The effectiveness of canteen-based dietary intervention for metabolic syndrome in occupational men: A randomized controlled trial

doi: 10.6133/apjcn.202508/PP.0003
Published online: August 2025

Running title: Dietary intervention improves metabolic syndrome

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ABSTRACT

Background and Objectives: Dietary intervention is the important strategy for the treatment and management of metabolic syndrome (MetS). Aim of this study is to investigate the effectiveness of canteen-based dietary intervention on MetS in occupational men. **Methods and Study Design:** A randomized controlled study was conducted in May 2022. A total of 321 men with MetS aged 25 to 59 years were recruited from Shengli Oilfield. Participants in one canteen were randomly allocated to dietary intervention group (IG) and those in the other canteen as control group (CG). CG received health education for 6 months. IG received a 6-month healthy lunch and personalized dietary advice added health education. Levels of blood pressure, fasting blood glucose (FBG), lipid profiles, waist circumference (WC) and body mass index (BMI) were detected before and after intervention. **Results:** Compared with CG, FBG (β: -0.72, p = 0.010), TC (β: -1.49, p <0.001), LDL-C (β: -0.65, p<0.001), WC (β: -7.73, p <0.001), BMI (β: -2.01, p <0.001) decreased and HDL-C (β: 0.13, p <0.001) increased significantly in IG. The proportion of MetS had a 30.4% reduction in IG, while a 1.3% decline in CG (p <0.01). Moreover, a significant reduction in central obesity (-30.4%, p <0.001), high FBG (-8.8%, p <0.001), and low HDL-C (-4.1%, p = 0.008) was observed in IG. Conversely, the CG showed an increase in low HDL-C (10.7%, p <0.001). **Conclusions:** Canteen-based intervention with a healthy lunch and personalized dietary advice can reduce the risk of MetS in occupational men. This study provides new empirical data for dietary intervention in ameliorating MetS.

Key Words: metabolic syndrome, dietary intervention, canteen, randomized controlled trial, occupational men

INTRODUCTION

Metabolic syndrome (MetS) is a group of clinically complex syndromes characterized by abdominal obesity, elevated blood pressure, dyslipidemia and impaired glucose metabolism.[1] It has been linked to multiple health problems and chronic conditions, including cardiovascular disease, diabetes, high blood pressure, and obesity. Evidence show that MetS increases the risk of cardiovascular diseases and type-2 diabetes onset by five-fold and two-fold, respectively.[2] The global world is experiencing an epidemic of MetS. The prevalence of MetS in people Chinese adults aged 15 years and above is 24.5%,[3] while it increases to 37.1% in middle-aged and elderly adults.[4] Although the pathogenesis of MetS is still controversial, diet and lifestyle factors are widely considered to be the main influences on its onset.[5]

Research on the global burden of disease shows that unhealthy dietary habits are the leading cause of disease and death in China.[6] Mediterranean diet (MedDiet) and dietary approach to stop hypertension (DASH) diet as representatives of healthy dietary patterns had been reported to be beneficial for reducing the risk of MetS comprehensively.[7, 8] However, these healthy dietary patterns are usually hard for individuals to adhere to in practice. In addition, few studies are focused on the relationship between diet and MetS in occupational population of workers in large enterprises, where most workers eating in the canteen. Poor food environment plays an important role in inducing metabolic disorders and cardiovascular diseases, which predisposes workers to the initiation and progress of MetS. More effective dietary interventions need to be explored in future research.

Shengli Oilfield is a large enterprise with a majority of male workers. There is a high prevalence of MetS in this special population due to the workplace environment and occupational characteristics, including high-intensity work, irregular working hours and greater work stress. Meanwhile, food environments of worksites expose workers to easily form an unhealthy eating habit such as excessive intake of high-sugar and high-fat foods. MetS is a major cause of increased cardiovascular disease mortality in middle-aged men, seriously affecting their health status and quality of life. Our previous study found that the number of sudden death on job in men was 16 folds in women, 40 to 50 aged workers with the highest proportion.[9] The medical examination of workers in 2022 showed a serious health problem in males with 54.5% of overweight and obesity, and 44.4% of dyslipidemia. As the prevalence of each component of MetS increases, the healthcare cost of these workers increases and work performance decreases concomitantly.[10] The enterprise may increase the cardiometabolic health of their workers by increasing awareness, routine screening for MetS, and by providing various health promotion programs at the worksite. Workplace can provide a special intervention environment to promote healthy eating and improve employee health.[11] Evidence has showed that a dietary intervention in workplace cafeteria increased the consumption of healthy foods and reduced cardiometabolic risk factor profiles.[12] Facing the challenges on increasing prevalence of MetS, tailored nutrition prescription represents a promising approach for both the prevention and management of MetS.[13] While tailored dietary advices are already implemented successfully in some research, personalized dietary interventions may still lack sufficient evidence for full implementation in workers eating in workplace canteen.

