabetes mellitus by affecting both β -cell function and insulin sensitivity.¹¹ Patient's adherence to diabetes self-care behaviors plays a major role in improving their overall quality of life. To our knowledge, no studies have been done in South Indian populations to describe the risk factors associated with poor glycemic control in T2DM patients. However, studies from different parts of the world have found a variety of risk factors that predict poor glycemic control. Most of these studies were done in North America and Europe.

This study was conducted to determine predictors associated with poor glycemic control and to shed light on the patient's knowledge with regards to glucose control and to understand the barriers to achieving good glucose control among Type 2 diabetes who attended the Ideal Diabetes Care Center in Bangalore.

METHODS

This was a cross-sectional study in which type 2 diabetes patients were sampled through systematic sampling in

Ideal Diabetes Care Center (IDCC), Bangalore. After obtaining informed consent (written consent from literate patients and a verbally informed consent from illiterate patients), data were collected through interview using structured questionnaire.

The target population was all type 2 diabetes patients aged ≥ 18 years. Apart from age, other inclusion criteria were patients who had type 2 diabetes for >1 year and who had been on treatment for ≥ 3 months. Very sick patients, newly diagnosed patients, pregnant women, and patients with mental disorders were excluded from the study. Using these criteria, a total of 500 patients were enrolled in the study.

Data included sociodemographic data, such as sex, age, marital status, occupation and health-related parameters such as smoking status, history of diabetes, treatment of history was taken, whether patient was only on oral anti-diabetic drugs (OADs) or taking only insulin or both, eating practices, physical activity and sources of nutritional information.

Height and weight were measured with only light clothes and without footwear. Body Mass Index (BMI) was calculated as weight in kilograms divided by height in meter squared. Body Mass Index was categorized as normal ($<25\text{kg/m}^2$), overweight ($25\text{-}29.9\text{kg/m}^2$), and obese ($\geq 30\text{kg/m}^2$).¹² Abdominal circumference was measured with a flexible tape over loose thin clothing (for cultural reasons). Blood pressure was measured using sphygmomanometer in supine position. A total of three reading was taken, and average of the readings was taken. Blood samples for glycosylated hemoglobin (HbA1c), Fasting blood sugar and Post prandial blood sugar were collected. HbA1c was analyzed using Nyocard method.

Statistical analysis

SPSS version 16 was employed for statistical analysis. Values of less than 0.05 were considered to be statistically significant. Microsoft word and excel have been used to generate graphs and tables. Values of less than 0.05 were considered to be statistically significant.

RESULTS

This study included a total of 76 patients (31 males (41%) and 45 females (59%)) with Type 2 DM aged between 22 and 81 years, with a mean (SD) of 53.8 ± 11.62 years and P value ~ 0.05 . 48 (63%) had poor glycemic control who belonged to medium group of socio-economic status. (Table 1).

Their clinical characteristics, co-morbidities, treatment modalities with poor glycemic control among Type 2 diabetes patients in Table 2. 40 (53%) patients had confirmed Type 2 diabetes for ≥ 7 years ($P = \sim 0.05$). The overall mean (SD) duration of the disease was 9 ± 7.02 years with a minimum of 1 year and a maximum of 35

years. 30% of the patients had poor glycemic control. The mean blood pressure for the respondents were 11.32 (P=<0.001). The mean BMI of Type 2 diabetes in this study

was 28.45±5.27. Percentage of poor glycemic control was seen in 39% of overweight patients.

Table 1: Socio-demographic characteristics of type 2 diabetic patients, and their association with poor glycemic control.

| Variable | N (%) | Poor glycemic control (%) | P value | |
|-----------------------|----------------|---------------------------|---------|--------|
| Age | <50 | 26 (34) | 22 (29) | ~0.05 |
| | 50-59 | 25 (33) | 12 (16) | |
| | ≥60 | 25 (33) | 17 (22) | |
| Gender | Male | 31 (41) | 23 (31) | ~0.05 |
| | Female | 45 (59) | 28 (37) | |
| Educational level | Illiterate | 14 (18) | 7 (9) | <0.001 |
| | Primary school | 3 (4) | 1 (1) | |
| | High school | 23 (30) | 14 (18) | |
| | Tertiary | 36 (48) | 29 (38) | |
| Socio-economic status | Low | 10 (13) | 9 (12) | <0.001 |
| | Medium | 48 (63) | 32 (42) | |
| | High | 18 (24) | 10 (13) | |

