

Does Jin-Oh-Sui (Mineral Water) Improve Serum Triglyceride Levels? A Pilot Study

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To investigate whether continual consumption of Jin-Oh-Sui (mineral water) has an effect in improving triglyceride levels, we conducted a self-controlled study with 6 male and 5 female residents of Okuizumo-cho, Shimane Prefecture in February 2013. Among men, fasting triglyceride levels improved significantly over baseline levels after drinking Jin-Oh-Sui for 1 month ($P<0.05$). However, when Jin-Oh-Sui consumption was ceased over the following month, triglyceride levels rose again. In women, no improvement in triglyceride levels was seen with continual consumption of Jin-Oh-Sui.

However, body mass index at month 1 and 2 was significantly decreased compared with baseline ($P<0.01$).

To confirm the effect of continual consumption of Jin-Oh-Sui in improving triglyceride levels, an intervention study with consideration of the intervention period, frequency, and intensity is necessary.

Key Words: Okuizumo-cho, Shimane; Jin-Oh-Sui; self-controlled study; triglyceride

Abbreviations: HDL, high-density lipoprotein;
LDL, low-density lipoprotein;
SD, standard deviation

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PURPOSE

Triglycerides reportedly represent an independent risk factor for coronary artery disease and cerebral infarction from epidemiological studies in both Japan and other countries [1]. Management of triglycerides is important in preventing the development of arteriosclerotic diseases [2].

Zair *et al.* investigated the effects of consuming high bicarbonate mineral water on fasting and non-fasting blood lipid levels in individuals with moderate hypercholesterolemia in an intervention study. The results showed that consumption of high bicarbonate mineral water improved fasting blood triglyceride levels [3].

Jin-Oh-Sui (Shimano System Corp., Tokyo, Hokuto Ishiyama Ltd., Okuizumo-cho, Shimane) is a commercial mineral water that uses groundwater (mineral water) from Okuizumo-cho as the raw water [4]. We conducted a self-controlled study [5] to investigate whether continual consumption of Jin-Oh-Sui improved blood triglyceride levels.

METHODS

Subjects

Residents of Okuizumo-cho (age range, 40-59 years) interested in the study were recruited as subjects. The analysis was performed with individuals from whom consent for participation was obtained. Residents of Okuizumo-cho drink from the waterworks supplied by the municipality.

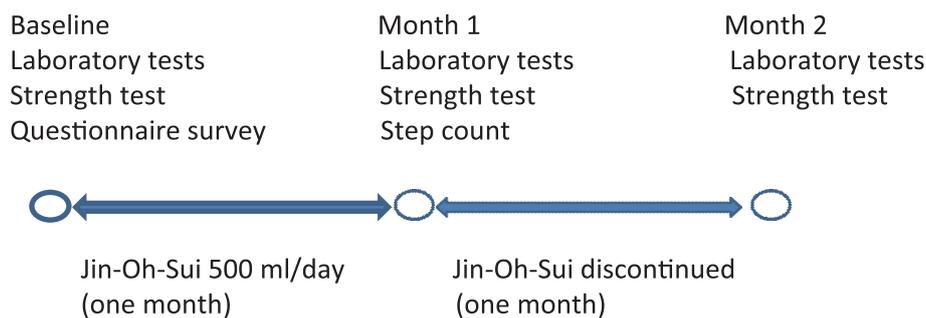


Fig. 1. Intervention study with a within-group comparison design.

Self-controlled study design

This study was an intervention trial implemented using a self-controlled study design (Fig. 1). Subjects were not required to drink Jin-Oh-Sui before or after meals. Jin-Oh-Sui consumption was then discontinued for 1 month. Clinical laboratory tests and a physical strength test were performed three times each: prior to the start of the intervention (baseline); immediately after consuming Jin-Oh-Sui for 1 month (month 1); and after Jin-Oh-Sui consumption had been discontinued for 1 month (month 2). A questionnaire survey was conducted at baseline. Daily step count was measured to observe the amount of physical activity during the month when subjects were drinking Jin-Oh-Sui.