Therefore, the purpose of this study was to explore the effectiveness of dietary intervention based on workplace canteen in male workers with MetS, so as to provide intervention methods and empirical practices for improvement of MetS.

MATERIALS AND METHODS

Study design and participants

This was a randomized controlled intervention study in two canteens. Using a computer-generated random number, the two canteens were randomly assigned as either the intervention canteen or control canteen. Eligible participants from each canteen were subsequently enrolled into the intervention group (IG) or control group (CG) accordingly. Sample size and power were calculated using PASS 15 software based on the results of a previous study.[14] The minimum sample size of 75 participants per group was needed to detect statistically significant differences in the positive and negative groups with 90% power and type I error $\alpha = 0.05$. Assuming an attrition rate of 20%, the planned sample size was 90 participants in each group.

Participant recruitment was conducted at two canteens in Shengli Oilfield, a large petrochemical enterprise, during May 2022. A total of 337 occupational men were assessed for eligibility (Figure 1). The primary inclusion criteria included the following: 1) men aged 25 to 59 years diagnosed with MetS, 2) eating at least 3 days per week in the settled workplace canteen, 3) completed the questionnaire survey, dietary assessment, physical measurement, biochemical examination and other contents during the study. MetS was defined with meeting at least three of the five criteria: 1) central obesity: waist circumference (WC) ≥ 90 cm for men; 2) hyperglycemia: fasting plasma glucose (FPG) ≥ 6.1 mmol/L or diagnosed with diabetes; 3) hypertension: systolic blood pressure (SBP) ≥ 130 mmHg or diastolic blood pressure (DBP) ≥ 85 mmHg or diagnosed with hypertension; 4) triglycerides (TG) ≥ 1.70 mmol/L; 5) high-density lipoprotein cholesterol (HDL-C) < 1.04 mmol/L.4 The main exclusion criteria included: 1) severe diabetes, hypertension and cardiovascular disease; 2) waist and knee lesions or other reasons caused by inactivity; 3) not able to provide blood samples or finish physical examination, or failure to comply with program requirements. This study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Dongying Shengli Shengdong Hospital (2022-003). All subjects gave their informed consent for inclusion before they participated in the study. This study has been registered at the Chinese Clinical Trail Registry (registry number:

ChiCTR2400093129). This study did not use blinding for the participants, but the laboratory testers and data analysts were blinded to the group assignment.

Dietary intervention

The IG was performed a 6-month health education and dietary intervention based on workplace canteens, provided with personalized dietary recommendations and recipes, healthy lunch meals according to DASH diet principles. Eating habits and food intake were obtained from a simple dietary survey before the intervention, which is the basic of personal dietary advice. In accordance with the individual differences and the goals of dietary intervention, tailored nutrition diet recipes were formulated for each participant through the agency service center. Types of food and intake of each meal were specified to ensure reasonable and healthy meals. Personal diet plans were timely adjusted and improved according to the feedback and effect of intervention in this study. In addition, dietary intervention guidance and training were given for canteen chefs, including the nutritional value of food, the selection and preparation of ingredients, and cooking skills like as low salt, low oil and low sugar. The IG canteen increased the supply of whole grains and mixed beans, fruits, soybean and its products, aquatic products in lunch, as well as moderately reduced the use of cooking oil, salt and condiments. The changes of food in lunch before and after intervention were shown in Figure 2(B). Moreover, participants in IG were encouraged to adhere to healthy food choices for breakfast and dinner. Health education was carried out in the form of setting up a health corner in the canteen and providing with brochures and manuals on dietary nutrition knowledge (e.g., food selection, reading labels), chronic disease health management (e.g., hypertension, diabetes, obesity), healthy lifestyles and mental health knowledge. The CG received the same health education as the IG during the 6-month period. It was not including specific guidance or prescriptions for exercise and other lifestyle changes. The lunch food supply in CG canteen was the same as before, and changes before and after intervention were not obvious in Figure 2(A).

Blood biochemical methods

Blood samples were obtained in the morning after an overnight fast, FPG, total cholesterol (TC), TG, HDL-C and low-density lipoprotein cholesterol (LDL-C) were measured at Dongying Shengli Shengdong Hospital clinical laboratory using an automated chemistry analyzer (Hitachi, Tokyo, Japan).

