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SHORT COMMUNICATION

Lifestyle modification intervention improves glycemic control in Mongolian adults who are overweight or obese with newly diagnosed type 2 diabetes

S. Sonomtseren[1], Y. Sankhuu[2], J. D. Warfel[3], D. L. Johannsen[3], C. M. Peterson[3] and B. Vandanmagsar[3]

Department of Endocrinology, School of Medicine, National University of Medical Sciences, Ulaanbaatar, Mongolia; Department of Endocrinology, State Central Clinical Hospital, Ulaanbaatar, Mongolia; Pennington Biomedical Research Center, Louisiana State University System, Baton Rouge, LA, USA

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Address for Correspondence:
B Vandanmagsar, Ph.D., Pennington Biomedical Research Center, Louisiana State University System, 6400 Perkins Road, Baton Rouge, LA 70808, USA. E-mail: vandanb@pbrc.edu

Summary

Objective

To evaluate the effectiveness of a weight loss intervention in Mongolian adults with newly diagnosed type 2 diabetes mellitus and with BMIs $\geq 25.0\ kg/m^2$.

Methods

Eighty participants (33 men/47 women) aged 32–56 years old received education sessions to improve nutritional habits and increase physical activity. Participants were counselled in-person on two occasions with regular follow-up by phone to eat less (reduce calorie intake by 30–40% and consume fewer fatty foods), shift food intake to earlier in a day and increase physical activity such as walking, jogging, running and biking. Measurements were performed before and after the 6-month intervention.

Results

After 6 months, the average weight loss was 4.3 ± 4.7 kg, representing a $4.9 \pm 5.4\%$ reduction in body weight ($p < 0.0001$). Mean HbA1c decreased from $8.5 \pm 2.7\%$ to $6.0 \pm 1.8\%$ ($p < 0.0001$), and the percent of individuals with HbA1c in the diabetic range dropped from 76.3% to 27.5%. These changes were accompanied by marked improvements in cardiovascular risk factors, including total cholesterol (3.92 ± 1.02 to 3.13 ± 0.80 mmol/l; $p < 0.0001$) and triglycerides (2.11 ± 0.82 to 1.54 ± 0.51 mmol/l; $p < 0.0001$), and modest reductions in systolic and diastolic blood pressure ($p < 0.05$).

Conclusion

The remarkable improvement in glycemic control and lipid profile in participants suggests that a lifestyle modification intervention targeting weight loss may be highly effective for early diabetes treatment and prevention in Mongolians.

Keywords: Diabetic by HbA1c, obesity, risk factors of diabetes, T2DM, weight loss, weight management, weight management intervention in Mongolians.

Introduction

In the 1950s, there were no registered cases of type 2 diabetes in Mongolia. Since the 1990s, incidents of diabetes have been on the rise and are linked to environmental and socioeconomic changes such as rapid urbanization, decreased physical activity, increased longevity and nutritional transitions in Mongolia from traditional foods to a Westernized diet.(12) The first Mongolian National Survey on diabetes was conducted in 1999 and revealed that the prevalence of diabetes and impaired glucose tolerance (IGT) were 3.1% and 9.2%, respectively.(1) A decade later, the second National Survey to determine the prevalence of non-communicable diseases found that the prevalence of diabetes had doubled to 6.5%, whereas the prevalence of IGT remained steady (9.5%).(12)

It is well known that the worldwide increase in type 2 diabetes is associated with obesity, and the fastest growing rates of obesity have been reported in developing

countries.(2) People who are overweight or obese (BMI $>$ 25.0 kg/m^2) are at a greater risk for developing type 2 diabetes than individuals with normal weight (BMI $<$ 25.0 kg/m^2).(3) Although the prevalence of obesity in Mongolia has not been determined, one study comparing atherosclerotic parameters between Mongolian and Japanese patients with hypertension and type 2 diabetes found that Mongolians had a mean BMI of 27.5 kg/m^2, suggesting that the majority of Mongolian patients with type 2 diabetes may be overweight or obese.(4)

