Chinese Herbal Medicine Tianqi Reduces Progression From Impaired Glucose Tolerance to Diabetes: A Double-Blind, Randomized, Placebo-Controlled, Multicenter Trial

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Context: Living in a prediabetes state significantly increases a patient's risk for both diabetes and cardiovascular disease. Tianqi capsule, containing 10 Chinese herbal medicines, is used in China for the treatment of type 2 diabetes mellitus (T2DM).

Objective: The purpose of this study was to assess whether Tianqi prevented T2DM in subjects with impaired glucose tolerance (IGT) over the course of a 12-month treatment.

Methods: Individuals with IGT were randomly allocated in a double-blind manner to receive Tianqi (n = 210) or a placebo (n = 210) for 12 months. Oral glucose tolerance tests were conducted every 3 months to assess the development of diabetes or restoration to normal glucose tolerance. All subjects received the same lifestyle education. The primary endpoint was the conversion of IGT to T2DM. Body weight and body mass index were observed. Adverse effects were monitored.

Results: Of the 420 enrolled subjects with IGT, 389 completed the trial (198 in the Tianqi group and 191 in the placebo group). At the end of the 12-month trial, 36 subjects in the Tianqi group (18.18%) and 56 in the placebo group (29.32%) had developed diabetes ($P = .01$). There was a significant difference in the number of subjects who had normal glucose tolerance at the end of the study between the Tianqi and placebo groups (n = 125, 63.13%, and n = 89, 46.60%, respectively; $P = .001$). Cox's proportional hazards model analysis showed that Tianqi reduced the risk of diabetes by 32.1% compared with the placebo. No severe adverse events occurred in the trial. There were no statistical differences in body weight and body mass index changes between the Tianqi group and the placebo group during the 12-month trial.

Conclusions: Treatment with a Tianqi capsule for 12 months significantly decreased the incidence of T2DM in subjects with IGT, and this herbal drug was safe to use. (***J Clin Endocrinol Metab* 99: 648–655, 2014**)

Prediabetes, including impaired glucose tolerance (IGT) and impaired fasting glucose, refers to a state in which the blood glucose level is higher than normal but does not meet the diagnostic criteria for diabetes mellitus (1, 2). IGT, defined as plasma glucose levels of 7.8–11.1 mmol/L measured 2 hours after a 75-g glucose load and a fasting plasma glucose (FPG) level greater than 7.0 mmol/L, is a major risk factor for type 2 diabetes mellitus (T2DM). In China, the overall prevalence of prediabetes is 15.5% (16.1% in men and 14.9% in women), with IGT

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Abbreviations: BMI, body mass index; BP, blood pressure; ESI, electrospray ionization; FPG, fasting plasma glucose; HbA1c, glycosylated hemoglobin; IGT, impaired glucose tolerance; LDL, low-density lipoprotein; NGT, normal glucose tolerance; OGTT, oral glucose tolerance test; T2DM, type 2 diabetes mellitus; UPLC, ultraperformance liquid chromatography.

being 2.5-fold more common than impaired fasting glucose (3). People with IGT have long been recognized to be at a substantially increased risk for both diabetes and cardiovascular disease. Approximately 90% of people with IGT progress to overt T2DM within 20 years in the absence of appropriate intervention, and half of the patients experience at least one myocardial infarction or stroke event (4). Thus, preventing the transition of IGT to T2DM represents an important approach in combating the T2DM pandemic.

Clinical studies have demonstrated that lifestyle interventions are effective for preventing the progression of IGT to diabetes. Study data have also indicated that insulin sensitizers, α-glucosidase inhibitors, and metformin can, to some extent, delay the development of diabetes. However, no published studies to date have described the role of traditional Chinese herbal medicines in this regard.

