Assessment of diabetic patients' adherence to insulin injections on basal-bolus regimen in diabetic care center in Saudi Arabia 2018: Cross sectional survey

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ABSTRACT

Background: Since insulin became a focal point of diabetes management, several studies have been carried out to monitor and improve patient outcomes. Adherence insulin therapy is an important part of diabetes management. **Aim:** This study reviews the responses of patients being managed in a diabetic care setting in monitoring their adherence to basal bolus insulin therapy. **Method:** A pre-validated questionnaire containing 18 questions was administered to patients in the diabetic care unit of the Security Forces Hospital, Riyadh, Saudi Arabia. **Results:** The levels of adherence with basal bolus insulin therapy was 61.9%. There is no considerable difference in adherence levels of male and female respondents with 31.62% and 31.58% respectively. The younger age groups (14-29) had the highest adherence levels at 65.75%. Higher levels of patient literacy and the location also have a positive relationship with adherence. **Conclusion:** To improve adherence levels, dosing should be made with consideration for patient convenience, and patients should be encouraged to build positive psychological relationships. Further studies should look to studying outcomes of therapy, and markers should be developed to monitor patient progress on therapy regimen regularly. The aspect of short clinic visits is another major consideration that needs to be look into properly to understand and monitor patients' proper adherence toward the basal bolus insulin.

Keywords: Basal bolus regimen, insulin injections, patient adherence

Introduction

The prevalence of diabetes mellitus (DM) is surprisingly increasing in the past 30 years; it is becoming a global epidemic major health issue.[1] In 2040, the estimated number of diabetic patients may reach 642 million people worldwide, and most of the cases will be type two diabetes (T2DM).[2]

Diabetes is a chronic illness that happens when the pancreas is no longer able to synthesize insulin, or when our body is unable to make good use of the insulin that it has been produced, or sometimes both combined.[3] The American Diabetes Association categorizes diabetes as insulin dependent, ketosis-prone diabetes, non-insulin dependent, and diabetes caused by other disease conditions, and gestational diabetes.[4]

Based on the pathophysiological mechanisms involved in its onset, it could be inferred that diabetes is usually characterized by high glucose levels, and that insulin remains a vital therapy option in many types once diagnosed. It must be noted therefore that diabetes tends to be progressive, causing multi-organ damage, and is usually accompanied by other disorders, leading to end-organ damage, termed co-morbidities.[5]

In therapy options for the management of diabetes, insulin treatment was first introduced in 1922, is always indicated

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in autoimmune type 1 diabetes. Insulin treatment in type 2 diabetes is shown in different conditions, including the setting of ketoacidosis, latent autoimmune diabetes, symptoms of hyperglycemia and failure of non-insulin therapies because of contraindications or adverse effects.[5]

The management of diabetes, like many chronic conditions, is such that it seeks to minimize the impact of the disorder especially on the physical and psychological aspect. This brings to the fore issues such as compliance, adherence, treatment markers, diet modification, lifestyle changes, literacy, location, and regular clinic appointments. Adherence and compliance are two similar terms used quite interchangeably, but adherence tends to imply patient agreement with therapy, and then compliance is simply following the laid down procedure. According to the World Health Organization (WHO), medication adherence is defined as "the degree to which the person's behavior corresponds with the agreed recommendations from a health care provider".[6] The non-adherent patients are those whose health-seeking or maintenance behaviors lack consistency with the advice recommended or prescribed by their healthcare provider.[7]

Non-adherence to medication is classified into three categories; primary non-adherence, where a medication regimen though prescribed isn't filled; non-persistence non-adherence describes a situation in which patients stop taking medications after starting without being told to do so. On the other hand, non-conforming adherence describes situations where drugs are not taken as prescribed.[8]