Physical examination

Height, weight and WC were measured with standardized procedures.[15] Body mass index (BMI) was calculated as weight (kg)/height (m2). Blood pressure (BP) was measured according to a standard protocol.

Statistical analysis

Data were analyzed using SAS version 9.4 (SAS Institute, Cary, NC, USA). Descriptive statistics were presented as means ± standard deviation (SD) for continuity variables with normal distribution. Categorical variables were presented as percentage and examined with a chi-square test. Repeated measures analysis of covariance (ANCOVA) was performed to determine significant interactions between the group and time, with adjustments for age, education, occupation, medication use, exercise frequency and MetS severity at baseline. Bonferroni correction was applied for post-hoc comparisons of differences within groups before and after intervention and differences between groups at after intervention. McNemar's test was used to determine the significant differences in MetS and its components before and after intervention in each group. Values were considered significant at $p < 0.05$.

RESULTS

Comparison of general characteristics of study participants at baseline

A total of 337 participants were assessed for eligible from two canteens. Of these, 330 participants were included and randomly assigned into IG or CG groups. However, 9 participants were lost to follow-up (dropout rate: 2.7%). The remaining 321 participants were included in data analyses with 171 in IG and 150 in CG. Table 1 shows the general features of the study participants between two groups at baseline. There were no statistically significant differences between the two groups in terms of age, education, occupation, medication use, exercise frequency and MetS severity ($p > 0.05$).

Comparison of outcome measures for participants in IG and CG before and after intervention

Changes in the BP, glucose, lipid profiles, WC and BMI before and after intervention in the two groups are shown in Table 2. A significant group by time interaction effect was observed on all of the outcomes (all $p<0.05$). No difference in all the outcomes between IG and CG was detected at baseline (all $p>0.05$). After 6-month dietary intervention, there was a significant decrease in terms of DBP, FBG, TG, TC, LDL-C, WC and BMI (all $p < 0.001$), and a notable increase of HDL-C ($p = 0.003$) in IG compared with baseline. However, a significant increase of FBG, TG, TC, LDL-C, WC, BMI (all p <0.001), and a decrease of SBP and HDL-C (all p <0.001) were observed in CG after health education for 6 months. Compared with those in CG, FBG (β: -0.72, 95%CI: -1.33, -0.12; $p = 0.010$), TC (β: -1.49, 95%CI: -2.02, -0.97; p <0.001), LDL-C (β: -0.65, 95%CI: -0.90, -0.40; p <0.001), WC (β: -7.73, 95%CI: -9.92, -5.55; p <0.001), BMI (β: -2.01, 95%CI: -3.09, -0.93; p <0.001) deceased and HDL-C (β: 0.13, 95%CI: 0.05, 0.21; p <0.001) increased significantly in IG after dietary intervention with adjusting for potential confounders.

Comparison of MetS and its components for participants in IG and CG before and after intervention

To study the effect of dietary intervention on MetS, participants were evaluated for MetS criteria again after the intervention. The results are shown in Figure 3 and Table 3 that the IG had a 30.4% reduction in MetS after 6 months of dietary intervention, while only a 1.3% reduction in CG (p <0.01). As for MetS components, there was a significant reduction in central obesity (-30.4%, p <0.001), high FBG (-8.8%, p <0.001) and low HDL-C (-4.1%, $p = 0.008$) in IG, but a significant increase of low HDL-C (10.7%, p <0.001) was observed in CG.

DISCUSSION

Dietary interventions play an essential role in the prevention and management of MetS. This study found that a 6-month dietary intervention with a healthy lunch at workplace canteen and personalized dietary advice significantly improved metabolic health outcomes, including blood glucose, lipid profiles, and central obesity in occupational male MetS, whereas a traditional health education did not improve these parameters obviously. These findings were similar to previous studies. Intake of a healthy lunch at workplace canteen for 3 months decreased blood pressure and serum lipids among middle-aged men.[16] A randomized controlled study revealed that dietary intervention reduced cardiometabolic risk and related indicators, including blood lipids, blood pressure and central obesity among Chinese population with dyslipidemia.[17] These changes were significantly associated with clinical benefits relevant to MetS. The adoption of a healthy diet has been recommended as one of the first-line interventions for management of MetS. Evidence based meta-analysis showed a 50% reduction in MetS incidence with adherence to a MedDiet pattern.[18] Moreover, some of observational and clinical studies have been reported the effective role of MedDiet and DASH diet in ameliorating risk of MetS incident or its components.[19, 20] However, findings for beneficial effects of DASH diet on changes in some metabolic characteristics in intervention studies were not entirely convincing. Besides, personalized dietary advice resulted in positive effects on metabolic health in pre-MetS adults.[21] In this research, we provided a healthy lunch based on DASH diet principles and personalized dietary recommendations for a 6-month intervention in occupational male MetS, finding a significant decline in the proportion of participants with MetS and its components, including central obesity, high FBG and low HDL-C. Obesity is a key factor for promoting MetS and its components, while weight loss is associated with metabolic benefits such as lowering BP,[22] regulating blood glucose and lipids levels.[23] Related to the above mentioned, the dietary intervention contributed to improved BP, FBG levels and four items of lipids levels. This result confirms the importance of dietary changes in the prevention of hypertension, type-2 diabetes and dyslipidemia.