Table 2: Association of clinical characteristics, treatment modalities and co-morbidities with poor glycemic control among type 2 diabetes mellitus patients.

| Variable | N (%) | Poor glycemic control (%) | P value | |
|---|--------------------------------|---------------------------|---------|--------|
| Body mass index (kg/m ²), mean (SD)= 28.45±5.27 | Normal (18.5 - 24.9) | 19 (25) | 13 (17) | ~0.005 |
| | Overweight (25-29.9) | 29 (39) | 20 (26) | |
| | Obesity (>30) | 27 (36) | 17 (22) | |
| Hypertension | Yes | 27 (36) | 18 (24) | <0.001 |
| | No | 49 (64) | 33 (43) | |
| Duration of diabetes (year), mean (SD) = 9±7.02 | ≥7 | 40 (53) | 26 (34) | ~0.05 |
| | <7 | 32 (42) | 24 (32) | |
| Glycemic control (HbA1C) | <7 % (good control) | 5 (7) | 5 (7) | <0.001 |
| | >7% (poor control) | 48 (63) | 28(36) | |
| Treatment modalities | Oral antidiabetic agents (OAA) | 50 (66) | 34 (45) | <0.001 |
| | 1 oral | 10 (18) | 10 (18) | |
| | Insulin only | 0 | 0 | |
| | OAA and insulin | 10 (18) | 10 (18) | |

Of the total 76 respondents, 63% had HbA1c ≥7%, which is categorized as a poor glycemic control. Possible interaction between poor glycemic control and variables is shown in Table 1, 2 and 3. Poor glycemic control was found to be associated with age, body mass index and duration of diabetes. Similarly, the glycemic level of the patients was possibly affected by self-management behaviors such as diet and physical activity.

66% of the patients were on combination of oral antidiabetic agents (OAA). 18% of the patients were taking only one oral antidiabetic agents (OAA) and 18% of the patients were on oral antidiabetic agents and insulin. However, patients who were using combination therapy of OHAs had a higher proportion of poor glycemic control (45%) (P =<0.001), compared with 18% of patients using only one OHA (Figure 1).

45% of the patients did not follow healthy eating plans as recommended by the nutritionist. 43% of the subjects had poor glucose control who did not follow healthy eating plans. 84% of the patients did participate in physical exercise but did not follow as recommended. Most of the patients (94%) were highly adherent to their medications as shown in Table.

Looking at barriers (Figure 2), 54% of the subjects not interested to respond, 17% of the subject's lack awareness on glucose control and 8% of subjects have no time to think on glucose control. Overall, there is a clear correlation between knowledge, attitude and barriers for glucose control. It suggests that good awareness is required about glucose control, and education them on glucose control is very much necessary.

Table 3: Proportion of patients with poor glycemic control according to diabetes self-care management behaviors.

| Variable | | N (%) | Poor glycemic control (%) | P value |
|----------------------------------|--------------------|---------|---------------------------|---------|
| Follow diet plan as recommended | Yes | 42 (55) | 18 (24) | <0.001 |
| | No | 34 (45) | 33 (43) | |
| Participate in physical exercise | Yes | 40 (84) | 36 (47) | ~0.05 |
| | No | 36 (16) | 28(37) | |
| Alcohol use | Yes | 8 (11) | 4 (6) | <0.001 |
| | No | 67 (88) | 46 (61) | |
| Medication adherence | Good adherence | 71 (94) | 47 (62) | <0.001 |
| | Moderate adherence | 4 (5) | 3 (4) | |
| | Low adherence | 1 (1) | 0 | |

Table 4: Patients’ barriers to achieve good glucose control.

| | No. of patients | % |
|---|-----------------|----|
| No response (nil) | 41 | 54 |
| Lack of awareness | 13 | 17 |
| No time | 6 | 8 |
| Not interested | 4 | 5 |
| Not serious about health | 4 | 5 |
| Lazy, not interested | 2 | 3 |
| Just like that | 1 | 1 |
| Lazy, not motivated | 1 | 1 |
| Motivation required | 1 | 1 |
| Recently detected | 1 | 1 |
| Same routine, bored | 1 | 1 |
| Staying alone, not interested in eating on time | 1 | 1 |