A number of studies have shown that weight loss through lifestyle changes can have a large impact on preventing, treating and managing type 2 diabetes. Notably, the Diabetes Prevention Program (DPP) reported that weight loss because of dietary restriction of calories and saturated fat and exercising 150 minutes per week at moderate intensity decreased the progression from IGT to diabetes by 58% over a 4-year period, outperforming the most popular diabetes drug metformin.(5) Moreover, the LookAHEAD study found that even in individuals with type 2 diabetes, modest weight loss (~5–10% of initial body weight) achieved through lifestyle changes improved glycemic control and reduced cardiovascular risk factors.(6) Here, we report the results of the first clinical weight loss trial to be conducted in Mongolia. We investigated the effectiveness of a lifestyle modification intervention to reduce weight and improve glycemic control and cardiovascular risk factors in Mongolian participants with newly diagnosed type 2 diabetes and who are overweight or obese.

Methods

Ninety-two participants (42 men and 50 women) with BMI $\geq$ 25.0 kg/m^2 were recruited through the Health Centers of Chingeltei, Sukhbaatar and Khan-Uul districts of Ulaanbaatar city, Mongolia. All participants were diagnosed with type 2 diabetes between 1 and 5 months prior to enrollment. Individuals qualified as diabetic if they met at least one of the three standard diagnostic criteria (fasting plasma glucose $\geq$ 7.0 mmol/l or, 75-g oral glucose tolerance test with 2-hour plasma glucose $\geq$ 11.1 mmol/l or, HbA1c $>$ 6.5%) of the WHO and International Diabetes Federation.(13,14) Individuals who were pregnant or breast feeding, disabled or who had a diabetic complication or a disease condition other than type 2 diabetes were excluded from the study. Written informed consent was obtained from all individuals prior to enrolling in the study. The study was approved by the institutional review board of the School of Public Health, National University of Medical Sciences of Mongolia and was conducted following the guidelines of the Declaration of Helsinki.

During the 6-month counselling-based intervention, all participants attended two educational lectures with small group discussions on healthy lifestyle changes to promote weight loss. Informational brochures were provided at the first lecture. During the intervention, participants also had three to four individual phone calls with study coordinators to provide encouragement and to answer any questions they had. Participants were counselled to eat less (reduce calorie intake by 30–40% and consume fewer fatty foods) and shift food intake to earlier in a day. Participants were recommended to increase their physical activity such as through walking, jogging, running or biking up to 150 minutes a week, but no strict target was provided. Measurements were performed before and after the intervention and included body weight, height, BMI, fasting glucose, HbA1c, and lipids, blood pressure, waist and hip circumferences, and percent body fat as measured using the Omron (HBF-375) Karada Scan Body Composition Monitor (Japan, Asia Pacific Headquarter in Singapore). Each participant's baseline value served as the control or reference value.

The statistical power was set at the 80% level to detect at least a 1.5 mmol/l change in blood glucose levels or a 1% change in HbA1c%, using the standard deviations from the baseline measured values in the 92 recruited patients. A significance level of 0.05 was used (two-tailed test). Of the 92 initial recruits, the sample size needed was 59 participants for detecting a significant difference in the blood glucose levels, and 58 participants for HbA1c%.

Statistical analyses were performed using software SPSS v19.0 (SPSS Inc., Chicago, IL, USA) and GraphPad Prism 5 (GraphPad Software Inc., La Jolla, CA, USA). Data are expressed as mean $\pm$ SD. A paired two-tailed *t*-test was used to determine significant differences in anthropometric and clinical parameters before and after the intervention, and Pearson's correlation coefficient was used to perform linear regressions. *P* values $<$ 0.05 were considered statistically significant.