Dietary intervention based on canteens was observed to improve the food environment for workers in enterprise, mainly by increasing the whole grain and mixed beans, soybean and soybean product, aquatic products like fish and fresh fruits, simultaneously decreasing red meet, salt and sodium. Whole grain contains abundant and diverse nutrients with potential health benefits and may decrease the risk of hypertension and diabetes.[24] Moreover, whole grain consumption was indicated to be associated with a lower risk of MetS.[25] A whole grain-based diet could reduce blood glucose and TC level in MetS.[26, 27] Soybean known as a cardioprotective food, may be a useful food choice for the treatment of MetS. Although some clinical trials have evaluated the effect of soybean consumptions in patients with MetS, they are inconsistent in their results. A meta-analysis has revealed that consuming soybean products in patients with MetS effectively improved lipid profile and glycemic parameters, but not significantly change anthropometric measures and BP.[28] Another cohort study suggests that habitual intake of soy protein and isoflavones is inversely associated with the risk of MetS and its components.[29] Mean soybean intake from lunch increased by 39.0% after dietary intervention to meet daily requirement, which may contribute to improvement of metabolic parameters. In a dose-response analysis of cohort studies and cross-sectional studies, an increment of 100 g/d in fruit consumption was related to a 3% lower risk of the MetS, whereas an increase of vegetable consumption was not associated with a reduction in the MetS.[30] Higher intake of fruits was associated with modest weight loss and decreased WC.[31] Despite the dietary intervention increased fruits intake from lunch by 15.7%, actual intake of fruits in males was still well below recommended intakes.

Evidence from observational studies indicates that the MetS may be positively associated with red meat consumption, inversely associated with fish consumption and neutrally associated with poultry consumption.[32] The positive association between red meat consumption and the prevalence of the Mets appeared to be largely driven by increased prevalence of elevated WC. Moderate red meat intake plays a potentially protective role against development of high BP.[33] Regular fish consumption has a positive impact on losing weight, improving glucose homeostasis, reducing age-associated increases in BP and the risk of MetS.[34] Daily fish consumption was associated with a 57% reduction in the risk of developing MetS for men in a cohort study in South Korea.[35] In particular, fish intake was significantly associated with TC and HDL-C levels among the MetS components. A 13-year follow-up study has reported lean fish consumption was associated with beneficial changes in abdominal obesity, lipid profile and BP, albeit some only statistically significant among men.[36] A significant lowering effect was also shown in individuals with MetS after the dietary intervention with fish on LDL-C concentrations, WC and BP. Dietary intervention in this study reduced red meat and poultry intake and increased aquatic products intake such as fish. These changes are beneficial for metabolic health, but the average consumption is much higher than the daily recommended amount, which may negate the benefits and translate into potential risk factors.

Salt may play an important role in the development of hypertension and metabolic disorders. High salt intake is one of the dietary factors with the strongest association with cardiometabolic morbidity and mortality, and its consumption by individuals with MetS increased compared to individuals without MetS, even in these individuals only with elevated WC and/or BP.[37] Salt intake should be reduced worldwide, but strategies must be more intense in MetS, especially people with elevated BP and WC. In this study, the amount of salt used in the IG canteen has been reduced to 5.6 grams per person, but excessive use of sauces/condiments still lead to a high intake of sodium, which may explain the insignificant improvement in BP. On the contrary, the CG also had a significant reduction in SBP, which may be related to a reduction in salt and sodium intake at lunch.