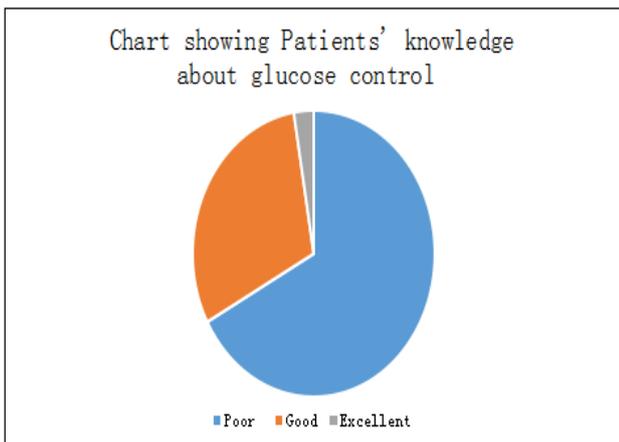


Figure 1: Patients’ knowledge about glucose control.

DISCUSSION

Poor glycemic control (HbA1c) was present in 63% of the patients enrolled in our study. A study conducted in Jordan, showed the proportion of poor glycemic control among patients with Type 2 diabetes was 65% (HbA1c >7%).¹³ In Pakistan study it shows, the proportion of poor

glycemic control was 46.7% (HbA1c >7.5%).¹⁴ HbA1c is one of the primary techniques to assess the effectiveness of the management plan on glycemic control. It reflects average glycemia over several months and has strong predictive value for diabetes complications. The American Diabetes Association recommendation of HbA1c value in diabetic patients is <7% since it is associated with a long-term reduction of microvascular complications of diabetes.¹⁵

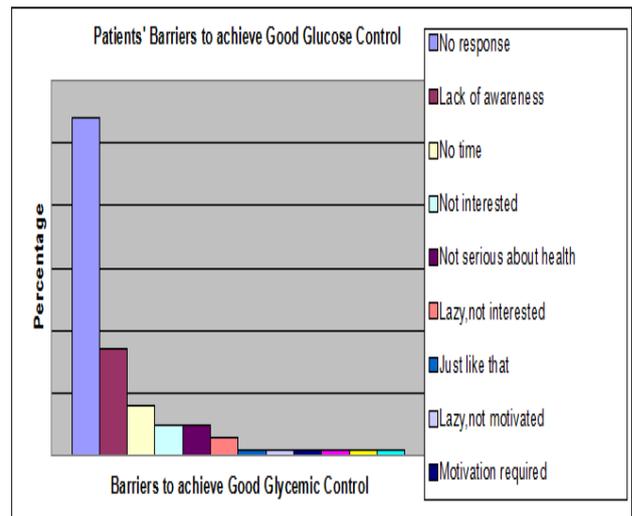


Figure 2: Patient’s barriers to achieve good glucose control.

However, there was no significant association between gender, age group, level of education, working status, monthly income and glycemic control. Meanwhile, the results showed that there was a significant association between family history of diabetes mellitus and glycemic control.

In this study, the mean age of T2DM patients was about 53.86±11.62, with the majority of them in the age <50 years. This study shows that younger age was significantly associated with poor glycemic control like other studies.¹⁶⁻¹⁸ Self-management behaviors among

younger patients might be low compared to older patients who could be more motivated in taking care of their diabetes AMD more compliant with their diet and medications.¹⁸

Furthermore, the study reported that instead of males, females were the majority of patients with DMT2 (59%) as more number of females were enrolled for the study. Studies have shown that women have more adverse effects on lipid profile than men an indication that estrogen-related protective mechanisms may also be affected by diabetes.^{19,20} The decrease in protective effect of estrogen on body fat distribution and insulin action may also be caused by low-grade inflammation, which may have a greater role in disturbing insulin action in women, or inflammatory factors may interact with female sex hormones.²¹

The proportion of patients with poor glycemic control was found to increase with increase in disease duration. Longer duration of diabetes is known to be associated with poor control, possibly because of progressive impairment of insulin secretion with time because of β -cell failure, which makes the response to diet alone or oral agents unlikely (UK Prospective Diabetes Study (UKPDS) Group, 1998).