At baseline and the two follow-up times, sex, age, height, weight, body mass index (BMI), waist circumference, red blood cell count, hemoglobin, hematocrit, systolic blood pressure, diastolic blood pressure, total cholesterol, high-density lipoprotein (HDL)-cholesterol, low-density (LDL)-cholesterol, fasting triglyceride, fasting blood glucose, hemoglobin A1c (HbA1c), aspartate aminotransferase (AST), alanine aminotransferase (ALT), γ -glutamyl transpeptidase (γ -GTP), and grip strength (average of right and left) were recorded. BMI was calculated as weight (kg) divided by the square of height (m^2). Information on smoking history, alcohol consumption history, dietary habits, and exercise habits was gathered in a questionnaire survey. However, information on antihyperlipidemic drug use was not gathered on a questionnaire survey. Information on total daily intakes of water and lipid during intervention trial was not also recorded. Blood was collected with subjects in a fasted state before 08:00

on the day of the survey.

The self-controlled study was started on February 18, 2013. Month 1 ended on March 25, 2013, after subjects drank 500 ml of Jin-Oh-Sui per day for 1 month. Month 2, in which subjects stopped drinking Jin-Oh-Sui for 1 month, ended on April 26, 2013. Subjects were notified of baseline clinical test results on March 4, 2 weeks after starting the study. Subjects were notified of the month 1 laboratory test results on April 2, 8 days after blood collection, and the month 2 laboratory test results on May 27, 1 month after blood collection.

Statistical analysis

Laboratory test results and physical strength test results at month 1 and month 2 were compared with laboratory test results and physical strength test results at baseline. A paired t-test was used to test for differences between mean values.

Ethical considerations

Written consent to participate in the study was obtained from the subjects. The study was approved by the Shimane University Institutional Committee on Ethics.

RESULTS

Subjects

Participants comprised 11 residents (6 men, 5 women) of the town of Okuizumo-cho in Shimane Prefecture. At baseline, mean age (standard deviation (SD)) was 56.6 (8.7) years for men and 48.8 (3.6) years for women. Smoking, alcohol drinking, and dietary habits were observed at baseline. One

man (17%) and no women were current smokers, three men (50%) and one woman (20%) consumed alcohol daily, and three men (50%) and two women (40%) exercised regularly. Two men (33%) and one woman (20%) had a preference for salty foods. The percentage of men who drank alcohol was greater than that of women. Changes in water and lipid intakes during intervention trial were not estimated because information on intakes of water and lipid were not acquired.

The mean step count (SD) per day during the time that subjects drank Jin-Oh-Sui was 8,270 (4,401) steps for men and 5,981 (2,718) steps for women. Daily step count was significantly greater in men than in women ($P<0.01$).

Results of clinical laboratory tests and physical strength test

Clinical laboratory and physical strength test results at baseline, month 1, and month 2 were observed. At baseline, one man (17%) and three women (60%) showed total cholesterol ≥ 220 mg/dl. Four men (67%) and two women showed triglycerides ≥ 150 mg/dl. No men and only one woman (20%) had HDL-cholesterol < 40 mg/dl, while one man and three women displayed LDL-cholesterol ≥ 140 mg/dl.

Table 1 shows laboratory test results and physical strength test results for men. Mean (SD) triglyceride level was 156.3 (28.0) mg/dl at baseline, but then decreased to 107.2 (32.3) mg/dl at month 1, representing a significant improvement compared with baseline ($P<0.05$). However, at month 2 the

Table 1. Results of clinical laboratory and physical strength tests in men (n=6)