Even the health education is important in the prevention and management of metabolic diseases and their risk factors, the effect of it in this study is limited. The decrease in the proportion of MetS at the end of the study compared to baseline was greater in IG than CG. Furthermore, the analysis of the proportions of MetS components suggests that a healthy lunch and personalized dietary recommendations were superior to health education in MetS improvement. Dietary intervention based on the workplace canteens can provide more reasonable diet advice, nutritional recipes and food environment. It is easier to form and adhere to a healthy eating habit for improvement of MetS, as well as metabolic parameters, and obtained health benefits. In the future, a dietary intervention and diet management at workplace canteen may be the direction to improve healthy dietary habits, prevent and control chronic diseases and promote health.

Canteen-based dietary intervention with a healthy lunch and personalized dietary advice for workers is the highlight of this study. Though the alteration of dietary improvement was only for lunch, the amelioration of metabolic parameters in occupational male MetS indicated this intervention is effective. Nevertheless, there also has some limitations. First, no blinding for participants might result in bias. We blinded laboratory testers and data analysts to minimize bias. Second, dietary adherence was not evaluated using dietary recall logs or biomarkers. The positive feedback on personal diet recipes and records of not reducing the frequency of healthy lunches may indicate that participants had a good adherence, but we did not investigate the implementation of dietary recommendations and diet satisfaction among participants during the intervention. Third, most people get more than 50% of their food and energy from lunch during the day, yet dietary intakes of food in breakfast and dinner were not controlled for the participants, these confounding factors may have some impacts on the outcome of the dietary intervention. Fourth, the study was followed up and observed for only 6 months. Although this is sufficient to observe the short-term effect of the intervention, it limits to assess the long-term sustainability of these positive changes. Finally, this study was conducted in the canteen of a large enterprise, potentially limiting the applicability and feasibility of the findings to populations in different workplace settings. In short, dietary intervention based on the workplace canteen to improve the metabolic parameters and obtain health benefits is acceptable and executable in male MetS, that is worthy to be attempted and implemented in enterprises for improvement of MetS and its components.

Conclusions

The study results revealed that a 6-month dietary intervention had ameliorated FBG, lipid profiles (TG, TC, HDL-C and LDL-C), WC and BMI, and reduced the proportion of MetS, especially a reduction in central obesity, high FBG and low HDL-C, among occupational men with MetS. These findings demonstrated that a dietary intervention consisting of a healthy lunch at workplace canteen and personalized dietary advice contributes to improve workers' metabolic health, which might lead to a novel approach to improve and prevent of metabolic syndrome.

ACKNOWLEDGEMENTS

The authors thank professor Jian Zhang from National Institute for Nutrition and Health, Chinese Center for Disease Control and Prevention, Beijing, for the technical support provided.

CONFLICT OF INTEREST AND FUNDING DISCLOSURE

The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

This research was funded by Sinopec Shengli Petroleum Administration Co., Ltd., grant number GKY2201.

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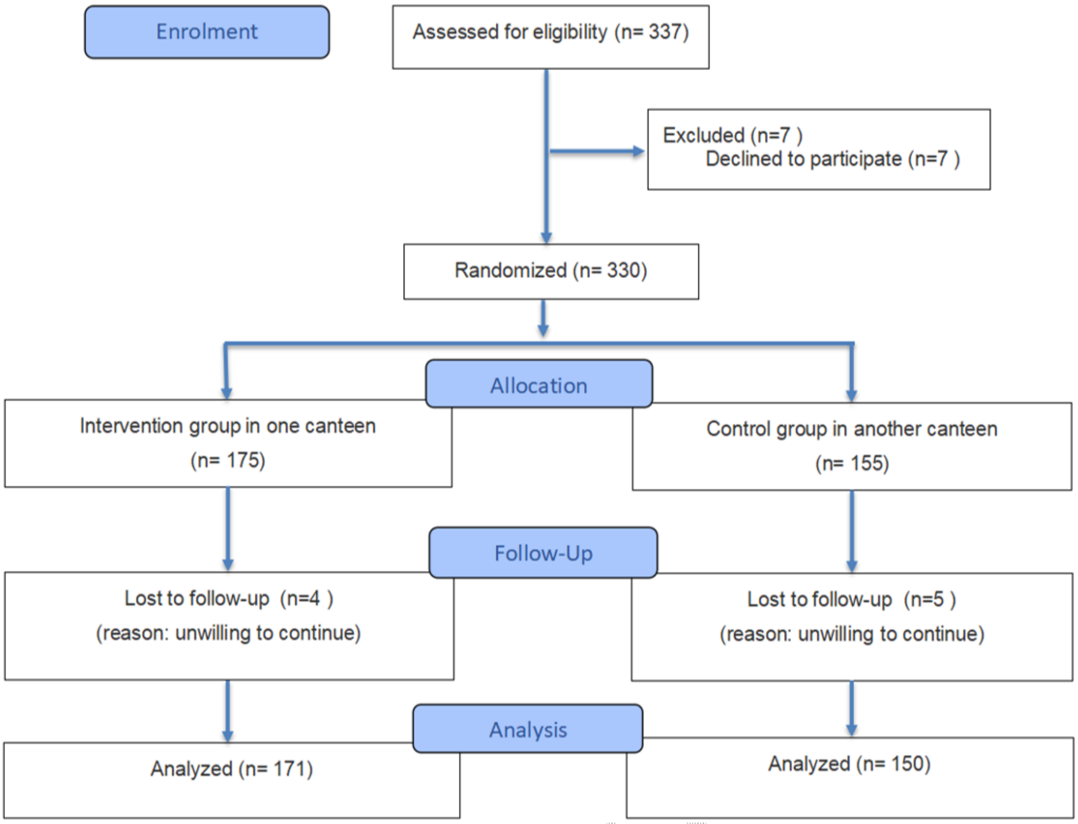