Tianqi capsule is a novel Chinese herbal medicine for the treatment of T2DM in China (5, 6). Manufactured by Heilongjiang Baoquan Pharmaceutical Co, this herbal drug consists of 10 Chinese herbal medicines, Astragali Radix, Coptidis Rhizoma, Trichosanthis Radix, Ligustri Lucidi Fructus, Dendrobii Caulis, Ginseng Radix, Lycii Cortex, Ecliptae Herba, Galla Chinensis, and Corni Fructus. The quality of these herbs and decoction preparation was in accordance with the Chinese Pharmacopoeia (2005). Previous studies have shown that astragalin, a constituent of Astragali Radix, possesses a glucose-lowering activity comparable with that of diformin (7, 8). Berberine, a constituent of Coptidis Rhizoma, was reported to improve glycemic parameters, including glycosylated hemoglobin (HbA1c) and FPG (9–11). Studies have also shown that ginsenoside Re, a constituent of Ginseng Radix, has significant antihyperglycemic effects (12–14), whereas iridosides, constituents of Corni Fructus, prevented diabetic vascular complications (15). Another Chinese herbal formulation, TM81, has been reported to be safe and effective in treating patients with T2DM (16).

In an early observational study of 300 patients with T2DM, 8 weeks of Tianqi treatment reduced HbA1c by 1.15% ± 1.58% and decreased blood glucose levels before and 2 hours after a meal (5). In addition, a good safety profile of Tianqi was observed. Chinese herbal medicine is often used in the prevention of different medical conditions. However, the effects of Tianqi in preventing the progression from IGT to T2DM have not been studied in a large-scale controlled trial. In this study, we performed a double-blind, randomized, placebo-controlled, parallel-group, multicenter trial to evaluate whether Tianqi capsule can prevent the progression of IGT to T2DM or restore normal glucose tolerance (NGT) in people with IGT.

Materials and Methods

The research protocol was approved by the local Medical Ethics Commission in China. Study subjects were recruited from 11 research sites in China between August 18, 2008, and March 5, 2010.

Subjects

Individuals who met all of the following criteria were eligible for this study: 1) had IGT with a 2-hour plasma glucose concentration of 7.8–11.1 mmol/L after a 75-g oral glucose tolerance test (OGTT) and fasting plasma glucose greater than 7.0 mmol/L (according to World Health Organization 1999 criteria); 2) aged 25–70 years; 3) had no history of using drugs to treat IGT; 4) had no participation in clinical trials within the 3 months before the study; and 5) signed the informed consent form.

Patients were excluded from the study if they met one of the following conditions: 1) had acute cardiocerebrovascular disease or myocardial infarction in the past 6 months; 2) were under severe stress or had secondary hyperglycemia; 3) were unable to adhere to the control diet or showed poor compliance; 4) had evidence of mental disorders; 5) females who were pregnant, lactating, planning for pregnancy, or sexually active but with no contraceptive measures; 6) had allergies to Tianqi or its constituents; 7) had other endocrine disorders or severe primary diseases; 8) had systolic blood pressure (BP) of 160 mm Hg or greater and diastolic BP of 100 mm Hg or greater; or 9) had serum total cholesterol of 6.22 mmol/L or greater (240 mg/dL) or low-density lipoprotein (LDL) cholesterol of 4.14 mmol/L or greater (160 mg/dL).

There were 804 subjects who participated in the initial screening, and 480 subjects were recruited as having IGT after a standardized 75-g OGTT. Informed consent was obtained from each study subject.

Based on the literature, under the lifestyle intervention, the conversion rate from IGT to NGT was approximately 30% (17–19). Under the lifestyle education, our pilot observations using the test herbs and a report using Chinese herbal medicine (20) showed that the conversion rate was approximately 46%. Thus, we needed to enroll 155 subjects per group to ensure an 80%