	Baseline	Month 1	Month 2
	Mean (SD)	Mean (SD)	Mean (SD)
Height (cm)	168.1 (7.0)	168.0 (6.9)	168.0 (7.1)
Weight (kg)	69.9 (4.5)	69.6 (4.6)	69.0 (4.8)
Body mass index (kg/m ²)	24.9 (3.0)	24.8 (3.1)	24.6 (3.1)
Waist circumference (cm)	87.5 (9.0)	87.8 (9.4)	87.2 (9.1)
Systolic blood pressure (mmHg)	127.0 (7.0)	127.0 (11.5)	128.2 (2.7)
Diastolic blood pressure (mmHg)	81.8 (10.6)	80.3 (9.1)	82.7 (4.2)
Red blood cell count ($\times 10^4/\mu\text{l}$)	505.7 (29.1)	502.7 (23.3)	511.3 (25.5)
Hemoglobin (g/dl)	15.5 (0.9)	15.6 (0.8)	15.9 (0.8)**
Hematocrit (%)	46.2 (1.7)	46.1 (1.9)	46.7 (1.2)
Total cholesterol (mg/dl)	196.8 (27.8)	196.5 (30.4)	201.2 (35.0)
Fasting triglycerides (mg/dl)	156.3 (28.0)	107.2 (32.3)*	120.5 (51.9)
HDL-cholesterol (mg/dl)	57.7 (12.1)	57.6 (7.4)	57.7 (9.9)
LDL-cholesterol (mg/dl)	121.0 (26.2)	123.8 (28.5)	132.2 (31.2)
Fasting blood glucose (mg/dl)	124.8 (33.4)	107.7 (12.2)	111.7 (15.8)
Hemoglobin A1c (HbA1c) (JDS) (%)	5.8 (1.1)	5.7 (1.0)	5.7 (1.0)
Aspartate aminotransferase (AST) (IU/l)	25.0 (7.2)	27.2 (8.4)	26.8 (7.3)
Alanine aminotransferase(ALT) (IU/l)	25.7 (13.4)	24.5 (12.9)	29.5 (16.6)
γ -glutamyl transpeptidase(γ -GTP) (IU/l)	37.5 (14.4)	38.2 (22.0)	37.7 (13.6)
Grip strength [#] (kg)	37.7 (8.7)	42.2 (7.2)##	40.4 (7.6)**

[#] average of right and left

n=5

* $P<0.05$ vs. baseline

** $P<0.01$ vs. baseline

level was 120.5 (51.9) mg/dl, no longer representing a significant difference from baseline.

Mean (SD) hemoglobin was 15.5 (0.9) g/dl at baseline. The level was 15.6 (0.8) g/dl at month 1, showing no marked change, but rose to 15.9 (0.8) g/dl at month 2, representing a significant increase compared with baseline ($P<0.01$).

Mean (SD) grip strength was 37.7 (8.7) kg at baseline, increasing to 42.2 (7.2) kg at month 1, but this was not a significant difference from baseline. At month 2, grip strength was 40.4 (7.6) kg, showing a significant increase compared with baseline ($P<0.01$). In the remaining clinical laboratory test results in men, no marked changes were seen between baseline and months 1 and 2.

Figure 2 shows changes in triglycerides in the individual men. Triglycerides improved at month 1 compared with baseline in Subjects 1, 2, and 5, but rose in month 2. In Subjects 3 and 4, triglycerides improved at months 1 and 2 compared with baseline. Subject 4 continued drinking 500 ml of Jin-Oh-Sui per day even after month 1. In Subject 6, triglycerides rose at month 1 compared with baseline, but improved at month 2.

Table 2 shows laboratory test results and physical strength test results for women. Mean (SD) triglyceride level was 102.2 (66.2) mg/dl at baseline,

and showed no marked changes at month 1 (107.0 (47.6) mg/dl) or month 2 (106.8 (45.1) mg/dl).

Mean (SD) aspartate aminotransferase (AST) level was 21.0 (5.1) IU/L at baseline. No marked change was seen at month 1, at 20.4 (4.6) IU/L, but a decrease to 19.2 (4.9) IU/L was found at month 2, representing a significant decrease compared with baseline ($P<0.01$). Mean (SD) body weight was 53.1 (5.6) kg at baseline. No marked change was seen at month 1, at 52.4 (5.8) kg, but at month 2 after Jin-Oh-Sui consumption had ceased, mean body weight had decreased significantly compared with baseline to 52.4 (5.6) kg ($P<0.05$). Mean (SD) BMI was 21.9 (2.3) kg/m² at baseline. At months 1 and 2, values were 21.7 (2.4) and 21.6 (2.3), respectively, showing significant decreases compared with baseline ($P<0.01$). In women, no marked changes were seen between baseline and months 1 and 2 in other laboratory test results or in physical strength test results.