Figure 1. Flow diagram of participants in a study testing the effectiveness of dietary intervention on improvement of metabolic syndrome in occupational men

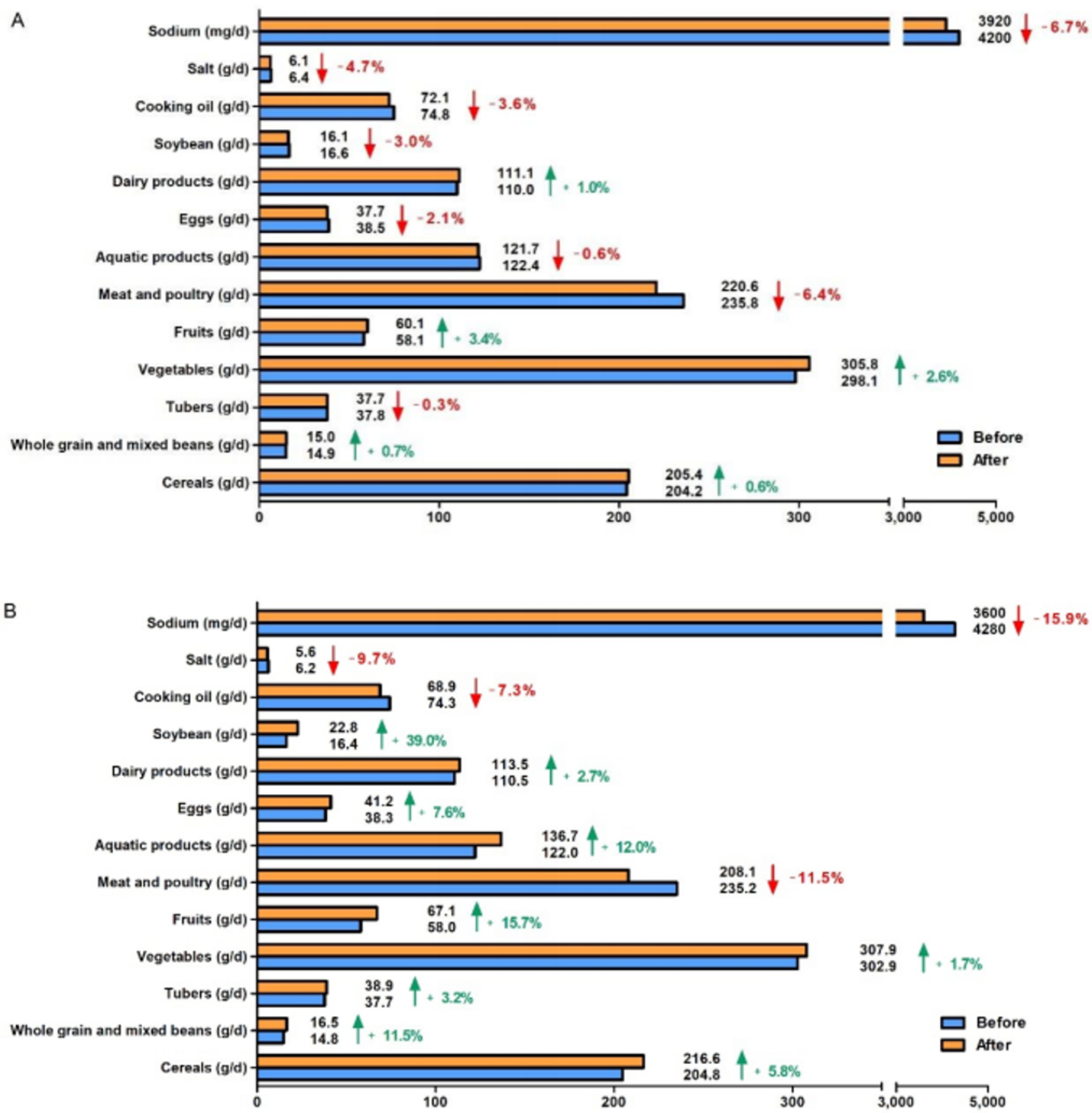

Figure 2. Changes of food consumptions in lunch before and after intervention in control group (A) and intervention group (B). Red arrow indicates a decrease and green arrow indicates an increase