Patient's non-adherence is a significant health concern that poses a hard challenge to achieve our goals in treating and preventing diabetes mellitus complications; it is widespread and has been reported from all over the world.[7] Patient non-adherence is not only focused on medications, but also the inability to make lifestyle changes, undergo tests or keep appointments with their health care providers. The non-adherent patients, especially with diabetes mellitus, have been shown to have a higher incidence of severe complications with unwanted difficulties.[9]

There have been several reports, studies and efforts to improve patient adherence. Notably, the American Diabetes Association categorizes the barriers to adherence as either patient barriers, medication factors, or system factors. The patient-physician relationship had played a significant rule in affecting the compliance and following the physician's advice.[10] Patient barriers include difficulty remembering to get refills from the clinician or to pick them up from the pharmacy, trouble remembering to take medications, fear of making medications, depression, or health beliefs regarding medications. Medication regimen complexity, multiple daily dosing of drugs, cost, and side effects are all medication factors that may be barriers to adherence. System factors include inadequate follow-up and support.[11]

Adherence rates to insulin therapy has been estimated to be above average at best, going at a rate of 61%.[12] Sex has been proven

to be a factor, though this study will investigate this further, as females tend to have slightly lower cases of non-adherence than males with 65.45% to 69.34%. Also, in a primary healthcare (PHC) centre in Al-Hasa region in Saudi Arabia, there was a significant difference between rural participants and urban participants pointing to more compliance in urban patients.[10]

Common factors identified as barriers to patient adherence to insulin in diabetes patients include injection site reactions, fear of hypoglycemia, time-consuming, interference with physical activity, and lack of adequate injection instruction.[11] Specifically, the following factors have been posited to have a role to play in reduced adherence inn patients with diabetes: younger age, smoking, lower socioeconomic status, lack of family support, lower educational status, other chronic diseases, concurrent medication use, and a previous poor experience with medication.[13-16]

Methods

Study population

Saudi Arabian male and female diabetic patients over the age of 14 years, placed on insulin injection therapy, were selected among patients attending family medicine department, diabetic care centre, and security forces hospital in Riyadh.

Sampling technique

A convenient sampling technique was used in this study.

Study design

A questionnaire was designed to cover these categories as earlier mentioned. (Patient-related factors, socioeconomic factors, condition related, health system, and therapy related barriers). The questionnaire was designed to contain 18 questions and was validated by pre-testing. The questionnaire was self-administered and retrieved.

Sample size

Using convenient sampling with a margin of error set at 5%, confidence level 95%, with a set prevalence from literature at 60%, the sample size was set at 336. Calculating for a 15% non-response rate, the final sample size was calculated at 387.

Using the formula: $n = (z^2 \, P \, (1\text{-p}))/d^2$

Where n = sample size, z = z statistic for the level of confidence, P = expected prevalence and d = allowable error. This formula assumes that 'P' and 'd' are decimal values.

Study area

The study area used for this assessment was the family medicine department diabetic care centre Security Forces Hospital, Riyadh.

Duration of study

1st May–1st June, 2018.

Sampling technique

Inclusion criteria

The following criteria were used to determine participants for the study.

1. Male and female.
2. Age group above 14.
3. Type 1 diabetic patients on basal-bolus regimen.
4. Type 2 diabetic patients on OHD and insulin regimen.
5. Type 2 diabetic patients on insulin regimen only.
6. Self-administering injections only.

Exclusion criteria

1. Age below 14 (pediatrics).
2. Non diabetic population.
3. Diabetic patients on OHD only.
4. Non self-administering diabetic patients.
5. Mentally retarded or mentally challenged diabetic patients on insulin regimen.
6. Gestational diabetes.

Questionnaire: A sample of the questionnaire used for the study is attached in the appendix.

The questionnaire used were filled by a trained diabetic educator of the diabetic care center in the Security Forces Hospital, Riyadh. The information was gathered via a direct personal interview with each of the patients.

