Impact of Brief Smoking Cessation Intervention on Abstinence Rate and Glycaemic Control in Patients with Diabetes Mellitus: A Randomised Controlled Trial

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Abstract

Aims: This study aimed to evaluate the impact of brief smoking cessation intervention on smoking cessation outcomes as well as on glycaemic and blood pressure control among patients with diabetes.

Methods: This was a randomised controlled trial involving patients with diabetes who smoked tobacco and attended the out-patient Diabetes Clinic at Penang Hospital in Malaysia. One hundred forty participants were randomised into either control (n = 70) or intervention (n = 70) groups. The intervention consisted of a 5-minute physician-delivered brief counselling on tobacco cessation using 5A's strategy (Ask, Advise, Assess, Assist, and Arrange) in addition to usual care for patients with diabetes, while the control group received only the usual care.

Results: There was no significant difference between the two groups with respect to glucose control, blood pressure levels, and smoking abstinence rates (P >0.05). Furthermore, significant main effects were found between the groups with respect to the number of cigarettes smoked per day (F [1,116] = 6.306).

Conclusions: Brief smoking cessation intervention did not result in better abstinence rates or glycaemic control in patients with diabetes. However, it resulted in reduction in the number of cigarettes smoked per day over the study period (6 months), which is the first step in the tobacco cessation process.

Trial registration

Approval for the conduct of this study was granted by the Medical Research Ethics Committee of the Ministry of Health, Malaysia and the Clinical Research Centre at Hospital Pulau Pinang, Malaysia (NMRR-11-477-9538) at (05-10-2011).

Background

Smoking tobacco is considered as an avoidable cause of morbidity and premature mortality worldwide (1). In recent years, there has been an alarming increase in the prevalence of diabetes mellitus worldwide as well as in Malaysia (2). The association between tobacco smoking and diabetes is becoming increasingly important. Several studies have reported the association between tobacco smoking and poor glycaemic control and that smoking increases morbidity and mortality among patients with both type 1 and 2 diabetes (3–8). Furthermore, smokers had twice the risk for developing diabetes than non-smokers (9). A meta-analysis and systematic review identified an association between active tobacco smoking and diabetes mellitus (10). Quitting tobacco reduces mortality risks among patients with diabetes within several years after quitting (11). Therefore, tobacco cessation is strongly recommended to improve glycaemic control and to slow the development of diabetic complications (1, 12). The International Diabetes Federation guidelines for type 2 diabetes included tobacco cessation advice as a standard of care to reduce or stop tobacco consumption (2, 13). This intervention is anticipated to improve clinical outcomes of diabetes care and ultimately quality of life. Despite the importance of improving glycaemic control and screening for microvascular complications, it may be even more important to detect major macrovascular risk factors and control them.

Previous studies have investigated the effectiveness of tobacco cessation interventions among patients with diabetes who smoke (9, 14–21). The major limitations of these studies included, but are not limited to, some are not RCT some small sampling, some inconclusive results. Moreover, most studies focused on evaluating the effectiveness of the interventions on smoking cessation outcomes such as smoking abstinence rate, and number of cigarettes smoked per day, but rarely investigated the impact of the interventions on diabetes control. Consequently, rigorous studies are needed to evaluate the effect of structured tobacco cessation interventions tailored to patients with diabetes on both smoking and diabetes-related outcomes. Previous tobacco cessation intervention studies in other disease conditions such as tuberculosis (TB) (22–25) and chronic obstructive pulmonary disease (COPD) have shown the benefits of brief counselling delivered by healthcare professionals on smoking and disease-related outcomes (26, 27). This study aimed to evaluate the impact of a physician-delivered disease-specific brief tobacco cessation intervention in diabetes care on quitting rate, the number of cigarette smoked per day, glycaemic control, blood pressure (BP), and lipid profile. The individually-tailored intervention aimed at helping patients with diabetes who smoke to quit smoking.

Methods

Study design and participants

A randomized controlled trial was carried out and involved patients with diabetes who smoked tobacco and who attended the out-patient Diabetes Clinic at Penang Hospital in Malaysia. Randomly participants were assigned into one of the two study groups: control group who received routine diabetes care counselling or intervention group who received diabetes-specific brief tobacco cessation counselling in addition to the routine diabetes care counselling. Figure 1 illustrates the study design. The study was conducted between March 2012 and August 2013. Each patient was followed for three sequential visits. The medical records of the patients included in the study were prospectively reviewed for the laboratory data.