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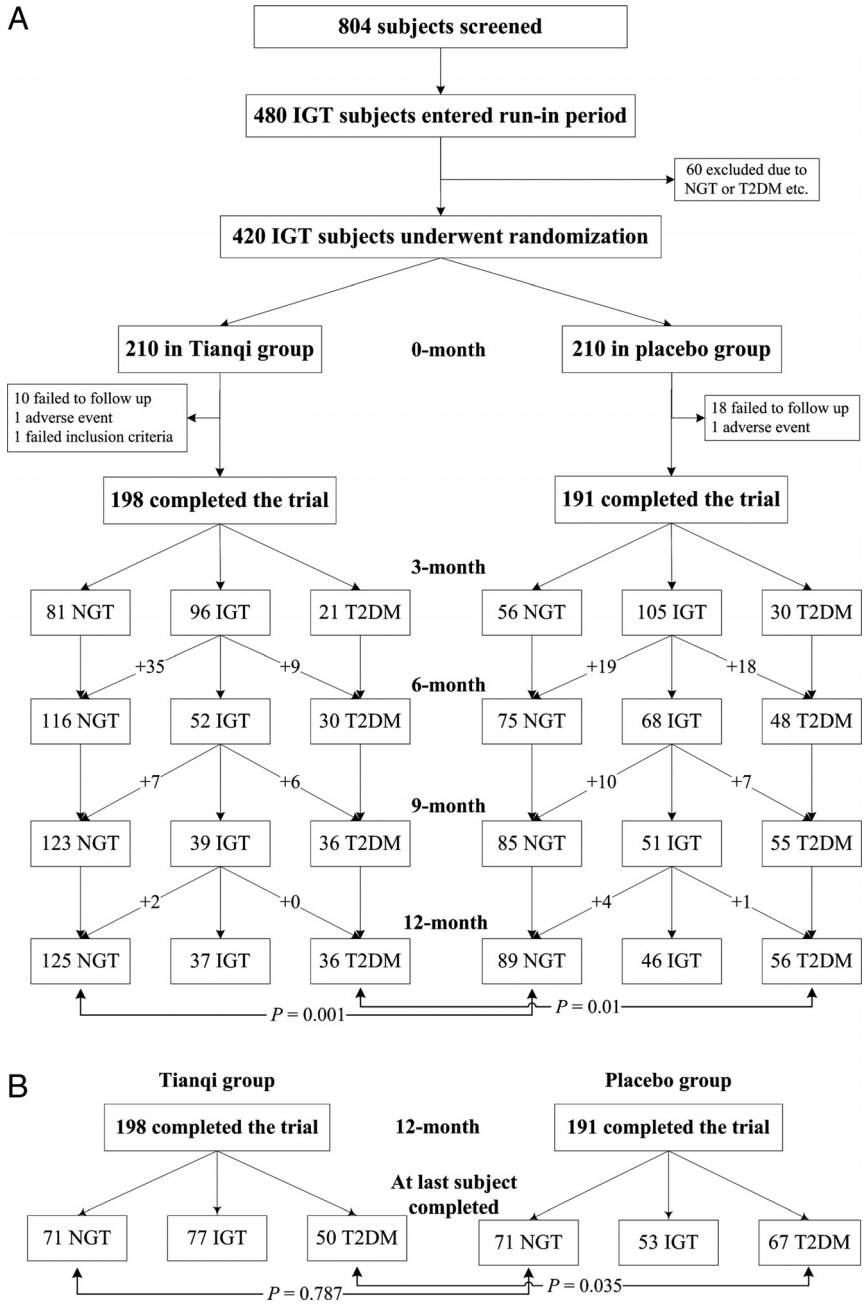

Figure 1. Progression of IGT in both Tianqi and placebo groups (A), and when last subject completed the study (B).

power to detect that the drug group has a significantly better conversion rate than the that of control group with lifestyle education. Considering factors such as dropouts, 210 subjects were recruited per group (Figure 1).

Run-in period

The 480 subjects received 1 month of lifestyle education. They were then asked to complete another OGTT to confirm their IGT status. The lifestyle education did not intensely interfere with the subjects' lives, and after this washout period, a total of 420 subjects remained eligible and enrolled in the study. These subjects were subsequently randomized to receive either Tianqi or placebo (Figure 1).

Lifestyle guidance

Dietary education consisted of advice on maintaining a balanced and reasonable diet. The intervention education included two face-to-face counseling sessions with certified nutritionists. The daily caloric requirements were calculated based on the individual subject's height, weight, and physical activities. A daily diet was selected based on clinical nutritional requirements using the Chinese Food Composition Table or Food Serving Exchange Table. The subjects were also asked to maintain their usual patterns of physical exercise and to continue normal daily lifestyles throughout the trial. Additional counseling sessions were held at 3 months, 6 months, and 9 months to ascertain that subjects followed the lifestyle guidance, or the subject would be excluded from the study.