Figure 3 shows changes in triglyceride levels in the individual women. Subjects 7, 10, and 11 showed no marked changes between baseline and months 1 and 2. Subject 8 had elevated triglyceride levels at both month 1 and month 2 compared with baseline. Subject 9 had improved triglyceride levels at months 1 and 2 compared with baseline.

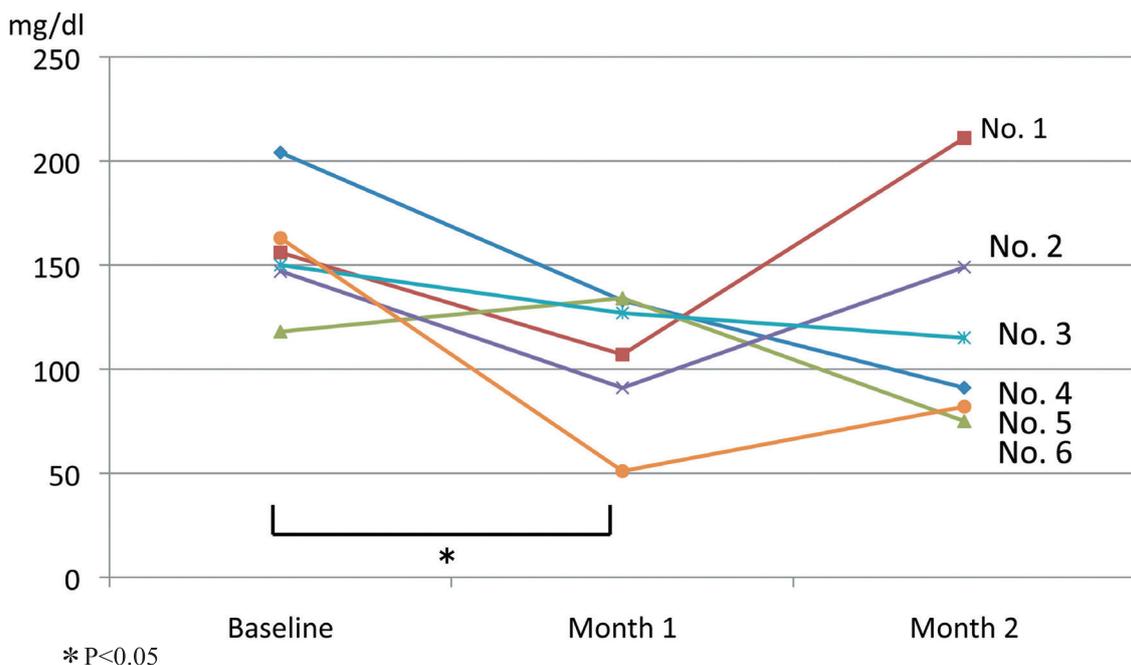


Fig. 2. Triglycerides in individual men (n=6).

Table 2. Results of clinical laboratory and physical strength tests in women (n=5)