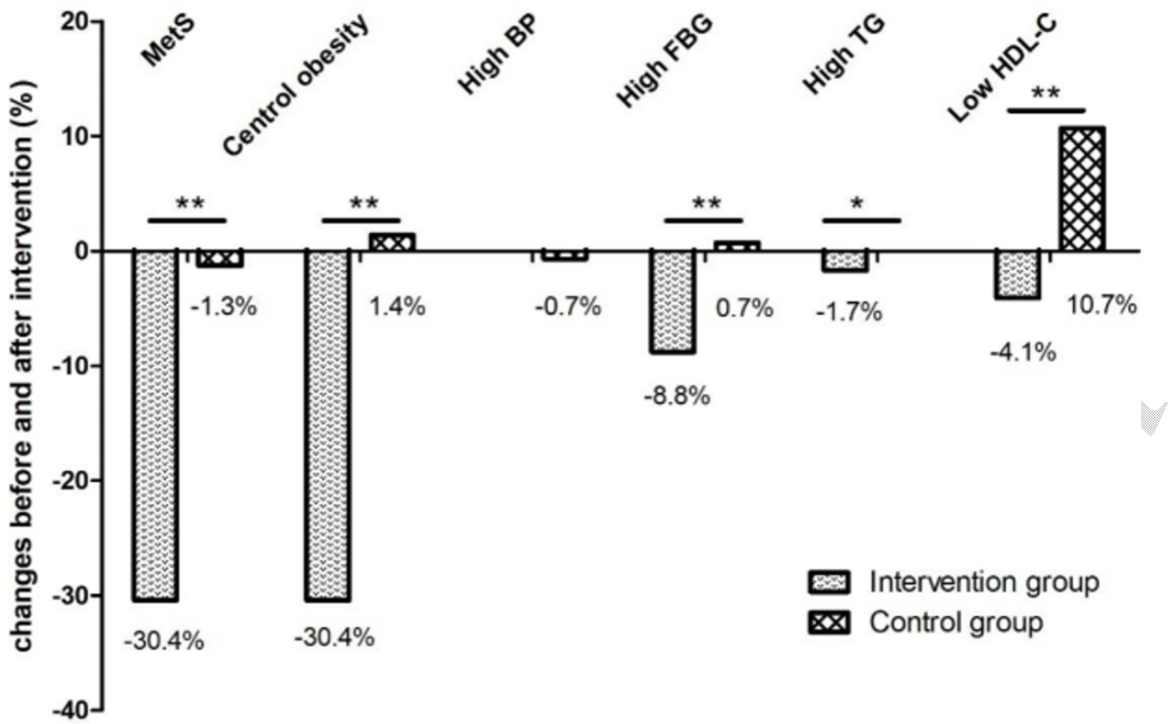

Figure 3. Changes of proportions of MetS and its components before and after intervention in intervention group and control group. MetS: metabolic syndrome; BP: blood pressure; FBG: fasting blood glucose; TG: triglyceride; HDL-C: high-density lipoprotein cholesterol. Data were performed with chi-squared test. * p<0.05; ** p<0.01

Table 1. General characteristics of study participants in IG (N=171) and CG (N=150) at baseline

Characteristics	IG (N=171)	CG (N=150)	Statistics	*p*-value
Age (years, n, %)			0.844	0.656
25~39	43 (25.1)	34 (22.7)		
40~49	87 (50.9)	84 (56.0)		
50~59	41 (24.0)	32 (21.3)		
Education (n, %)			3.037	0.219
≤9 years	4 (2.3)	2 (1.3)		
10-12 years	74 (43.3)	79 (52.7)		
>12 years	93 (54.4)	69 (46.0)		
Occupation (n, %)			0.854	0.652
managers	20 (11.7)	13 (8.67)		
technicians	36 (21.1)	31 (20.7)		
machine operators	115 (67.3)	106 (70.7)		
Medication use (n, %)			1.605	0.658
none	96 (56.1)	94 (62.7)		
1~2 kinds	36 (21.1)	29 (19.3)		
3~4 kinds	28 (16.4)	19 (12.7)		
≥5 kinds	11 (6.4)	8 (5.3)		
Exercise frequency (n, %)			1.828	0.401
None	95 (55.6)	76 (50.7)		
1~2 times/week	59 (34.5)	52 (34.7)		
≥3 times/week	17 (9.9)	22 (14.7)		
MetS severity (n, %)			1.363	0.506
3 items	116 (67.8)	93 (62.0)		
4 items	46 (26.9)	46 (30.7)		
5 items	9 (5.3)	11 (7.3)		