Study medication

The Tianqi capsules, manufactured by Heilongjiang Baoquan Pharmaceutical Co, were used. The placebo, which contained sugar-free starch and medicinal yellow iron oxide, was also supplied by the same manufacturer. The color, odor, shape, and packaging of the placebo capsules were exactly the same as those of the Tianqi capsules. The study drugs were supplied by the manufacturer free of charge, but the manufacturer was not involved in the design and analysis of the study.

Chemical analysis of Tianqi capsules

The chemical composition of Tianqi capsules was analyzed using an ultraperformance liquid chromatography(UPLC)/mass spectrometry method. The UPLC system was a Waters ACQUITY instrument, with a Waters Synapt high-definition mass spectrometry system, and MassLynx version 4.1software for peak identification and integration. The separation was carried out on a Waters HSS T3 column (1.8 μ, 100 $\times$ 2.1 mm inner diameter). For UPLC analysis, a 5-μL test sample was injected into the column and eluted at 45°C with a constant flow rate of 0.5 mL/min. Water with 0.1% formic acid (solvent A) and acetonitrile with 0.1% formic acid (solvent B) were used. Gradient elution started with 99% solvent A and 1% solvent B, changed to 90% A for 1 minute, then to 75% A for 3 minutes, to 73% A for 2 minutes, to 20% A for 9 minutes, to 10% A for 3.5 minutes, and to 1% A for 0.5 minutes. The detection wavelength was set to 202 nm.

Chemical standards and Tianqi capsule powder were dissolved in methanol. All solutions were filtered through Millex 0.22-μm nylon membrane syringe filters before use. Magnoflo-