Statistical analysis

Statistical analysis was performed by SPSS, Version 20.0 (Chicago, IL, USA). Qualitative statistics had expressed as a percentage at the level of accepted as <0.05 for significance value. Multinomial logistic regression analysis was carried out on the adherence to insulin dose to identify the limitations that relate to poor adherence.

Results

This section expresses the data obtained and presents the result in evaluating adherence to basal bolus insulin therapy.

Respondents demographics

The demographic characteristics of the study population are present in Table 1. Out of 399 diabetic subjects, 202 were females (50.63%) and 197 were males (49.37%). Out of the total participants, 39.10% of the patients were in the age group 45-60. The study participants were grouped according to the education level - such as Illiterate, primary school, secondary school, high school, college/university and post-graduation study [Figure 1]. Out of 399 subjects, 163 (40.85%) had associated chronic diseases like hypertension 59 (14.79%) had thyroid disorder, 206 (51.63) had hypercholestemia. Out of 399 subjects, 69.67% had diabetes for a period of more than 10 years of duration, 39.85% were taking 4 injections per day, and 22.31% of the patients were taking 3 injections per day.

Table 1: Demographic information of respondents		
Variable	**Sub variable**	**Total number - 399 (%)**
Gender	Male	197 (49.37)
	Female	202 (50.63)
Age (Years)	14-29	73 (18.30)
	30-44	60 (15.04)
	45-60	156 (39.10)
	>60	110 (27.57)
Education Level	Illiterate	149 (37.34)
	Primary School	24 (6.02)
	Secondary School	47 (11.78)
	High School	99 (24.81)
	College/university	76 (19.05)
	Post-Graduation Study	4 (1)
Type of Diabetes	Type 1 Diabetes	86 (21.55)
	Type 2 Diabetes	77 (19.30)
	I don't know	236 (59.15)
Diabetes		274 (68.67)
Hypertension		163 (40.85)
Thyroid Disorder		59 (14.79)
Hypercholestemia		206 (51.63)
Other Complication		45 (11.28)
Duration of Diabetes (years)	<2	23 (5.76)
	2-5	32 (8.02)
	5-8	27 (6.77)
	8-10	39 (9.77)
	>10	278 (69.67)
Clinic attendance in the last year	never missed appointment	241 (60.40)
	missed 1-2 appointments	74 (18.55)
	Missed >2 appointment	20 (5.01)
	Didn't got appointment	64 (16.04)
Number of Daily injections	2	151 (37.84)
	3	89 (22.31)
	4	159 (39.85)
Missed Dose		154 (38.60)
How many missed Dose (Dose)	1-2	71 (17.79)
	3	45 (11.28)
	4-6	18 (4.51)
	>6	18 (4.51)
	Never miss	247 (61.90)

Respondents adherence to daily insulin

The response of the patients was stratified according to the demographic information and educational levels. The results were then subjected to regression analysis at a significant level of $P > 0.05$. This was done in order to be able to assess and measure adherence at various levels of the population.

In our study, we compared skipping a dose of insulin to a normally prescribed insulin injection by the physician to the patient, with the reference to the non-skipping insulin dose. Patients who were prescribed number of 2 insulin dose are skipping 1-2, 2-4 and a 4-6 dose of insulin, and are respectively [Table 2] 0.778, 1.315 and 1.558 significantly times reduced compared to non-skipping insulin dose. [Table 3].

Table 2: Comparison between skipped and non-skipped doses

Variable	Sub variable	Skipped dose	Non skipped dose	P
Gender	Female	121	76	0.994
	Male	124	78	
Age	14-29	25	48	<0.0001
	30-44	36	24	
	45-60	99	57	
	>60	85	25	
Education Level	Illiterate	105	44	0.004
	Primary School	17	7	
	Secondary School	32	15	
	High School	46	53	
	College/university	43	33	
	Post-Graduation Study	2	2	

Figure 1: Gender wise age group distribution

Discussion

Basal Bolus insulin is given to patients in order to mimic the body production of Insulin. Thus, appropriate insulin levels are maintained, and glucose is appropriately metabolized. Insulin therapy thus is dependent on the time injected, period of activity and the pre-prandial test to reflect insulin effect.[13] Thus it is important to ensure that therapy levels are kept up for optimum therapy results.