IG: intervention group; CG: control group; MetS: metabolic syndrome.
Data were presented as frequencies (percentages) and compared with chi-squared test.

Table 2. Comparison of outcomes in IG and CG before and after intervention

Variables	IG (N=171)			CG (N=150)			p group*time	β (95%CI)	p between-group
	Before	After	p	Before	After	p			
SBP (mmHg)	143.1±17.7	142.8±17.0	1.000	145.4±17.1	143.0±16.2	<0.001	<0.001	0.08 (-4.85, 5.01)	0.964
DBP (mmHg)	92.1±13.7	91.2±12.4	<0.001	92.7±12.0	92.6±11.8	1.000	0.005	-0.83 (-4.37, 2.72)	0.536
FBG (mmol/L)	6.45±2.42	5.86±1.69	<0.001	6.14±2.02	6.54±2.61	<0.001	<0.001	-0.72 (-1.33, -0.12)	0.002
TG (mmol/L)	3.30±3.29	3.03±2.84	<0.001	3.19±2.74	3.23±2.74	1.000	<0.001	-0.12 (-0.91, 0.68)	0.697
TC (mmol/L)	5.34±1.28	4.98±1.10	<0.001	5.40±1.71	6.54±2.29	<0.001	<0.001	-1.49 (-2.02, -0.97)	<0.001
HDL-C (mmol/L)	1.12±0.26	1.16±0.28	0.003	1.13±0.26	1.03±0.26	<0.001	<0.001	0.13 (0.05, 0.21)	<0.001
LDL-C (mmol/L)	3.26±0.81	3.02±0.74	<0.001	3.32±0.74	3.65±0.92	<0.001	<0.001	-0.65 (-0.90, -0.40)	<0.001
WC (cm)	98.6±8.7	91.1±6.3	<0.001	97.3±8.2	98.7±8.5	0.001	<0.001	-7.73 (-9.92, -5.55)	<0.001
BMI (kg/m^2)	28.6±4.0	27.3±3.7	<0.001	28.7±3.5	29.4±3.8	<0.001	<0.001	-2.01 (-3.09, -0.93)	<0.001

IG: intervention group; CG: control group; SBP: systolic blood pressure; DBP: diastolic blood pressure; FBG: fasting blood glucose; TG: triglycerides; TC: total cholesterol; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; WC: waist circumference; BMI: body mass index.
Data were presented as means ± SD and compared with repeated measures covariance (ANCOVA) with adjustments for age, education, occupation, medication use, exercise frequency and MetS severity at baseline.
Bonferroni correction was applied for post-hoc comparisons of differences within groups before and after intervention and differences between groups at after intervention.

Table 3. Comparison of MetS and its components in IG and CG before and after intervention

Variables	IG (N=171)				CG (N=150)			
	Before	After	χ^2	p	Before	After	χ^2	p
MetS	171 (100%)	119 (69.6%)	-	-	150 (100%)	148 (98.7%)	-	-
Central obesity	153 (89.5%)	101 (59.1%)	52.000	<0.001	137 (91.3%)	139 (92.7%)	1.000	0.317
High BP	151 (88.3%)	151 (88.3%)	-	-	139 (92.7%)	138 (92%)	1.000	0.317
High FBG	65 (38%)	50 (29.2%)	15.000	<0.001	48 (32%)	49 (32.7%)	0.200	0.655
High TG	135 (78.9%)	132 (77.2%)	3.000	0.083	132 (88%)	132 (88%)	-	-
Low HDL-C	73 (42.7%)	66 (38.6%)	7.000	0.008	62 (41.3%)	78 (52%)	16.000	<0.001

IG: intervention group; CG: control group; MetS: metabolic syndrome; BP: blood pressure; FBG: fasting blood glucose; TG: triglyceride; HDL-C: high-density lipoprotein cholesterol.
Data were presented as frequencies (percentages) and compared with McNemar's test