Patients were included into the study if they: (1) have a documented diagnosis of type 1 or type 2 diabetes mellitus; (2) were currently smoking tobacco (have smoked at least 100 cigarettes during lifetime and have smoked within the last month) and; (3) could speak English and/or Malay.

Sample size and sampling method

The sample size needed for the RCT study was calculated using the equation below (28):

$$m = C \times \frac{\pi_1(1-\pi_1) + \pi_2(1-\pi_2)}{(\pi_1 - \pi_2)^2}$$

where C = 7.9 for 80% power, π_1 and π_2 are the proportions of the primary outcome measure in the intervention and control groups which were estimated from the literature (14). The minimum estimated

sample size for each group was ~ 48 patients. The sample size per group was increased by 30%, resulting in 67 patients. This study enrolled 70 eligible patients per group to compensate for patients lost to follow-up and non-response.

Randomisation

Participants were randomly assigned to intervention or control groups using a computer-generated allocation method.

Description of the brief tobacco cessation intervention program for patients with diabetes

The tobacco cessation protocol consisted of performing a routine assessment (asking) for tobacco use; providing advice on the importance of quitting; performing an assessment of the tobacco user's readiness to quit; assisting in setting a quit date; and making arrangements for follow-up visits (29). This protocol is popularly known as the 5A's strategy. The intervention in this study was delivered by physicians (who provided diabetes care to the participants) and nurses who assisted during follow-up and monitoring. The physicians were specially trained on providing tobacco cessation intervention and were supported by a booklet that provided specific information on counselling, which was adapted from tobacco cessation guidelines. Patients were counselled during each routine visit to the endocrine clinic (which should be every 3 to 4 months) (29, 30).

Outcome measures

The primary outcome that was measured in every visit (every 3 to 4 months) included mean glycated haemoglobin (HbA1c), abstinence rates, and the mean number of cigarette smoked per day. The secondary outcome measures included blood pressure and lipid profile. Smoking cessation was validated using breath carbon monoxide (CO) test as a biochemical measure. A breath carbon monoxide (CO) monitor called Smokerlyzer piCO + was used to verify smoking cessation (31).

Data analyses

The collected data were analysed using SPSS (version 18.0) software package (SPSS Inc., Chicago, IL). Descriptive and inferential statistics were used as appropriate. To determine the differences between the intervention and the control groups with respect to outcome measures (HbA1c, number of cigarette smoked per day, BP, lipid profile, CO level), the independent t-test, Mann-Whitney U test and Pearson's chi-square test were used as appropriate. To determine the differences between the control and intervention groups in repeated time points, a mixed ANOVA test was applied (32, 33). P-value ≤ 0.05 was considered statistically significant.

Results

A total of 140 patients with diabetes who smoke tobacco were initially enrolled in the study. However, 14 were lost to follow-up due to several reasons: seven patients relocated from Pulau Pinang, two died, three withdrew from participating, and two were excluded due to incomplete data. Thus, 126 participants (X

number of participants in the intervention group and Y number of participants in the control group) were included in the analyses. Male participants represented the majority (95%) of them. Approximately 41% of the participants were Malay and the rest of them were Chinese and Indian.

Table 1 demonstrates that a non-significant difference between patients in the two groups was observed with respect to their glucose control (HbA1c) and the BP levels (systolic and diastolic BP). In general, a high mean HbA1c level was observed in the two groups over the three visits based on the Malaysian Clinical Practice Guideline for normal values reference (7–9% fair control) (34). However, the BP of the patients in both groups was well controlled throughout the study period (< 130/80 mmHg) and was within the normal range of BP as determined by the Malaysian Clinical Practice Guidelines 2004 for normal values reference (34) (Table 1). However, a significant difference was observed in the number of cigarettes smoked per day between the two groups during the first two visits (intervention was better than the control group) (Table 1), but this difference was not significant in their last visit.

Table 1 presents the mean level of CO as ppm and the % CO Hb, which stratifies the study participants as low-frequency smokers or smokers according to the manufacturer's (Bedfont) guide. No significant differences were noted between patients in the two groups during the first two visits with respect to CO level. During the third visit, the control group had significantly lower CO concentration compared with the intervention group (9.2 ± 6 ppm vs. 11.8 ± 6.9 ppm; $p = 0.032$). Quitting rate is defined as the proportion of patients who achieved success in quitting smoking tobacco at their second and/or last visit. There was no significant difference between the two groups in terms of abstinence rate at 6 months. However, the proportion of patients who reduced their cigarette consumption in both groups was considered favourable. Table 1 demonstrates a non-significant difference between patients in the two groups with respect to their lipid profile (TG, LDL, HDL, and total cholesterol). Among the intervention group the number of cigarettes smoked per day, systolic BP and diastolic BP revealed a significant difference between baseline and the last visit.

