Received: 25 May 2018 | Revised: 15 November 2018 | Accepted: 4 December 2018

DOI: 10.1002/1348-9585.12039

ORIGINAL ARTICLE

WILEY Journal of Occupational Health Open Access

One-year weight loss maintenance outcomes following a worksite-based weight reduction program among Japanese men with cardiovascular risk factors

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Funding information
Ministry of Health, Labour and Welfare of Japan; Japan Society for the Promotion of Science, Grant/Award Number: C:JP 17K12555

Abstract

Objectives: Worksite-based programs present a simple and effective approach to facilitate weight reduction in employees. Despite the importance of 1-year weight loss maintenance, studies have generally focused on the short-term effects of weight reduction programs. In addition, little is known about the long-term weight maintenance outcomes in Asian populations. We examined the long-term maintenance effects of a worksite-based weight reduction program among Japanese men with cardiovascular risk factors.

Methods: The study sample comprised 58 overweight men with cardiovascular risk factors who had voluntarily participated in a randomized crossover trial involving a 3-month weight reduction program. Participants were followed up for 1 year after the trial concluded, and both groups were merged for the analysis. We compared the changes in body weight before the post-trial follow-up and after 12 months to examine the long-term maintenance effects of the program. Changes in other cardiovascular risk factors (eg, waist circumference, blood pressure, lipid measures, and diabetes-related measures) were also examined.

Results: Both groups of study participants achieved weight loss during the weight reduction program. Total 53 participants (91.4%) completed the 12-month post-trial follow-up. There were no significant changes in mean body weight (mean: −0.11, 95% confidence interval: −0.7-0.49 kg) and other cardiovascular risk factors between the beginning and end of the follow-up period.

Conclusions: This study showed that the worksite-based weight reduction program not only enabled short-term weight loss, but that the participants were able to

Abbreviations: AG, anhydroglucitol; BMI, body mass index; CI, confidence interval; FBG, fasting blood glucose; HbA1c, hemoglobin A1c; HDLC, high-density lipoprotein cholesterol; LDLC, low-density lipoprotein cholesterol; MetS, metabolic syndrome; SBP, systolic blood pressure; SD, standard deviation; TG, triglycerides.

successfully maintain their weight for 1 year after the program without any supplementary interventions.

KEYWORDS
cardiovascular risks, lifestyle modification, obesity, weight maintenance, weight reduction program, worksite

1 | INTRODUCTION

Obesity and type 2 diabetes are rapidly becoming more widespread throughout Asia. In Japan, the prevalence of obesity has risen steadily over the past two decades, and obesity-related diseases such as dyslipidemia, diabetes, and cardiovascular disease are increasingly common among Japanese men.[1] Accordingly, the prevention of these lifestyle-related diseases has become an important public health challenge. Previous studies have reported metabolic syndrome (MetS) to be a risk factor for cardiovascular disease.[2-4] In order to monitor and reduce the prevalence of MetS, Japan's Ministry of Health, Labour, and Welfare implemented an annual health check-up system and community-based weight reduction program in 2008.[5] Effective and simple weight reduction programs are required to facilitate both short-term weight reduction and long-term weight maintenance. Although several programs have reported successful short-term weight reduction,[6-8] long-term weight management remains a challenging issue in the treatment of obesity.[9-18] Furthermore, few studies have evaluated the long-term maintenance effects of weight reduction programs among individuals with MetS in an Asian population.

In addition to the government's efforts, occupational interventions also provide a potential avenue of influence to reduce obesity and its associated risks. We have previously developed and conducted a 3-month weight reduction program for overweight Japanese men with cardiovascular risk factors in a worksite setting that improved weight loss.[6] This study examines the 1-year weight loss maintenance outcomes of this worksite-based weight reduction program.

2 | SUBJECTS AND METHODS

2.1 | Study design and participants

We have previously conducted an open-label, randomized crossover trial to examine the effects of a 3-month weight reduction program implemented at two worksites (a semiconductor manufacturing factory in Shiga prefecture and a similar factory in Hyogo prefecture).[6] The present study assessed the 1-year weight loss maintenance outcomes of our program in the Shiga-based factory. Randomized crossover trial in Shiga-based factory was conducted from May to November in 2007, and 1-year follow-up was observed until November in 2008. The randomized crossover trial was jointly organized by staff from the Shiga University of Medical Science and occupational health specialists from the participating worksite (UMIN-CTR:UMIN000030083).