Adherence of patients to basal bolus insulin therapy

Of the patients sampled, 61.90% of them reported to have not missed a dose, i.e. they are 100% in adherence with their prescriptions. Our results matched with Yarlagadda 2015 results[12] which demonstrated in Ethiopia and reported 60% adherence in the given population. our finding is slightly lower than in a study by Rajagopalan et al., who reported an adherence rate of 63% ± 24% in patients with insulin-treated type 2 diabetes,[13] and slightly lower than that of Cramer et al., who reported an adherence rate of 77% ± 17%.[14]

Adherence differences among the sampled population

The gender influence on adherence is slightly diminished, as there are slightly similar adherence levels in male and female patients. 38.6% and 38.58% adherence, respectively. Our results matched with Geisel-Marbaise and Stummer (2010)[17-19] who reported that regarding adherence rates, there is also no identifiable gender-related behaviour. Also, those noticing gender aspects often report neutrality respectively, showing a weak influence of gender on adherence behaviour.[20-23] Already in 1981, Dunn and Turtle came to the conclusion that there was no diabetic person. Salient are only the differing health beliefs of women who are more confident with physicians and medications in general.[22,24] Overall, there seems to be too little research on gender-related adherence to gain significant insights.

Age plays a prominent role. Though a previous study suggested that younger age was a possible factor tending towards non-adherence, this study is at variance with that position,
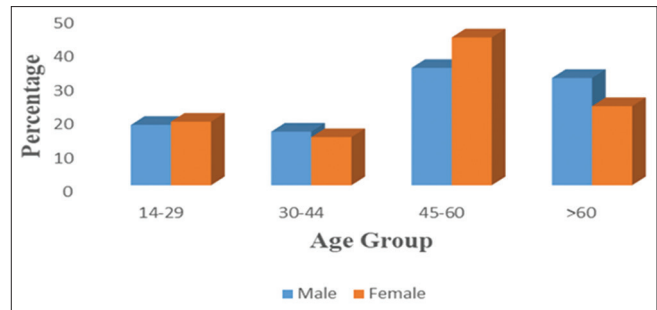
Our results show that poor levels of education has a negative impact on patient adherence. The solution is to advise them to keep reminders in order to keep to the prescriptions. These results matched with when adherence education was added to pharmacotherapy for 172 patients with uncontrolled diabetes.[25] However, data from a comprehensive literature review suggested that such interventions did not improve adherence if it was already high.[25] In a randomized trial, where patients received up to 10 telephone calls from their health educator at 4-6 week intervals over 1 year, there was a significant improvement in medication adherence for the patients. However, this intervention was not effective in those patients taking insulin.[26] Newer methods to increase communication and relationships between patients and healthcare providers are being developed using resources such as electronic medical records and websites,[27] and it is anticipated that these will result in improved medication adherence. An infographic showing the difference across education levels is shown in Figures 1 and 2, in the appendix.

Factors affecting adherence to basal bolus insulin therapy

Our study reported that Psychological and practical supports, Convenience of regimens and believe in efficacy of treatment are significant factors that affecting adherence to Basal Bolus Insulin therapy. An infographic showing various reasons for skipping doses and regimen is in Figures 3 and 4. Patients tend to have a well-defined dietary adaptation over the years which most are already used to. Changing such plans have shown to take several steps and counselling on the importance of the new modifications and why there is need for patients to adapt to it as fast as possible to have an effective diabetic control. Inappropriate timing, complex regimen, forgetting to take the doses among others are some of the principal influencing factors for adherence to therapy.