Table 1
Outcome measures for tobacco cessation intervention among patients with diabetes

Item	Intervention group (n = 63) Mean ± SD	Control group (n = 63) Mean ± SD	*P* Value
HbA1c (%)			
First visit (baseline)	8.6 ± 2.6	8.8 ± 2.5	0.427**
Second visit	8.4 ± 2	8.6 ± 2.3	0.819**
Third visit	8.8 ± 2.5	8.7 ± 2.4	0.762*
Systolic BP (mmHg)			
First visit (baseline)	126.4 ± 15.3	127.9 ± 29	0.270**
Second visit	123.6 ± 16.1	124.5 ± 25.8	0.641**
Third visit	120.8 ± 23.1	124.3 ± 24.4	0.304**
Diastolic BP (mmHg)			
First visit (baseline)	75.6 ± 8.1	76.1 ± 13.2	0.809*
Second visit	73.5 ± 13.3	73.9 ± 14.1	0.866*
Third visit	71.1 ± 8.5	72.2 ± 15.4	0.152**
No. of cigarettes/day			
First visit (baseline)	16.51 ± 9.7	12.81 ± 9.2	0.009 (S)**
Second visit	12.97 ± 9.3	9.05 ± 7.4	0.005 (S)**
Third visit	11.03 ± 8.8	8.83 ± 7.4	0.120 **
CO level, ppm			
First visit (baseline)	12.8 ± 9.7	11.1 ± 7.7	0.271*
Second visit	10.5 ± 5.8	11.8 ± 11.5	0.477**
Third visit	11.8 ± 6.9	9.2 ± 6	0.032 (S)*
CO level, Hb			
First visit (baseline)	2.6 ± 1.6	2.4 ± 1.2	0.282*
Second visit	2.3 ± 0.9	2.5 ± 1.8	0.426**

CO ppm: carbon monoxide level in parts per million; CO Hb: carbon monoxide level in the haemoglobin; TG: triglycerides; HDL: high-density lipoprotein; LDL: low-density lipoprotein.**P* values were calculated using the independent t-test and were significant (S) at < 0.05.***P* values were calculated using the Mann-Whitney U test and were significant (S) at < 0.05.****P* values were calculated using Pearson's chi-square test and were significant (S) at < 0.05.

Item	Intervention group (n = 63) Mean ± SD	Control group (n = 63) Mean ± SD	*P* Value
Third visit	2.5 ± 1.1	2.1 ± 0.9	0.038 (S)*
Abstinence rate			0.934***
No change	31 (49.2)	33 (52.4)	
Reduced	28 (44.4)	26 (41.3)	
Quit	4 (6.3)	4 (6.3)	
TG (mmol/L)			
At baseline	2 ± 1.2	2.4 ± 3.4	0.631**
Third visit	2 ± 1	2.2 ± 1.8	0.631**
HDL (mmol/L)			
At baseline	1.1 ± 0.3	1.1 ± 0.3	0.398**
Third visit	1.1 ± 0.3	1.1 ± 0.2	0.944**
LDL (mmol/L)			
At baseline	2.8 ± 0.9	3.1 ± 1.1	0.344
Third visit	2.7 ± 0.7	2.8 ± 1.3	0.605
Total cholesterol (mmol/L)			
At baseline	4.79 ± 0.9	5.1 ± 1.6	0.572**
Third visit	4.71 ± 0.9	4.8 ± 1.4	0.661**

CO ppm: carbon monoxide level in parts per million; CO Hb: carbon monoxide level in the haemoglobin; TG: triglycerides; HDL: high-density lipoprotein; LDL: low-density lipoprotein.**P* values were calculated using the independent t-test and were significant (S) at < 0.05.***P* values were calculated using the Mann-Whitney U test and were significant (S) at < 0.05.****P* values were calculated using Pearson's chi-square test and were significant (S) at < 0.05.

Table 2 illustrates the repeated measures effects expressed as F values: number of cigarettes smoked per day F (1.662, 192.768) = 41.736, systolic blood pressure F (2, 212) = 4.899, and diastolic blood pressure F (2, 212) = 9.108.