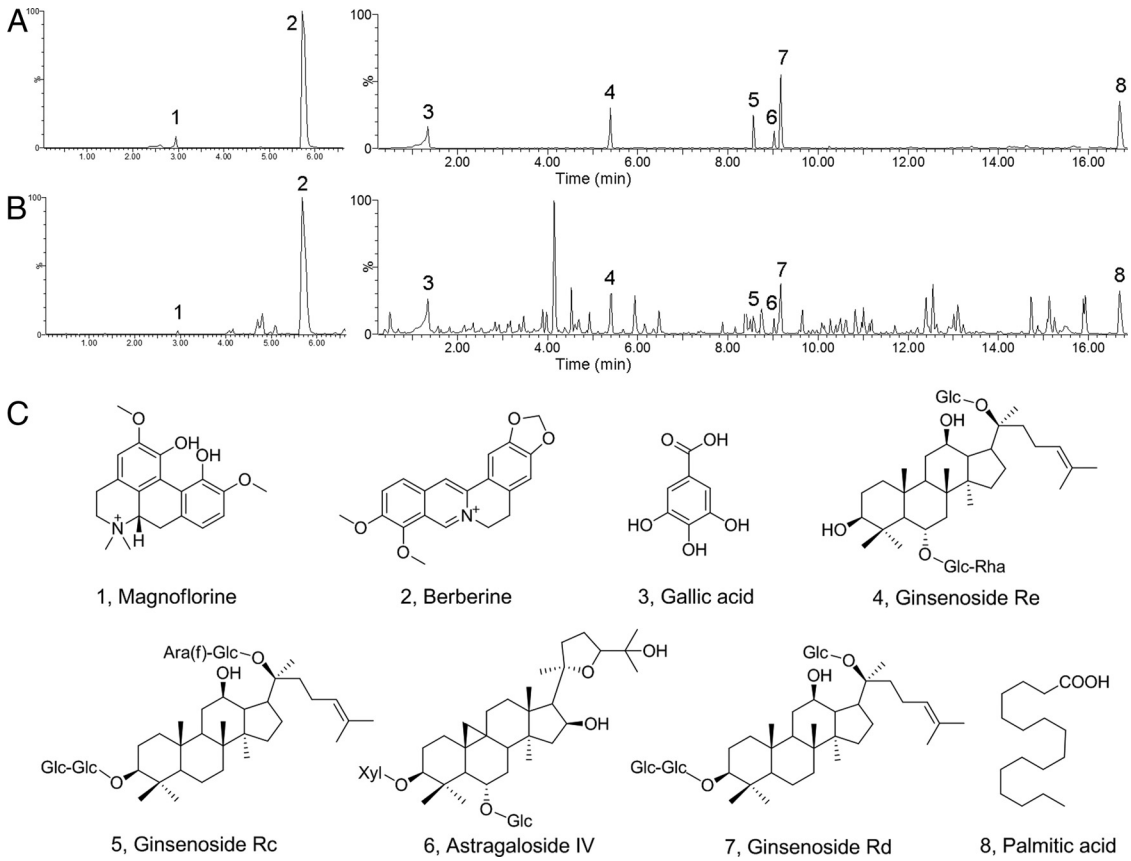

Figure 2. UPLC mass spectrometry analysis of Tianqi capsules. Representative total ion current (TIC) chromatograms of eight standards (A) and Tianqi capsules (B) is shown. Compound peaks include the following: 1, magnoflorine; 2, berberine; 3, gallic acid; 4, ginsenoside Re; 5, ginsenoside Rc; 6, astragaloside IV; 7, ginsenoside Rd; and 8, palmitic acid. Compounds 1 and 2 were monitored using the ESI-positive ion mode; compounds 3–8 were monitored using the ESI-negative ion mode. C, Chemical structures of assayed compounds in Tianqi capsules.

rine and berberine were determined using the electrospray ionization (ESI) positive ion mode, whereas gallic acid, astragaloside IV, palmitic acid, ginsenosides Re, Rc, and Rd were determined using ESI-negative ion mode. These compounds were used as the quality control markers in the Tianqi capsules. The contents of the eight compounds in the capsules were calculated using standard curves of corresponding standards. Representative chromatograms of standards and tested drug and chemical structures of marker compounds are shown in Figure 2. The contents of these marker compounds in the Tianqi capsules were as follows: magnoflorine (0.04 ± 0.01 mg/g), berberine (2.14 ± 0.07 mg/g), gallic acid (21.39 ± 0.12 mg/g), astragaloside IV (0.07 ± 0.01 mg/g), palmitic acid (3.55 ± 0.08 mg/g), ginsenosides Rc (0.31 ± 0.01 mg/g), Rd (0.60 ± 0.02), and Re (0.25 ± 0.01).

Intervention and efficacy evaluation

The subjects were randomly allocated to receive either Tianqi or the placebo in capsulated forms for 12 months. Subjects in both the Tianqi and placebo groups were orally administered five capsules (1.6 g) three times daily before each meal.

The Tianqi or placebo treatment lasted 12 months. During this 12-month period, subjects were assessed every 3 months by undergoing a standard 75-g OGTT. The primary endpoint was the progression of IGT to T2DM over 12 months, based on changes in FPG and the results of 2-hour OGTT. Body weight and body mass index (BMI) were also monitored. Liver and kidney functions, routine blood and urine tests, and electrocardiograms were examined as safety indicators before and after the intervention. If a subject had confirmed diabetes (with a repeated OGTT in 1 week) at any 3-month interval, the individual was instructed to take the appropriate antihyperglycemic medications. Conversely, if a subject showed restored NGT or continuous IGT at any visit, the individual was instructed to continue their study medications.

Randomization and blinding

A stratified, block randomization method was conducted by the study center. Study drugs were packed and numbered according to the random coding form and randomly allocated to each research site using concealed opaque envelopes. These envelopes and case report forms were not collected until the end of the trial. Study drugs were provided based on the assigned numbers, which were determined according to the visit sequence and study drug number sequence, and remained unchanged throughout the trial. Independent statisticians performed the data analysis (Peking University Health Science Center and China-Japan Friendship Hospital, China).

Safety monitoring

Based on previous reported clinical trial and our pilot study using multiple Tianqi doses, observational human experience has indicated that the test herbal medication was well tolerated and not associated with any safety issues. We thus considered the

overall level of risk of the clinical study to be low. During the study, all adverse experiences were monitored and recorded on the case report form with special notes made on time of onset and resolution, severity, and the investigator's analysis of the relationship between the adverse experience and the test drug. The safety procedures were also in place when the proposal was approved by the local Medical Ethics Commission in China. A Data and Safety Monitoring Board was formed including physicians experienced in this research area and a biostatistician. The board was responsible for oversight all issues related the safety of the study subjects.