Results

Eighty out of 92 participants completed the 6-month intervention. All anthropometric and cardiovascular endpoints were significantly reduced after the intervention compared to baseline (Table 1). Body weight decreased from 84.4 $\pm$ 13.1 to 80.1 $\pm$ 12.0 kg ($p < 0.0001$) corresponding to an average loss of 4.9 $\pm$ 5.4% of initial body weight (6.71 $\pm$ 5.95% for men and 3.58 $\pm$ 4.51% for women). Waist circumference decreased from 104.1 $\pm$ 10.5 to 99.8 $\pm$ 8.6 cm ($p < 0.0001$), as did other body composition parameters such as hip circumference, waist-to-hip ratio and body fat percentage (all $p < 0.01$)

Table 1 Anthropometric and clinical parameters of subjects before and after intervention

	All (*n* = 80)			Men (*n* = 33)			Women (*n* = 47)		
Parameters	Baseline	Post-intervention	*P* value	Baseline	Post-intervention	*P* value	Baseline	Post-intervention	*P* value
Age (years)	48.1 ± 6.1	—	—	48.0 ± 6.5	—	—	48.2 ± 5.9	—	—
Weight (kg)	84.4 ± 13.1	80.1 ± 12.0	<0.0001	90.7 ± 14.0	84.5 ± 13.8	<0.0001	80.0 ± 10.5	77.0 ± 9.8	<0.0001
BMI (kg/m^2)	31.5 ± 4.1	29.9 ± 3.9	<0.0001	31.2 ± 4.1	29.1 ± 3.7	<0.0001	31.7 ± 4.1	30.5 ± 3.9	<0.0001
Waist circumference (cm)	104.1 ± 10.5	99.8 ± 8.6	<0.0001	106.0 ± 10.2	100.2 ± 8.0	<0.0001	102.8 ± 10.6	99.5 ± 9.0	0.0008
Hip circumference (cm)	107.1 ± 8.7	105.4 ± 7.8	0.007	106.8 ± 8.5	104.3 ± 6.9	0.02	107.3 ± 8.9	106.1 ± 8.3	0.15
WHR	0.96 ± 0.07	0.94 ± 0.05	0.0003	0.98 ± 0.06	0.96 ± 0.04	0.02	0.95 ± 0.06	0.93 ± 0.05	0.01
Body fat (%)	36.2 ± 5.6	34.6 ± 5.6	<0.0001	32.9 ± 4.3	31.6 ± 4.2	<0.0001	38.5 ± 5.4	36.8 ± 5.5	0.0006
Systolic blood pressure (mm Hg)	133 ± 22	127 ± 17	0.01	135 ± 21	129 ± 14	0.05	132 ± 23	127 ± 19	0.09
Diastolic blood pressure (mm Hg)	81 ± 13	77 ± 10	0.03	83 ± 11	79 ± 9	0.03	80 ± 14	77 ± 12	0.21
Fasting blood glucose (mmol/l)	11.6 ± 4.1	8.2 ± 2.5	<0.0001	12.4 ± 4.4	8.8 ± 2.7	<0.0001	11.0 ± 3.7	7.8 ± 2.2	<0.0001
HbA1c (%)	8.5 ± 2.7	6.0 ± 1.8	<0.0001	8.0 ± 2.4	5.9 ± 1.8	<0.0001	8.8 ± 2.9	6.1 ± 1.8	<0.0001
Total cholesterol (mmol/l)	3.92 ± 1.02	3.13 ± 0.80	<0.0001	4.20 ± 1.05	3.2 ± 0.71	<0.0001	3.72 ± 0.96	3.07 ± 0.86	0.0002
Triglycerides (mmol/l)	2.11 ± 0.82	1.54 ± 0.51	<0.0001	2.22 ± 0.92	1.6 ± 0.57	<0.0001	2.03 ± 0.74	1.53 ± 0.46	<0.0001

BMI, body mass index; WHR, waist-to-hip ratio. Data are mean ± standard deviation.

and fasting glucose dropped from 11.6 ± 4.1 to 8.2 ± 2.5 mmol/l ($p < 0.0001$). In men, all body composition parameters decreased significantly ($p < 0.05$), and fasting glucose dropped from 12.4 ± 4.4 to 8.8 ± 2.7 mmol/l ($p < 0.0001$). In women, all body composition parameters except hip circumference decreased significantly ($p < 0.01$), and fasting glucose dropped from 11.0 ± 3.7 to 7.8 ± 2.2 mmol/l ($p < 0.0001$).