In addition, studies have revealed that attachment to lifestyle modification plays an important role in diabetes control and nonadherence to lifestyle recommendations in patients with type 2 diabetes can affect the treatment outcome,[28] which chimes in with the results of Mirahmadizadeh et al., (2018)[29] study in as much as the patients with a non-diabetic diet had a 2.38-fold increase in the likelihood of reluctance to use insulin. Such findings highlight the significant role of education of type 2 diabetes patients in relation to diet and other lifestyle

changes. Moreover, they found a 6.75-fold increased chance of insulin initiation refusal among our illiterate patients, which emphasizes the need for designing simple and easy-to-understand educational materials for the illiterate diabetic population.[28] As previous investigations have reported poor glycaemic control among diabetic patients, it is necessary that physicians pay greater attention to illiterate patients and bring to bear more patience in their education with a view to attaining favourable treatment results.[30]

The other minor factors collected were described in terms of the patient's experiences in terms of complications. These included hypoglycemia, self-injection, fear of injections, running out of medications etc.

These barriers simply point to the fact that patients should be educated more, and should be closely monitored. The appointments intervals could be shortened for proper monitoring of the therapy outcomes and patient's adherence. For patients who are scared of the effects of hypoglycemia, it should be advised that they get glucometers, so they can monitor their blood sugar levels, and should be educated about the signs of hypoglycemia. Patients should be asked to fix their own convenient times for dosing, but the dose to be given, the extent of existing complications or otherwise, should be considered in setting dosing regimen. Psychological and practical support, patient belief in treatment efficacy, reduced number of injections are top factors, and recommended methods to increase adherence to insulin injection [Figure 4].
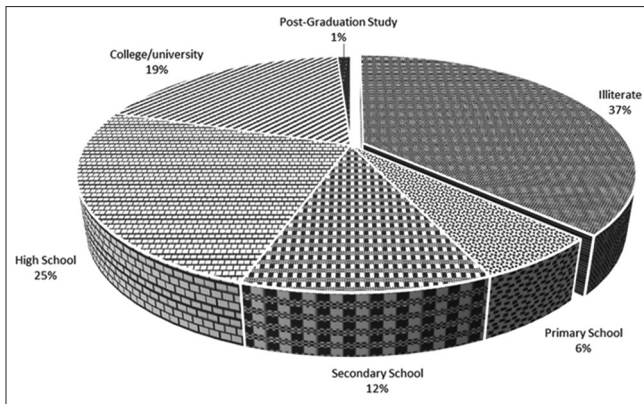
Correlation of number of injections to skipping dose

Time-specific dosing can impact adherence and people may miss, reduce, or mistime insulin doses[31] through eating habits and lifestyle, or recurrent hypoglycaemia or fear of hypoglycaemia.[32] It is well documented that reduced adherence is associated with poorer glycaemic control, as measured by HbA_{1c},[33] but little research has been published to explore the relationship between appropriate timing of insulin administration and glycaemic control.

From the results in Table 3, while reducing the number of injections may slightly increase adherence, we had compared the reasons for not taking your insulin injection, other reasons for missed doses, potential barriers that patients faced not to take insulin injections and difficulties faced during administering insulin injection, with skipping insulin dose amounts having an insignificant result. So, we could not identify any problem while we had compared barrier of factors increasing the adherence to insulin injections to how many amounts of skipping with the reference to minimize number of injections.

From Table 4, increasing adherence can be achieved by increasing regimen convenience, and helping the public gain confidence in medication use.