Statistical analysis

Data entry was completed twice by two staff members using Epidata software. Continuous variables were summarized as means ± SD, and categorical data were presented as frequencies. Data were analyzed using two-sided tests and Cox's regression model. χ^2 tests were used to compare the incidence of adverse events between the two groups. The level of statistical significance was set at $P < .05$.

Results

Subject characteristics

There were 804 subjects who participated in the initial screening and 480 subjects were recruited as having IGT. Sixty subjected were excluded after the run-in period due to NGT, T2DM, or other reasons. Of the 420 subjects with IGT who entered the randomization, 389 subjects completed the study including 198 in the Tianqi group and 191 in the placebo group. The remaining 31 subjects (n = 12 in the Tianqi group and n = 19 in the placebo group) dropped out of the study, mainly due to lack of follow-up, and one subject per group had mild adverse reactions (Figure 1).

The baseline clinical characteristics of the subjects are shown in Table 1. The mean BMI in both the Tianqi and placebo groups was 25 kg/m^2. More than half of the subjects had elevated triglyceride, total cholesterol, and LDL levels, whereas their BP was in the normal range. There were no significant differences at baseline in subjects' age, gender, FPG, 2-hour plasma glucose, lipid levels, BP, heart rate, BMI, and waist circumference between the two groups.

Table 1. Subject Characteristics at the Baseline

	Tianqi Group (n = 210)	Placebo Group (n = 210)	*P* Value
Age, y	52.95 ± 10.06	51.86 ± 10.16	.38
Sex, male/female	98/112	106/104	.44
FPG, mmol/L	6.11 ± 0.59	6.10 ± 0.56	.93
2-Hour PG, mmol/L	9.07 ± 0.96	9.24 ± 0.98	.07
Triglycerides, mmol/L	1.86 ± 1.40	1.95 ± 1.17	.44
Total cholesterol, mmol/L	4.89 ± 0.92	5.04 ± 0.99	.08
HDL, mmol/L	1.29 ± 0.38	1.32 ± 0.35	.61
LDL, mmol/L	2.84 ± 0.73	2.95 ± 0.84	.14
SBP, mm Hg	123.79 ± 12.80	123.63 ± 11.51	.77
DBP, mm Hg	77.40 ± 8.11	77.67 ± 7.60	.73
Heart rate, min	73.63 ± 7.07	72.62 ± 7.19	.12
BMI, kg/m^2	25.15 ± 3.07	25.50 ± 2.66	.25
Waist circumference, cm	87.85 ± 9.43	88.73 ± 8.57	.29

Abbreviations: 2-hour PG, 2-hour postload plasma glucose; HDL, high-density lipoprotein cholesterol; SBP, systolic BP; DBP, diastolic BP. Data are presented in mean ± SD.

Effects of Tianqi on glucose tolerance status

For each subject, the effects of Tianqi were evaluated at the end of the 12-month test drug administration. In addition, the effects of also were evaluated at the time point when the last subject completed the study. Thus, the effects on subjects after drug treatment were also to be evaluated.

At the end of the 12-month trial, 36 subjects in the Tianqi group (18.18%) and 56 in the placebo group (29.32%) had developed diabetes ($P = .01$). There was a significant difference in the number of subjects who had NGT at the end of the study between the Tianqi and placebo groups (n = 125, 63.13%, and n = 89, 46.60%, respectively; $P = .001$) (Figure 1A). The annual incidence of diabetes was 283.68 per 1000 person-years in the Tianqi group vs 424.72 per 1000 person-years in the placebo group. The Cox's proportional hazards model analysis showed that Tianqi reduced the risk of diabetes by 32.1% compared with the placebo (hazard ratio 0.679; 95% confidence interval 0.471–0.979), after adjusting for age and sex (Figure 3).

From the 11 study sites, obtained data generally distributed uniformly across the various sites. At the end of the 12-month trial, the number of subjects who had developed diabetes between the Tianqi and placebo groups, in range (mean), was 13.79%–25.00% (18.18%) and 26.67%–35.71% (29.32%), respectively. In addition, the number of subjects who had NGT at the end of the study between the Tianqi and placebo groups was 56.25%–68.97% (63.13%) and 42.80%–50.00% (46.60%), respectively.