Mean HbA1c dropped precipitously from levels diagnostic of diabetes (8.5 ± 2.7%) to prediabetic levels (6.0 ± 1.8%; $p < 0.0001$) after the intervention (Figure 1A).(14,15) More specifically, at baseline, 76.3% of participants were classified as diabetic by HbA1c (>6.5%), 5.0% were prediabetic (6.0–6.5%) and the remaining 18.8% were in the normal range (<6.0%) (Figure 1B). After the intervention, the number classified as diabetic fell to 27.5%, while the number considered prediabetic increased to 16.3%, and those in the normal range rose to 56.3%. In male participants, the reduction in mean HbA1c was more marked in moving many of them into the normal range (from 8.0 ± 2.4% to 5.9 ± 1.8%; $p < 0.0001$), whereas in female participants, the decrease in mean HbA1c resulted in more of a shift from diabetic to prediabetic levels (from 8.8 ± 2.9% to 6.1 ± 1.8%; $p < 0.0001$) (Table 1).

These favourable changes in glycemic control were accompanied by significant improvements in cardiovascular risk factors, including total cholesterol (3.92 ± 1.02 to 3.13 ± 0.80 mmol/l; $p < 0.0001$), triglycerides (2.11 ± 0.82 to 1.54 ± 0.51 mmol/l; $p < 0.0001$), systolic blood pressure (133 ± 22 to 127 ± 17 mm Hg; $p < 0.05$) and diastolic blood pressure (81 ± 13 to 77 ± 10 mm Hg; $p < 0.05$) (Table 1). In men, diastolic blood pressure was reduced significantly (83 ± 11 to 79 ± 9 mm Hg; $p < 0.05$), whereas the change in systolic blood pressure was at the borderline of significance (135 ± 21 to 129 ± 14 mm Hg; $p = 0.05$). In women, both systolic and diastolic blood pressures were not changed significantly ($p = 0.09$ and $p = 0.21$ respectively). The change in HbA1c positively correlated with the change in body weight ($p < 0.05$) (Supplementary Figure 1A), whereas the change in body weight or HbA1c was not correlated with the age of participants ($p = 0.23$ and $p = 0.68$ respectively) (Supplementary Figure 1B and 1C).

Discussion

Here we present the results of the first weight loss study to be conducted in Mongolia. Our purpose was to determine the effectiveness of a healthy lifestyle modification intervention on improving glycemic control in adults who were overweight or obese and newly diagnosed with type 2 diabetes. Over the course of 6 months, participants lost 4.3 ± 4.7 kg or 4.9 ± 5.4% of initial body weight. As a result, the number of participants who were diabetic according to HbA1c status declined markedly from 76.3% at baseline to 27.5%, indicating that most shifted to the normal or pre-diabetic range for HbA1c. Although fasting glucose decreased significantly by 29% after the intervention, it remained in the diabetic range.

Previous studies conducted in patients with type 2 diabetes in developed countries have shown significant beneficial effects of >5% weight loss on HbA1c, lipids and blood pressure.(7–9) In the LookAHEAD study and a Mediterranean diet trial in persons with type 2 diabetes, HbA1c decreased by 0.6% and 1.2%, respectively, after 1 year.(7,8) In our study, however, the mean decline in HbA1c was substantially greater, falling by 2.5 ± 2.1%. Similarly, in our study, total cholesterol and triglycerides decreased by 0.79 ± 1.01 mmol/l and 0.56 ± 0.67 mmol/l, respectively, which exceeded values reported in other studies.(7,8) However, the modest improvements we