Table 2
Differences in the study outcome measures pre- and post- tobacco cessation intervention

Source Measure		Df	F	Sig.	Partial Eta-Squared
HbA1c	Huynh-Feldt	1.914	1.791	0.171	0.019
HbA1c*patient group	Huynh-Feldt	1.914	0.569	0.560	0.006
Error	Huynh-Feldt	176.104			
Systolic BP	Sphericity Assumed	2	4.899	0.008	0.044
Systolic BP*patient group	Sphericity Assumed	2	0.253	0.776	0.002
Error	Sphericity Assumed	212			
Diastolic BP	Sphericity Assumed	2	9.108	< 0.001	0.079
Diastolic BP*patient group	Sphericity Assumed	2	0.350	0.705	0.003
Error	Sphericity Assumed	212			
No. of cigarettes/day	Huynh-Feldt	1.662	41.736	< 0.001	0.265
No. of cigarettes/day* patient group	Huynh-Feldt	1.662	1.038	0.345	0.009
Error	Huynh-Feldt	192.768			
CO, ppm	Sphericity Assumed	2	1.448	0.237	0.013
CO, ppm, *patient group	Sphericity Assumed	2	3.021	0.051	0.027
Error	Sphericity Assumed	220			
TG	Sphericity Assumed	1	0.012	0.914	0.00
TG*patient group	Sphericity Assumed	1	0.543	0.463	0.006

The *P* value is significant (S) at < 0.05; BMI: body mass index; No. of cigarettes/day: number of cigarettes per day; HbA1c: glycated haemoglobin; Systolic BP: systolic blood pressure; Diastolic BP: diastolic blood pressure; LDL: low-density lipoprotein; HDL: high-density lipoprotein; TG: triglycerides; CO ppm: carbon monoxide level in parts per million; CO Hb: carbon monoxide level in the haemoglobin

Source Measure		Df	F	Sig.	Partial Eta-Squared
Error	Sphericity Assumed	86			
HDL	Sphericity Assumed	1	1.307	0.256	0.015
HDL*patient group	Sphericity Assumed	1	0.670	0.415	0.008
Error	Sphericity Assumed	84			
LDL	Sphericity assumed	1	1.077	0.302	0.013
LDL*patient group	Sphericity Assumed	1	0.233	0.630	0.003
Error	Sphericity Assumed	81			
Total Cholesterol	Sphericity Assumed	1	1.300	0.257	0.015
Cholesterol*patient group	Sphericity Assumed	1	0.528	0.469	0.006
Error	Sphericity Assumed	87			

The *P* value is significant (S) at < 0.05; BMI: body mass index; No. of cigarettes/day: number of cigarettes per day; HbA1c: glycated haemoglobin; Systolic BP: systolic blood pressure; Diastolic BP: diastolic blood pressure; LDL: low-density lipoprotein; HDL: high-density lipoprotein; TG: triglycerides; CO ppm: carbon monoxide level in parts per million; CO Hb: carbon monoxide level in the haemoglobin

Significant main effects were found among participants in the different groups with respect to the number of cigarettes smoked per day (Table 3) F (1,116) = 6.306).

Table 3
Differences between control and intervention groups in terms of the study outcome

Source	Df	F	Sig.	Partial Eta-Squared
No. of cigarettes/day (patient group)	1	6.306	0.013	0.052
Error	116			
HbA1c (patient group)	1	0.033	0.855	0.000
Error	92			
Systolic BP (patient group)	1	0.272	0.603	0.003
Error	106			
Diastolic BP (patient group)	1	0.429	0.514	0.004
Error	106			
CO, ppm (patient group)	1	0.792	0.376	0.007
Error	110			
CO, Hb (patient group)	1	0.589	0.445	0.005
Error	109			
TG (patient group)	1	0.032	0.859	0.000
Error	86			
LDL (patient group)	1	1.037	0.312	0.013
Error	81			
HDL (patient group)	1	0.056	0.813	0.001
Error	84			
Total Cholesterol (patient group)	1	0.611	0.437	0.007
Error	87			

The *P* value is significant (S) at < 0.05; BMI: body mass index; No. of cigarettes/day: number of cigarettes per day; HbA1c: glycated haemoglobin; Systolic BP: systolic blood pressure; Diastolic BP: diastolic blood pressure; LDL: low-density lipoprotein; HDL: high-density lipoprotein; TG: triglycerides; CO ppm: carbon monoxide level in parts per million; CO Hb: carbon monoxide level in the haemoglobin.