In our study, BMI was associated with poor glycemic control. A higher proportion of patients with poor glycemic control was observed in patients whom were overweight, followed by obese ($P \sim 0.005$). BMI was significantly associated with poor glycemic control.^{22,23}

In our study, hypertension was not associated with poor glycemic control ($P = < 0.001$). However, studies have shown that hypertension is a common co-morbidity in type 2 diabetes mellitus patients and a major risk factor for both cardiovascular disease and microvascular complications. Therefore, diabetic patients with hypertension should be treated to less than 140/90 mmHg.²⁴

In our study, the majority of T2DM patients were on OAs (66%), while only 20% of the patients were using a combination of OAs and insulin. Poor glycemic control was seen in patients who were on more than one OA. But studies have proven that insulin alone or insulin+ OAs are associated with poor glycemic control.²²

This study shows that most of the patients did not follow healthy eating plan and also did not participate in physical activity as recommended. Self-management behaviors such as diet and exercise are independent factors of poor glycemic control among type 2 diabetic patients like other studies.²⁵⁻²⁷

Lifestyle and behavioral factors play an important role in the development and successful management of type 2 diabetes. Current guidelines recommend that patients

with type 2 diabetes should perform at least 150 minutes per week of moderate to intense aerobic exercise, while resistance exercise should be performed at least three times a week.^{28,29} It is reported that, physical exercise protected from type 2 diabetes.³⁰

Overall the diabetes patient's knowledge regarding glucose control and awareness was low. Studies have shown that among self-reported diabetic subjects, knowledge about diabetes including awareness of complications of diabetes was poor.³¹ Therefore continuous education is recommended to encourage physical activity and diet regimen.

There are several limitations to this study. Our study did not include information on psychological characteristics, smoking, diabetic complications, that are known to be associated with glycemic control.

CONCLUSION

The main results indicate that glycemic control in type 2 diabetes is generally poor. Independent predictors of poor glycemic control in these patients were younger age, longer duration of diabetes, obesity and not adherent to diabetes self-care management behaviors. Patients' younger than age 65 years should be warned of the health risks of non-glycemic control. A holistic approach that emphasizes lifestyle modification would be of benefit in improving glycemic control and quality of life.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: Not required

REFERENCES

1. Shashank RJ, Das AK, Vijay VJ, Mohan V. Challenges in diabetes care in India: sheer numbers, lack of awareness and inadequate control. *J Asso Physic Ind.* 2008;56(6):443-50.
2. Roglic G, Unwin N. Mortality attributable to diabetes: Estimates for the year 2010. *Diabetes Res Clin Pract.* 2010;87:15-9.
3. Sarah W, Gojka R, Anders G, Richard S, Hilary K. Global prevalence of diabetes. *Diabetes care.* 2004;27:1047-53.
4. Home P. The challenge of poorly controlled diabetes mellitus. *Diabetes Metab.* 2003;29:101-9.
5. Fox KM, Gerber RA, Bolinder B, Chen J, Kumar S. Prevalence of inadequate glycemic control among patients with type 2 diabetes in the United Kingdom general practice research data base: A series of retrospective analysis of data from 1998 through 2002. *Clinical therapeutics.* 2006;28(3):388-95.
6. Lachin JM, Genuth S, Nathan D M, Zimman B, Rutledge B N. Effect of Glycemic Exposure on the Risk of Microvascular Complications in the Diabetes Control and Complications Trial Revisited. *Diabetes.* 2008;57:995-1001.