Figure 1 shows the flow chart of subject selection, the randomized crossover trial, and the follow-up timeline. Briefly, the participants of this trial comprised 108 male employees who applied to take part in this study; of these, 58 satisfied the inclusion criteria. The trial included men who (1) were aged 19-60 years, (2) had a body mass index (BMI) of 25 kg/m^2 or higher, (3) had received physician approval for study participation, and (4) had one or more of the following cardiovascular risk factors: high blood pressure (systolic blood pressure [SBP] ≥135 mmHg and/or diastolic blood pressure ≥85 mmHg, or prescribed medication for hypertension), dyslipidemia (high-density lipoprotein cholesterol [HDLC] <40 mg/dL and/or triglycerides [TG] >150 mg/dL, or prescribed medication for dyslipidemia), and hyperglycemia (fasting blood glucose [FBG] ≥110 mg/dL and/or glycated hemoglobin A1c [HbA1c] ≥5.5%, or prescribed medication for diabetes).

The 58 participants were randomly and equally divided into two groups, which were designated Group A and Group B. Group A participated in the 3-month weight reduction program, and underwent follow up for 12 months without any additional intervention. Group B participated in the same 3-month weight reduction program conducted 3 months after Group A began their program (delayed intervention). The details and results of the weight reduction program are summarized in Supporting Information (Tables S1-S3). The participants underwent group and individual counseling sessions to facilitate self-monitoring, light exercises (stretching, dumbbell exercises, and walking), and dietary modifications (Table S1).

The present study is an ancillary study of the randomized crossover trial, and was designed to assess the 1-year weight maintenance outcomes. We merged the participants of both groups into one cohort to examine the 1-year weight loss maintenance of the program during the 12-month post-trial follow-up period (Figure 1). This follow-up study was performed as a health promotion project organized by the occupational health specialists of the participating worksite. During the follow-up period, participants were not provided further lifestyle counseling or support for weight maintenance. As