Discussion

Study results revealed a significant effect of the intervention throughout the study period among all participants with respect to the number of cigarettes smoked per day, however this effect was not significant but obvious in terms of blood pressure. Furthermore, differences between participants in the control and intervention groups in terms of the cigarettes smoked per day can be considered one of the

main findings of this stud. Despite randomisation of subjects into the groups, patients in the control group smoked less number of cigarettes and had lower CO level than those in the intervention group (Table 1). However, patients in the intervention group demonstrated improvements in these terms. Furthermore, we observed a clear decrease in the mean number of cigarettes smoked per day between the baseline and third visits as well as a significant difference between the two groups for first and second visits, and these results were confirmed by the multivariate longitudinal analyses. These results can direct future research in this setting. The decrease in the number of cigarettes smoked can enhance future quitting attempts and the success rate (35). Previous studies have reported conflicting results. For instance, a study conducted in Indonesia had reported a non-significant difference between the patient groups with respect to the number of cigarettes smoked (18). However, a study by Canga et al. (14) had demonstrated similar results with the current study in which the mean number of cigarettes between both groups showed significant differences in favour of the intervention group after 6 months (14).

We assume that smoking cessation is a major determinant of glycaemic control, in addition to other measures for diabetes management. Participants' glucose control did not differ over the study period within or between the groups. It is possible that the duration of the study follow-up was insufficient to reveal a clear difference in glycaemic control. In addition, this study relies on a brief cognitive behavioural therapy (CBT) only rather than combination of CBT and pharmacotherapy which has been shown to give better abstinence rate. Therefore, the present study utilized low-intensity intervention strategy witho only 5-minute brief smoking cessation advice delivered by the physician. However, a study by Hokanson and colleagues in 2006 revealed an improvement in the HbA1c level over the study period that may have been related to the long study period of approximately three years (17). Another study in France reported a significant decrease in the glycated haemoglobin level (16). Furthermore, participants' BP significantly improved over the study period, as confirmed by the repeated measures effects. As BP can exhibit changes faster than any other measure and many studies showed that sudden quitting can lead to an increment in the BP rather than decrement (36–39), however this study participants reduced the number of cigarette smoked rather than cut it down that aligned with BP improvement (40). The lack of differences between the two groups may relate to random patients' selection and not according to their willingness to stop tobacco smoking based on the transtheoretical model's stage of change. The Hokanson study yielded different results, as there were no differences in BP between the participants over the study period (17).

One limitation of the present study was the use of Smokerlyzer piCO + to measure the CO level for verification of tobacco cessation. This tool cannot be considered as accurate as urine cotinine, because patients can inhale environmental CO from other sources that may tend to give false-positive results. The patients' CO levels decreased over the study period, consistent with the decrease in the number of cigarettes smoked; however, these results were not significant based on inferential analyses. The higher CO level in the intervention group compared with the control group comes consistent with the higher number of cigarettes smoked by them. A significant proportion of patients exhibited a reduction in the number of cigarettes smoked, but the number of patients who succeeded in quitting was small. Furthermore, there was no difference in the quitting rate between the two groups, which may be the result of the short study period (6 months only), absence of NRT to boost the intervention effect and random selection of patients

in the two groups not according to their willingness to quit smoking. A randomised controlled trial in Spain reported opposite findings in the difference in the quitting rate between the two groups; the rate of quitting cessation was 7.5-fold higher in the intervention group than the control group (14). Another randomised controlled trial in Canada showed no differences between the intervention and control groups after 6 months, although there was a difference at the 3-month time point (17).

No significant differences were observed neither between patients in the two groups with respect to their lipid profile (TG, and LDL, HDL, and total cholesterol) and nor in their repeated measures over the study period. Although patients in the two groups exhibited improved total cholesterol after the study, the improvement was insignificant. To improve and identify differences in patients' lipid profiles, long-term studies would be required.

Conclusion

In conclusion, reduction in the number of cigarettes smoked per day over the study period is the first step in the tobacco cessation process. This study finding are the cornerstone for future studies in tobacco cessation interventions among patients with diabetes in Malaysia; future research with more intensive counselling and adjunct nicotine replacement therapy with it as well as following the participants for longer period is highly recommended.

Abbreviations

BP: blood pressure

CO: carbon monoxide

LDL: low density lipoprotein

HDL: high density lipoprotien

TG: triglycerides

RCT: randomised controlled trial

COPD: chronic obstructive pulmonary disease

5A's strategy: ask, advise, assess, assist, and arrange

HB: haemoglobin

HbA1c: glycated haemoglobin

Declarations

Ethics approval and consent to participate

Approval for the conduct of this study was granted by the Medical Research Ethics Committee of the Ministry of Health, Malaysia and the Clinical Research Centre at Hospital Pulau Pinang, Malaysia. All participants were agreed to participate and signed an informed consent form upon participation in the study. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable.