Conclusion

The basal bolus insulin therapy is very important in managing several types of diabetes. The levels of adherence across the patients' samples for this study is 61.09%. People who skip a dose
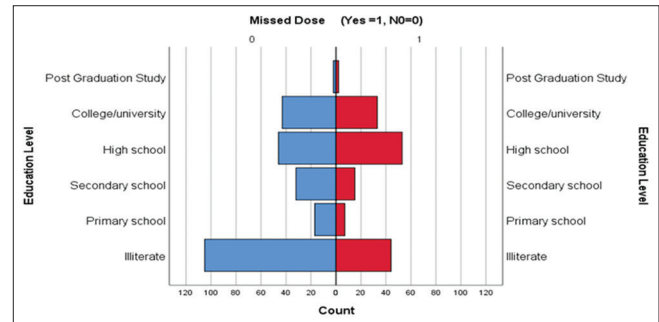

Figure 2: Education level of diabetic patients

Figure 3: Skipped doses and non-skipped doses against education level

Table 3: Prevalence of adherence of diabetic patients to insulin injection					
Prevalence of adherence of diabetic patients to insulin injections					
How many missed Dose	Number of Daily injections	B	Wald	Sig.	Exp (B)
1-2 doses	[Number of Daily injections=2]	-0.748	5.333	0.021	0.473 (0.251,0.893)
	[Number of Daily injections=3]	0.281	0.697	0.404	1.325 (0.685,2.564)
2-4 doses	[Number of Daily injections=2]	-1.315	9.167	0.002	0.268 (0.115,0.629)
	[Number of Daily injections=3]	0.174	0.204	0.651	1.19 (0.599,2.533)
4-6 doses	[Number of Daily injections=2]	-1.558	5.463	0.019	0.211 (0.057,0.778)
	[Number of Daily injections=3]	-0.341	0.31	0.577	0.711 (0.214,2.36)
More than 6 dose	[Number of Daily injections=2]	-0.105	0.033	0.855	0.901 (0.292,2.775)
	[Number of Daily injections=3]	0.488	0.596	0.44	1.63 (0.472,5.631)

Table 4: Factors increasing the adherence to insulin injections

Factors increasing the adherence to insulin injections					
	Missed Dose	B	Wald	Sig.	Exp (B)
Psychological and practical supports	How many missed Dose	0.568	31.366	<0.0001	1.765 (1.447,2.153)
Convenience of regimens	How many missed Dose	0.330	6.222	0.013	1.391 (1.073,1.804)
Believe in efficacy of treatment	How many missed Dose	0.759	42.620	<0.0001	2.137 (1.701,2.684)
Confidence of taking medications in public	How many missed Dose	0.035	0.021	0.885	1.036 (0.642,1.672)

a. The reference category is: Minimize number of injections
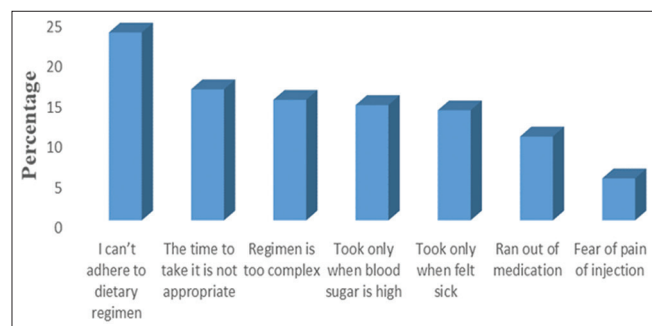

Figure 4: Reason for not taking insulin injections

of insulin 0.748 times compared to those who take 2 doses of insulin injection are more likely to adhere to their prescriptions. Literacy level and environmental factors (urban settlement) tend to have influence on level of adherence.

Since information and education are both vital as regards to adherence, the diabetic patients need psychological and practical support. They need to have convenient regimens and believe in the efficacy of the therapy more than minimizing the injections. It is important to also note that frequent clinic visits ensure effective monitoring of patient's adherences to the prescribed basal bolus insulin therapy. Shortcomings associated in the patient's adherences and proper counselling on the need for proper adherences will definitely improve patient's performance especially when we consider older patients that may be less informed in this information technology age.

Study strength

It is the first similar study which conducted in our area, included both genders with wide age range and spotted on different factors, which may affect insulin adherence.