	Baseline	Month 1	Month 2
	Mean (SD)	Mean (SD)	Mean (SD)
Height (cm)	155.8 (4.1)	155.6 (4.2)	155.5 (3.7)
Weight (kg)	53.1 (5.6)	52.4 (5.8)	52.4 (5.6)*
Body mass index (kg/m ²)	21.9 (2.3)	21.7 (2.4)**	21.6 (2.3)**
Waist circumference (cm)	79.3 (6.3)	77.0 (6.7)	76.6 (7.3)
Systolic blood pressure (mmHg)	115.0 (10.7)	116.0 (21.7)	121.8 (14.3)
Diastolic blood pressure (mmHg)	83.4 (10.2)	78.8 (8.4)	78.2 (9.8)
Red blood cell count ($\times 10^4/\mu\text{l}$)	473.6 (45.8)	472.0 (42.1)	472.8 (44.2)
Hemoglobin (g/dl)	13.9 (0.9)	13.9 (0.8)	14.0 (0.9)
Hematocrit (%)	41.9 (2.3)	41.6 (2.1)	41.8 (2.2)
Total cholesterol (mg/dl)	236.2 (53.6)	241.2 (37.5)	241.4 (36.7)
Fasting triglycerides (mg/dl)	102.2 (66.2)	107.0 (47.6)	106.8 (45.1)
HDL-cholesterol (mg/dl)	68.2 (25.9)	75.0 (23.2)	69.8 (20.2)
LDL-cholesterol (mg/dl)	152.6 (41.2)	154.4 (30.0)	161.8 (32.1)
Fasting blood glucose (mg/dl)	94.6 (4.7)	94.6 (5.0)	96.8 (5.2)
Hemoglobin A1c (HbA1c) (JDS) (%)	5.0 (0.2)	5.1 (0.2)	5.1 (0.2)
Aspartate aminotransferase (AST) (IU/l)	21.0 (5.1)	20.4 (4.6)	19.2 (4.9)**
Alanine aminotransferase(ALT) (IU/l)	17.8 (6.2)	17.0 (6.2)	15.0 (4.2)
γ -glutamyl transpeptidase(γ -GTP) (IU/l)	24.0 (21.0)	21.8 (15.9)	19.8 (11.9)
Grip strength [#] (kg)	26.1 (3.4)	27.1 (3.0)	26.9 (4.0)

[#] average of right and left

* P<0.05 vs. baseline

** P<0.01 vs. baseline

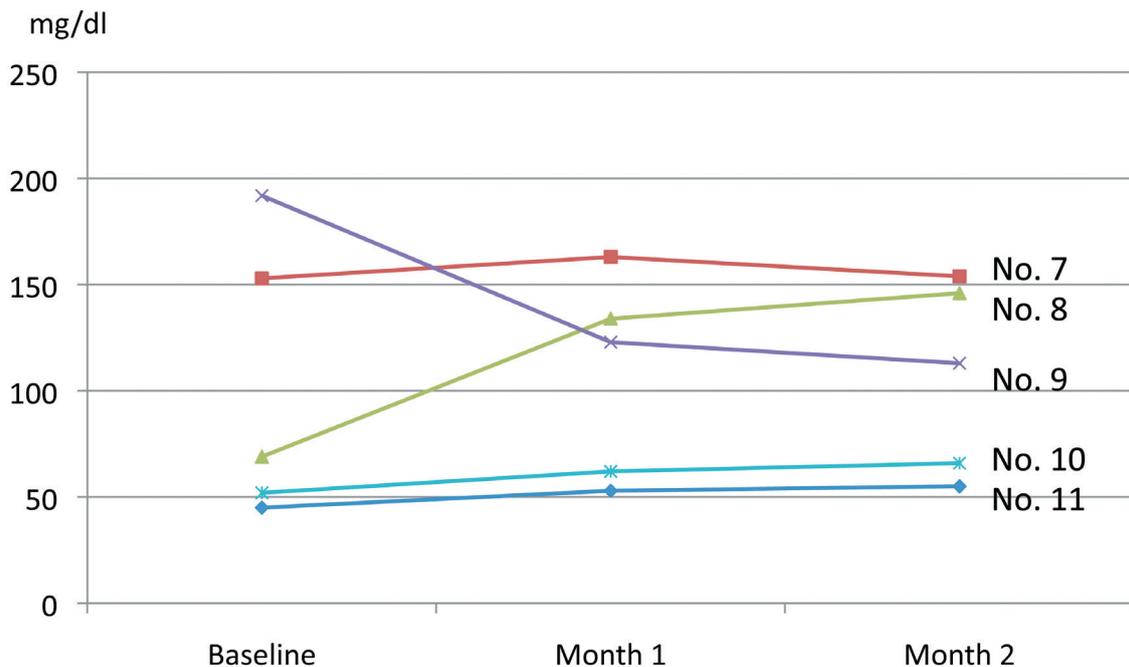


Fig. 3. Triglycerides in individual women (n=5).