Availability of data and materials

All data generated during this study are included in this article and its supplementary information files.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Albaroodi K.A.I. set the study design, data collection, data analyses, reporting results and preparing the manuscript, Syed Sulaiman S.A. supervised the whole work, Awaisu A. participate in study design and preparing the manuscript, Shafie A.A. supervised data analyses. All authors read and approved the final manuscript.

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Figures

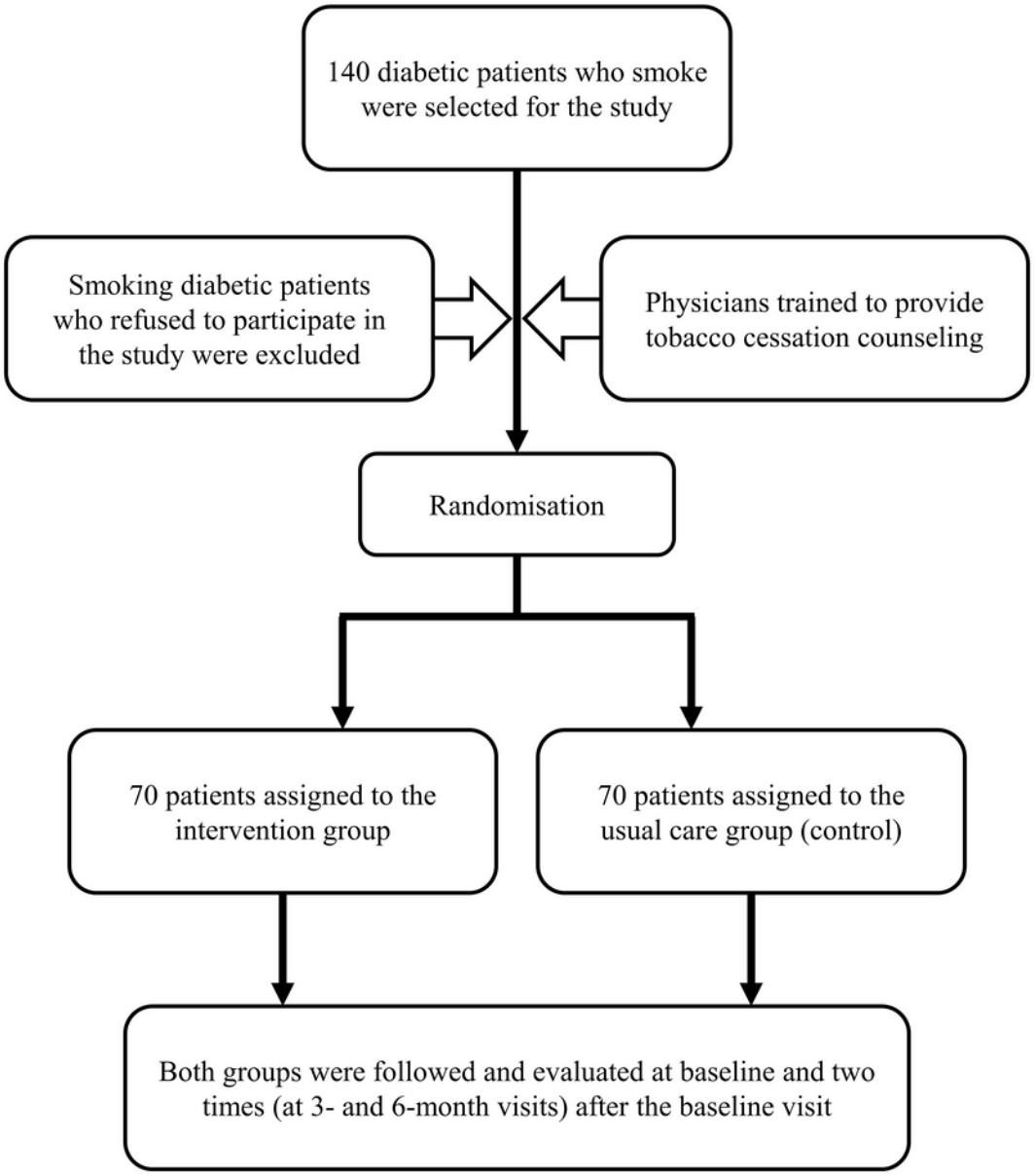

Figure 1

Study design

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