Study limitations and recommendations

First, the relatively small sample size and single-centre design limits the generalization of our findings to the overall diabetic population. Second, our findings are based on cross-sectional data on self-reported medication adherence, which could have been biased by patients' foreknowledge of their laboratory results. Third, lack of data on adherence to the other aspects of diabetes, such as Body Mass Index (BMI) and physical activity, is another possible limitation, which otherwise would extend the knowledge obtained in the current study. Nevertheless, despite these certain limitations, given the paucity of the solid information on the subject, our findings represent a valuable

contribution to the literature. Thus, future studies on higher population is recommended.

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Conflicts of interest

There are no conflicts of interest.

References

1. Animaw W, Seyoum Y. Increasing prevalence of diabetes mellitus in a developing country and its related factors. PLoS One 2017; 12:e0187670.

2. IDF Diabetes Atlas: Global estimates for the prevalence of diabetes for 2015 and 2040.

3. Jing J, Sklar GE, Min Sen Oh V, Li SC. Factors affecting therapeutic compliance: A review from the patient's perspective. Ther Clin Risk Manag 2008; 4:269-86.

4. American Diabetes Association. Diabetes Care 2004; (Suppl 1):s5-10. Available from: http://care.diabetesjournals. org/content/27/suppl_1.

5. Zieger A. Does Better Packaging Equal Better Patient Compliance?. [Online]. Available from: https://scholar. google.com/scholar?hl=en&as_sdt=0%2C5&q=Zieger+A.+ Does+Better+Packaging+Equal+Better+Patient+Complian ce%3F.+%5BOnline%5D.+%5BLast+cited+on+2010+Nov+20 %3B+Last+accessed+on+2011+Aug+01%5D.&btnG=. [Last cited on 2010 Nov 20; Last accessed on 2011 Aug 01].

6. World Health Organization. (2003). Adherence to long term therapies: Evidence for action [online]. Available from: http://www.who.int/chronic_conditions/en/adherence_ report.pdf.

7. OtCm. (2011). Assisting therapy compliance, on compliance. Available from: http://www.dsm.com/le/en_US/otcm/ htmlsolution_therapy_effectiveness.htm.

8. Beena J, Jimmy J. Patient medication adherence: Measures in daily practice. Oman Med J 2011; 26:155-9.

9. Al-Sowielem LS, Elzubier AG. Compliance and knowledge of hypertensive patients attending PHC centers in Al-Khobar, Saudi Arabia. East Mediterr Health J 1998;4:301-7.

10. Kahn AR, Al-Abdul Lateef ZN, Al Aithan MA, Bu-Khamseen MA, Al Ibrahim I, Khan SA. Factors contributing to non-compliance among diabetics attending primary health centers in the Al Hasa district of Saudi Arabia. J Family Community Med 2012; 19:26-32.

11. American Diabetes Association Standards of medical care in diabetes—2016: Abridged for primary care providers. Clin Diabetes 2016; 34:3-21.

12. Yarlagadda R. Patient adherence to insulin therapy in

diabetes Type 1 and Type 2 in chronic ambulatory clinic of Jimma University Specialized Hospital, Jimma, Ethiopia. Int J Pharm Sci Res 2015; 6:796-806.

13. Currie CJ, Peyrot M, Morgan CL, Poole CD, Jenkins-Jones S, Rubin RR, *et al.* The impact of treatment noncompliance on mortality in people with type 2 diabetes. Diabetes Care 2012; 35:1279-84.

14. Bezie Y, Molina M, Hernandez N, Batista R, Niang S, Huet D. Therapeutic compliance: A prospective analysis of various factors involved in the adherence rate in type 2 diabetes. Diabetes Metab 2006; 32:611-16.

15. Khowaja LA. Treatment compliance to diabetes care: A cross-sectional study from Pakistan. J Diabetes Sci Technol 2012; 6:A75.