7. Ramachandran A, Snehalatha C, Kapur A, Vijay V, Mohan V, Das AK, et al. Diabetes Epidemiology Study Group in India (DESI). High prevalence of diabetes and impaired glucose tolerance in India: National Urban Dia Sur Diabetologia. 2001;44(9):1094-101.
8. Vuori I. Physical inactivity is a cause and physical activity is a remedy for major public health problems. *Kinesiology.* 2004;36(2):123-53.
9. Armstrong N, editor. Paediatric exercise physiology. Elsevier Health Sciences; 2007.
10. Rodbard H, Blonde L, Braithwaite S. American Association of Clinical Endocrinologists medical guidelines for clinical practice for the management of diabetes mellitus. *Endocr Pract.* 2007;13:1-68.
11. Stratton I, Adler A, Neil HA. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. *BMJ.* 2000;321:405-12.
12. World Health Organization. Physical status: The use and interpretation of anthropometry: Report of a WHO Expert committee. Technical report series 854. Geneva, 1995. Available at <http://apps.who.int/iris/handle/10665/37003>.
13. Khattab M, Khader YS, Al-Khawaldeh A, Ajlouni K. Factors associated with poor glycemic control among patients with type 2 diabetes. *J Diabetes Complications.* 2010;24(2):84-9.
14. Al Sultan FA, Al Zanki N. Clinical epidemiology of type 2 diabetes mellitus in Kuwait. *KMJ-Kuwait Medic J.* 2005:98-104.
15. American Diabetes Association. Standards of Medical Care in Diabetes-2015. *Diabetes Care.* 2015;38:S1-S93.
16. Nichols GA, Hillier TA, Javor K, Brown JB. Predictors of Glycemic Control in Insulin-Using Adults with Type 2 Diabetes. *Diabetes Care.* 2000;23:273-7.
17. Toh MPHS, Wu CX, Leong HSS. Association of Younger Age with Poor Glycemic and Cholesterol Control in Asians with Type 2 Diabetes Mellitus in Singapore. *J Endocrinol Metab.* 2011;1(1):27-37.
18. El-Kebbi IM, Cook CB, Ziemer DC, Miller CD, Gallina DL, Phillips LS. Association of younger age with poor glycemic and obesity in urban african americans with type 2 diabetes. *Arch Intern Med.* 2003;163:69-75.
19. Glasgow RE, Hampson SE, Strycker LA, Ruggiero L. Personal-model belief and social-environmental barriers related to diabetes self-management. *Diabetes Care.* 1997;20:556-61.
20. Sanal TS, Nair NS, Adhikari P. Factors associated with poor control of type diabetes mellitus: A systematic review and Meta-analysis. *J Diabetol.* 2011;3:1.
21. Han TS, Sattar N, Williams K, Gonzalez-Villalpando C, Lean MEJ, Haffner SM. Prospective study of c-reactive protein in relation to the development of diabetes and metabolic syndrome in the Mexico City diabetes study. *Diabetes Care.* 2002;25:2016-21.
22. Benoit SR, Fleming R, Tsimikas AP, Ming JI. Predictors of glycemic control among patients with Type 2 diabetes: A longitudinal study. *BMC Public Health.* 2005;5:36-45.
23. Al-AkourNemeh Al A, Yousef K, Aysha MA. Glycemic control and its determinants among patients with type 2 diabetes mellitus attending a teaching hospital. *J Diabetes Metab.* 2011;2:4.
24. American Diabetes Association. Standards of Medical Care in Diabetes-2015. *Diabetes Care.* 2015;38:S1-S93.
25. Angamo MT, Melese BH, Ayen WY. Determinants of Glycemic Control among Insulin Treated Diabetic Patients in Southwest Ethiopia: Hospital Based Cross Sectional Study. *PLoS ONE.* 2013;8(4): e61759.
26. Khattab M, Khader YS, Al-Khawaldeh A, Ajlouni K. Factors associated with poor glycemic control among patients with type 2 diabetes. *J Diabetes Complications.* 2010;24:84-9.
27. Sanal TS, Nair NS, Adhikari P. Factors associated with poor control of type 2 diabetes mellitus: A systematic review and Meta-analysis. *J Diabetol.* 2011;3:1.
28. Umpierre D, Ribeiro PA, Kramer CK, Leitão CB, Zucatti AT, Azevedo MJ, et al. Physical activity advice only or structured exercise training and association with HbA1c levels in type 2 diabetes: a systematic review and meta-analysis. *JAMA.* 2011;305(17):1790-9.
29. Colberg SR, Albright AL, Blissmer BJ, Braun B, Chasan-Taber L, Fernhall B, et al. Exercise and type 2 diabetes: American College of Sports Medicine and the American Diabetes Association: joint position statement. *Exercise and type 2 diabetes. Medicine and science in sports and exercise.* 2010;42(12):2282-303.
30. Patja K, Jousilahti P, Hu G, Valle T, Qiao Q, Tuomilehto J. Effects of smoking, obesity and physical activity on the risk of type 2 diabetes in middle-aged Finnish men and women. *J Int Med.* 2005;258(4):356-62.
31. Mohan D, Raj D, Shanthirani CS, Datta M, Unwin NC, Kapur A, et al. Awareness and knowledge of diabetes in Chennai - the Chennai urban rural epidemiology study. *J Assoc Physicians India.* 2005;53:283-7.

Cite this article as: De P, Banu S, Muthukumar D. Predictors of poor glycemic control in type 2 diabetic patients in South Indian population. *Int J Res Med Sci* 2018;6:545-50.