DISCUSSION

The present intervention trial with a self-controlled study design was conducted to determine whether continual consumption of Jin-Oh-Sui improved triglyceride levels in community residents. The intervention involved consumption of 500 ml of Jin-Oh-Sui per day for 1 month. Jin-Oh-Sui consumption was then ceased the following month. Results in men showed improved fasting triglyceride levels after drinking Jin-Oh-Sui for 1 month. However, levels rose again when Jin-Oh-Sui consumption was discontinued the following month. No such trend was seen in women, although BMI at month 1 and 2 showed significant decreases compared with baseline.

Chan *et al.* examined the association between fatal coronary heart disease (CHD) and intake of water among 8,280 male and 12,017 female participants aged 38-100 years in the Adventist Health Study, a prospective cohort study in the United States [6]. They reported that the risk of CHD was lower in people with high daily intakes of water (five glasses (1,240 ml) or more) than those with low intake (two glasses (480 ml) or fewer).

Carson *et al.* studied the relationship of the consumption of caffeine from coffee, tea and all caffeine-containing soft drinks to blood lipid levels in 1,035 Caucasian women ranging in age from 65 to 90 years in the United States [7]. They reported that the inconsistent relationships between caffeine from various sources and blood lipids did not support a significant association of blood lipid levels with caffeine consumption in elderly women.

The present study is unable to clearly state that Jin-Oh-Sui directly acted to improve triglyceride levels. We are also unable to clarify whether the amount of water intake acted to improve triglyceride levels and decrease BMI because information on water and lipids intakes was not collected.

In a randomized controlled trial with a double-blind cross-over design, Zair *et al.* examined the effect of high bicarbonate mineral water in fasting and non-fasting blood lipids in 12 moderately hypercholesterolemic patients (all males, 20-60 years old). The results showed improved fasting blood triglyceride levels with consumption of high bicarbonate mineral water [3]. However, non-fasting blood

triglyceride levels did not improve. The present study did not measure non-fasting blood triglyceride levels, and so could not verify the effect of Jin-Oh-Sui on non-fasting blood triglycerides.

Iso *et al.* conducted a cohort study to clarify the relationship between triglycerides and coronary artery disease in 11,068 Japanese community residents [8]. They found a dose-response relationship between non-fasting triglycerides and risk of coronary artery disease. As non-fasting triglyceride levels increased, the risk of coronary artery disease rose.

The present pilot study showed that subjects could readily drink 500 ml of Jin-Oh-Sui per day. To examine the health effects of Jin-Oh-Sui on fasting and non-fasting triglycerides, we propose an intervention study with consideration of both sample size and intervention method. The subjects in this intervention trial would be 25 men and 25 women. The intervention period and controls would be 3 months of Jin-Oh-Sui consumption and 3 months of tap water consumption, and the intensity of intervention would be 500 ml and 1,500 ml of Jin-Oh-Sui per day.

The post-intervention triglyceride improvement effect in this pilot study could not be conclusively shown to represent an effect of Jin-Oh-Sui. An intervention trial with consideration of confounding factors such as exercise and diet is therefore needed.

CONCLUSION

A self-controlled study was performed to assess whether continual consumption of Jin-Oh-Sui improved triglyceride levels in community residents in the town of Okuizumo-cho, Shimane Prefecture. The results showed improved fasting triglyceride levels in men after drinking Jin-Oh-Sui for 1 month. However, when Jin-Oh-Sui consumption was ceased over the following month, fasting triglyceride levels rose. Women showed no trend toward improvement in triglyceride levels with continual consumption of Jin-Oh-Sui; however, BMI at month 1 and 2 showed significant decreases compared with baseline.

An intervention study with consideration of the duration, frequency, and intensity of intervention is proposed to confirm the effects of continual Jin-Oh-Sui consumption in improving triglyceride levels.

Conflict of interest

Research expenses in carrying out this intervention study were subsidized by Shimano System Corp..

Acknowledgment

We would like to thank the residents of Okuizumo-cho who agreed to participate in this study.

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