16. Gwadry-Sridhar F, Leslie RS, Patel B, Sanchez-Trask L. Understanding predictors of compliance in fixed-dose combination vs loose-dose combination therapy for treatment of type 2 diabetes. Vol. 59. ALEXANDRIA, VA, USA: AMER DIABETES ASSOC, InDiabetes; 2010. p. A346.

17. Rajagopalan R, Joyce A, Ollendorf D, Murray FT. PDB5: medication compliance in type 2 diabetes subjects: retrospective data analysis. Value in Health 2003;6:328.

18. Cramer JA, Pugh MJ. The influence of insulin use on glycemic control: How well do adults follow prescriptions for insulin?. Diabetes Care 2005; 28:78-83.

19. Geisel-Marbaise S, Stummer H. Diabetes adherence—Does gender matter?. J Public Health 2010; 18:219-26.

20. Shah NR, Hirsch AG, Zacker C, Taylor S, Wood GC, Stewart WF. Factors associated with first-fill adherence rates for diabetic medications: A cohort study. J Gen Intern Med 2009; 24:233-7.

21. Fitzgerald JT, Anderson RM, Davis WK. Gender differences in diabetes attitudes and adherence. Diabetes Educ 1995; 21:523-9.

22. Navuluri RB. Gender differences in the factors related to physical activity among adults with diabetes. Nurs Health Sci 2000; 2:191-9.

23. Vermeire E, Hearnshaw H, Van Royen P, Denekens J. Patient adherence to treatment: Three decades of research. A comprehensive overview. J Clin Pharm Ther 2001; 26:331-42.

24. Farsaei S, Sabzghabaee AM, Zargarzadeh AH, Amini M. Effect of pharmacist-led patient education on glycemic control of type 2 diabetics: A randomized controlled trial. J Res Med Sci 2011; 16:43-9.

25. Doggrell SA. Does intervention by an allied health professional discussing adherence to medicines improve this adherence in type 2 diabetes? Diabet Med 2010; 27:1341-9.

26. Walker EA, Shmukler C, Ullman R, Blanco E, Scollan-Koliopoulus M, Cohen HW. Results of a successful telephonic intervention to improve diabetes control in urban adults: A randomized trial. Diabetes Care 2011; 34:2-7.

27. Morrow DG, Conner-Garcia T, Graumlich JF, Wolf MS, McKeever S, Madison A, *et al.* An EMR-based tool to support collaborative planning for medication use among adults with diabetes: Design of a multi-site randomized control trial. Contemporary clinical trials, 2012; 33:1023-32.

28. Mumu SJ, Saleh F, Ara F, Afnan F, Ali L. Non-adherence to life-style modification and its factors among type 2 diabetic patients. Indian J Public Health 2014; 58:40.

29. Mirahmadizadeh A, Delam H, Seif M, Banihashemi SA, Tabatabaee H. Factors Affecting Insulin Compliance in Patients with Type 2 Diabetes in South Iran, 2017: We Are Faced with Insulin Phobia. Iranian Journal of Medical Sciences. 2018 Jun 9.

30. Garcia AA, Zuniga J, Reynolds R, Cairampoma L, Sumlin L. Evaluation of the spoken knowledge in low literacy in diabetes scale for use with Mexican Americans. Journal of Transcultural Nursing 2015;26:279-86.

31. Brod M, Rana A, Barnett AH. Adherence patterns in patients with type 2 diabetes on basal insulin analogues: Missed, mistimed and reduced doses. Curr Med Res Opin 2012; 28:1933-46.

32. Farsaei S, Radfar M, Heydari Z, Abbasi F, Qorbani M. Insulin adherence in patients with diabetes: Risk factors for injection omission. PrimCare Diabetes 2014; 8:338-45.

33. DiBonaventura M, Wintfeld N, Huang J, Goren A. The association between nonadherence and glycated hemoglobin among type 2 diabetes patients using basal insulin analogs. Patient Prefer Adherence 2014; 8:873-82.