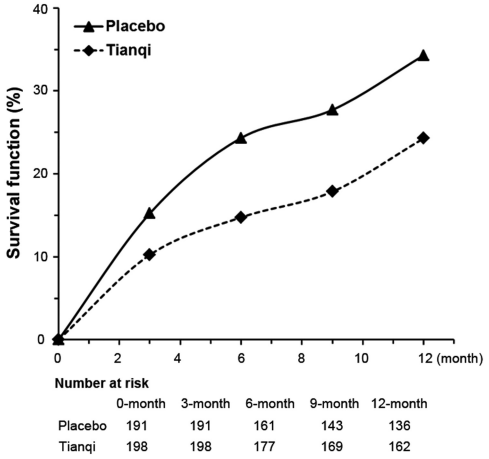

Figure 3. Percentage progression from IGT to type 2 diabetes in subjects treated with Tianqi or placebo for 12 months.

As shown in Figure 1B, when the last subject completed the study, 50 subjects in the Tianqi group (25.25%) and 67 in the placebo group (35.08%) still remained diabetic ($P = .035$). However, there were 71 subjects in the Tianqi group (35.68%) and 71 in the placebo group (37.17%) who remained in NGT ($P = .7878$).

Effects of Tianqi on body weight and BMI changes

At 0, 6, and 12 months, the body weight in the Tianqi group (n = 198) and the placebo group (n = 191) were 67.86 ± 9.94, 67.69 ± 10.24, and 67.6 ± 10.18 kg and 69.26 ± 10.31, 69.04 ± 9.85, and 69.17 ± 9.78 kg, respectively. At 0, 6, and 12 months, the BMI in the Tianqi group (n = 198) and the placebo group (n = 191) were 25.13 ± 3.02, 25.04 ± 3.00, and 25.01 ± 2.96 and 25.52 ± 2.64, 25.45 ± 2.72, and 25.5 ± 2.70, respectively. There were no statistical differences in body weight and BMI changes between the two groups at any of these time points.

Safety and adverse events

Safety indicators are shown in Table 2. The table also shows that 26 subjects in total (15 in the Tianqi group and 11 in the placebo group) experienced adverse events, all of which were mild adverse reactions (grades 1–2). Gastrointestinal reactions, such as nausea, flatulence, constipation, and diarrhea, were the most common. These gastrointestinal events occurred in 15 subjects (n = 6 in Tianqi group and n = 9 in placebo group). In addition, in the Tianqi group, one subject experienced a skin rash and another subject experienced tinnitus. In the placebo group, one subject experienced genital swelling and another subject experienced elevated urinary protein (Table 2). No severe adverse events occurred in the trial.

Discussion

Compared with people without T2DM, patients with diabetes have a remarkably higher prevalence of complications and a higher mortality rate. Without intervention, individuals with IGT can develop T2DM. The prevalence of diabetes in China has reached 9.7% among people older than 20 years of age or 92 million people, and more than 100 million Chinese individuals have IGT (3, 4).

Several large-scale studies have demonstrated that improvements in unhealthy lifestyles or use of some antidiabetic drugs can effectively prevent diabetes. It was also reported that the lowering of BMI through dietary changes and increased physical exercise decreases the risk of diabetes among people with IGT by approximately 50%. A study that followed up residents of Daqing, China, for 20 years observed that group-based lifestyle interventions lasting more than 6 years could prevent or delay diabetes for up to 14 years after the initial intervention (4, 21). Of note, subjects who received the intervention spent a mean of 3.6 fewer years with diabetes than those who did not receive the lifestyle intervention. Clearly, effective lifestyle interventions are necessary for people with IGT.