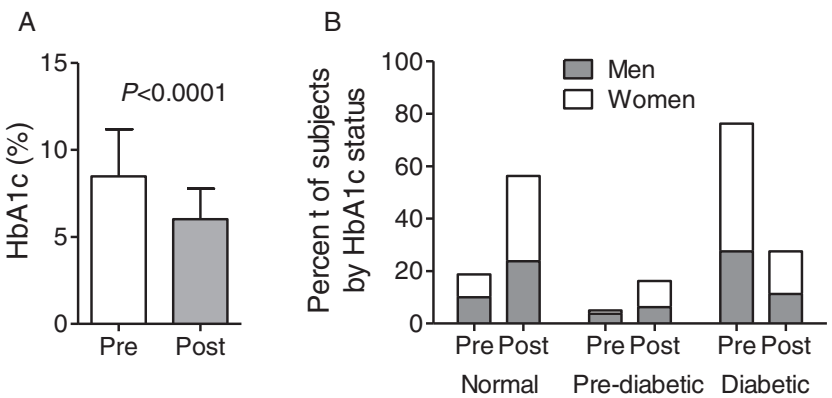

Figure 1 (A) Serum HbA1c levels in study participants before and after 6-month intervention. Values are means ± standard deviation, *n = 80*, *P – p* value. (B) Number of subjects with HbA1c levels in normal (<6.0%), pre-diabetic (6.0–6.5%) and diabetic (>6.5%) ranges before and after 6-month intervention. *n = 33* for men; *n = 47* for women.

observed in blood pressure were in line with previous reports.(7,8)

An unanticipated but very positive response was the marked shift of HbA1c from levels diagnostic for diabetes to pre-diabetic or normal levels. One explanation may be the very recent diagnosis of diabetes. Previous reports have shown that weight loss interventions implemented earlier after the diagnosis of diabetes are more effective.(9,10) Notably, obesity and type 2 diabetes are relatively new health concerns in Mongolia and thus study participants did not have a family history of obesity or type 2 diabetes. Another possibility is that Mongolians traditionally eat 60–70% of daily calories at dinnertime late at night, when they consume energy dense meat-based dishes. During the counselling sessions, participants were instructed to eat dinner earlier and to shift much of their calorie intake to breakfast and lunch, which is known to facilitate weight loss.(11) Also, most of our participants were sedentary prior to starting the study, and therefore they may have reaped greater-than-expected benefits by adopting regular exercise.

In comparison to the DPP and LookAhead studies, our lifestyle intervention was significantly simpler, less intensive and cost-effective. The DPP and LookAhead trials targeted weight loss goals of 7% of initial body weight, achieved through reduced caloric intake, lower fat intake ($<$25% and $<$30% of caloric intake, respectively) and increased physical activity ($>$150 minutes and $>$170 minutes, respectively, of moderate physical activity per week). Both trials involved at least 16 intensive in-person counselling sessions over the first 6 months. By contrast, we observed greater reduction in HbA1c with a mean weight loss of 4.9 ± 5.4% using less stringent instructions to reduce calorie and fat intake, to eat earlier in the day and to increase physical activity. Moreover, this information was delivered through only two group in-person sessions and three to four follow-up phone calls. Thus, less intensive lifestyle interventions with the additional instruction of eating earlier in the day – which was not present in the DPP and LookAhead trials – are promising for mitigating diabetes in Mongolian and similar populations.

In summary, a mean weight loss of 4.9% in Mongolians who are overweight and obese with newly diagnosed type 2 diabetes resulted in marked improvements in glycemic control according to HbA1c and substantial reductions in fasting glucose, lipids and blood pressure. It remains unclear whether the success of our lifestyle modification intervention is because of unique characteristics of the Mongolian population to the recentness of their diabetes diagnosis, or to the advice to eat earlier in the day. Regardless, our results highlight the importance of lifestyle changes as a first-line treatment for newly diagnosed diabetes in Mongolian and similar populations.

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Conflict of Interest

S.S. and Y.S. conducted the clinical trial and collected the study data. J.D.W provided expertise in data and statistical analysis, and editing the manuscript. D.L.J. and C.M.P. provided expertise in writing the grant proposal, in data and statistical analyses and in writing the manuscript. B.V. wrote the grant proposal, designed the clinical study, worked as consultant during the clinical trial, analysed the data, and prepared and wrote the manuscript. The authors declare no conflicts of interest.

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