Pharmacotherapies for IGT consist mainly of antidiabetic and antiobesity medications, which are shown to prevent or delay the progression of IGT to T2DM in sev-

Table 2. Safety Indicators and Adverse Events in Both Tianqi and Placebo Groups

	Tianqi (n = 210)	Placebo (n = 210)	Total (n = 420)	*P* Value
Safety indicators				
SBP, mm Hg	124.06 ± 9.81	123.31 ± 9.93		.45
DBP, mm Hg	77.46 ± 6.72	76.97 ± 7.24		.49
Heart rate, min	72.63 ± 5.93	72.99 ± 5.97		.55
BUN, mmol/L	5.35 ± 0.90	5.69 ± 1.10		.15
CR, μmol/L	70.28 ± 18.55	68.74 ± 17.80		.69
ALT, U/L	22.47 ± 6.62	24.87 ± 8.98		.19
AST, U/L	23.71 ± 12.18	22.66 ± 8.51		0.66
Adverse events				
Gastrointestinal reactions	6 (2.85%)	9 (4.28%)	15 (3.57%)	
Rash	1 (0.48%)	0	1 (0.24%)	
Weakness	1 (0.48%)	0	1 (0.24%)	
Weight loss	1 (0.48%)	0	1 (0.24%)	
Frequent urination	1 (0.48%)	0	1 (0.24%)	
Tinnitus	1 (0.48%)	0	1 (0.24%)	
Genital swelling	0	1 (0.48%)	1 (0.24%)	
Elevated blood white blood cell	1 (0.48%)	0	1 (0.24%)	
Decreased hemoglobin	1 (0.48%)	0	1 (0.24%)	
Elevated urine white blood cell	2 (0.95%)	0	2 (0.48%)	
Elevated urinary protein	0	1 (0.48%)	1 (0.24%)	
Total	15 (7.14%)	11 (5.24%)	26 (6.19%)	

Abbreviations: ALT, aminotransferase; AST, aspartate aminotransferase; BUN, blood urea nitrogen; CR, creatinine; DBP, diastolic BP; SBP, systolic BP.

eral large-scale clinical trials, including Study to Prevent Non-Insulin-Dependent Diabetes Mellitus and Diabetes Prevention Program. Treating diabetes with Chinese herbal medicines is popular in China, particularly in the rural areas. Clinical trials have revealed that some traditional herbal medicines can control blood glucose levels and therefore have systemic benefits in patients with diabetes (22–26). However, controlled clinical trials have not been conducted to evaluate whether Chinese medicines are useful for the prevention of diabetes.

In the present controlled trial, we used a Chinese herbal medicine to prevent the transition from prediabetes to diabetes. To our knowledge, this was the first controlled trial to examine the efficacy of Chinese medicines among individuals with IGT. We observed that the Chinese herbal formulation Tianqi effectively delayed the progression from IGT to diabetes. The overall reduction in risk for diabetes over 12 months was 32.1%, which was less than that achieved by rosiglitazone in the Diabetes Reduction Assessment with Ramipril and Rosiglitazone Medication study (62%) (24, 27) and pioglitazone (72%) (28), but it was similar to that achieved by acarbose (25%) (29) and metformin (31%) (17, 30, 31). Our data also showed that after a period of cessation of the Tianqi treatment, the preventive effects on T2DM development remained significant.

Due to adverse effects, no pharmacotherapies are widely used in IGT subjects to prevent T2DM. In fact, long-term administration of acarbose or metformin is often associated with unfavorable gastrointestinal events. The Tianqi capsule, on the other hand, was generally safe and well tolerated in the present study. Preclinical acute toxicity studies showed that the dose of Tianqi used in this study was greater than 500-fold less than the toxic dose. Long-term toxicity experiments in Wistar rats also showed that continuous feeding with Tianqiat high doses for 6 months did not significantly affect body weight, complete blood count, or liver or kidney functions. In the current study, the adverse reactions associated with Tianqi were generally similar to those of the placebo, and no severe adverse events occurred, which suggested that this herbal drug is safe to use. Although the results of the present study need to be confirmed in future larger clinical trials, Tianqi holds promising potential as an effective and practical means to prevent T2DM, particularly in places in which herbal medicines are culturally accepted and widely used.

Our study had some limitations, such as the 12-month study period, which was relatively short. Due to limited research funding availability, plasma insulin levels and HbA1c were not able to be measured. Our data require further verification in interventional studies with a larger sample size and longer length of treatment and follow-up.

In summary, the Tianqi capsule effectively reduced the incidence of diabetes in Chinese prediabetes subjects with IGT. This Chinese herbal medicine may help prevent diabetes in individuals who are at high risk of developing T2DM.

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This clinical trial, with the number of ISRCTN90063632 is registered at www.ISRCTN.org.

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