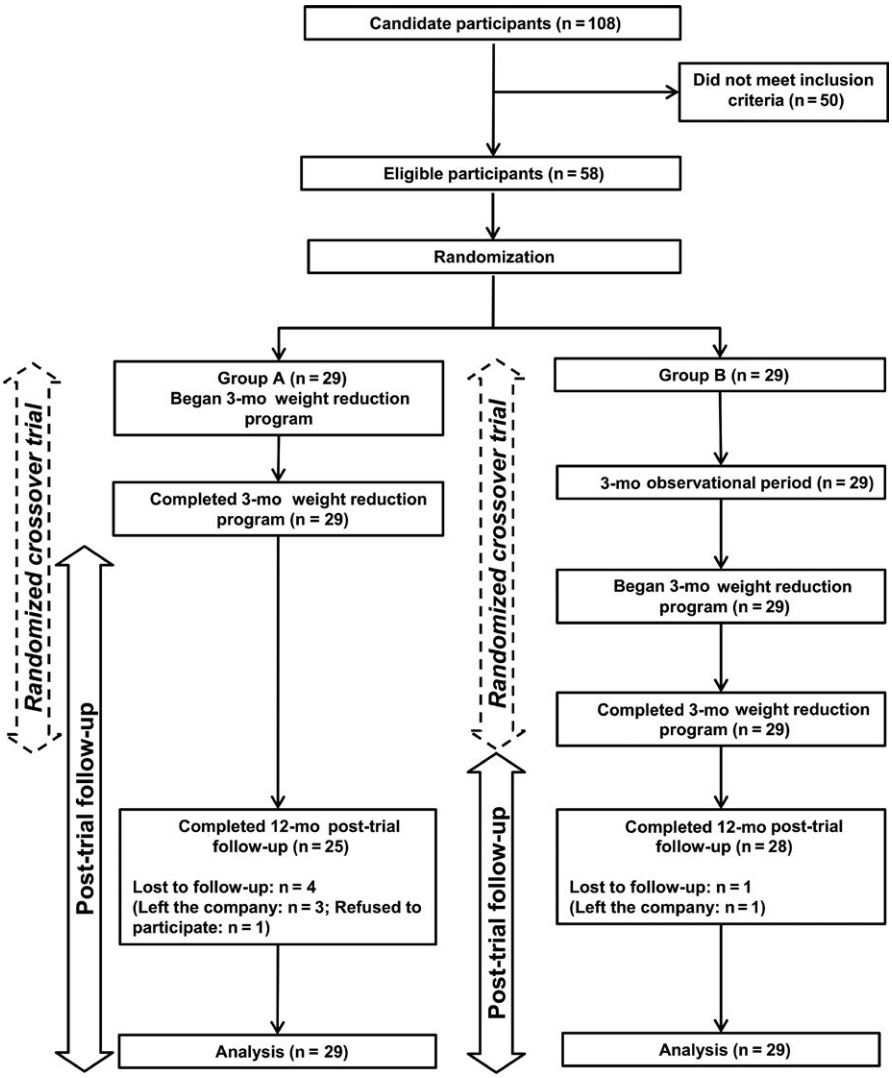

FIGURE 1 Flow diagram of the randomized crossover trial and 12-month post-trial follow-up (enrollment, allocation, and follow-up)

shown in Figure 1, five participants were lost to follow-up (left the company: n = 4, refused to participate in the follow-up: n = 1).

Approval of this study was obtained from the Institutional Ethics Committee of Shiga University of Medical Science (Approval number: 18-21-1). All participants were provided informed consent to participate in this follow-up study.

2.2 | Outcome measures

The primary endpoint of the study was the change in body weight (kg) in the period before the post-trial follow-up and after 12 months. The secondary endpoints were changes in the following anthropometric and laboratory measures of obesity: waist circumference, SBP, lipid measures (total cholesterol, HDLC, low-density lipoprotein cholesterol [LDLC], and TG), and diabetes-related measures (FBG, HbA1c, and 1,5-anhydroglucitol [AG]).

Weight was measured in lightweight clothing without shoes to the nearest 0.1 kg using a digital scale. BMI was calculated as the weight divided by the square of the height (kg/m^2). Waist circumference was measured at the umbilical level during the exhalation phase in a standing position. Blood pressure was measured in duplicate using a digital blood pressure monitor (BP-103ill; Nippon Colin, Komaki, Japan) with the participant in a seated position after resting for 5 minutes. Blood samples were collected after an 8-hour fast and analyzed within 24 hours at BML Inc (Kyoto, Japan) based on standards stipulated by the US Cholesterol Reference Method Laboratory Network.[19] These measurements were collected at the start of the trial and at 1.5 months, 3 months (when Group A started follow-up), 4.5 months, 6 months (when Group B started follow-up), 7.5 months, 9 months, 15 months (when Group A completed follow-up), and 18 months (when Group B completed follow-up) after trial initiation. MetS was defined using the Japanese definitions.[4,20] Central obesity was defined as a Waist ≥0.85 m. High blood pressure was defined as a mean systolic/diastolic blood pressure ≥130/85 mmHg and/or currently taking anti-hypertensive

medication. High-serum triglyceride was defined as a level ≥1.7 mmol/L (150 mg/dL) and low-HDL cholesterol as a level <1.0 mmol/L (40 mg/dl). High FBG was defined as an FBG level ≥5.5 mmol/L (100 mg/dL) and/or current use of anti-diabetic medication.

2.3 | Statistical analysis

One-year weight loss maintenance was assessed using the differences in body weight between the beginning and the end of the 12-month post-trial follow-up period. The changes to the secondary endpoints were also examined. These differences were described using box plots, and their statistical significance was assessed using means and 95% confidence intervals (CIs). All analyses were performed using Stata 12.0 (Stata Inc College Station, Texas, USA).

3 | RESULTS

Table 1 shows the participants' characteristics at the start of the 12-month post-trial follow-up (n = 53). The mean age of the participants was 43.8 years (standard deviation [SD]: 4.6 years), and the current smoking rate was 32.1%. Approximately, half of the participants were factory workers (49.1%), and the remaining half were engineers and administrators (50.9%). The mean body weight of the participants was 85.0 kg (SD: 9.0 kg), and the mean BMI was 28.1 kg/m^2 (SD: 2.5 kg/m^2). Although five workers were lost to follow-up, the overall baseline characteristics of the remaining 53 participants (Table 1) were similar to those of the original 58 participants (Table S2).

TABLE 1 Participants' characteristics at the start of the 12-month post-trial follow-up (n = 53)

	Mean (SD)
Age (years)	43.8 (4.6)
Occupation, n (%)	
Factory workers	26 (49.1)
Engineers and administrators	27 (50.9)
Smoking status, n (%)	
Never smoker	22 (41.5)
Current smoker	17 (32.1)
Ex-smoker	14 (26.4)
Weight (kg)	85.0 (9.0)
BMI (kg/m^2)	28.1 (2.5)
Waist circumference (cm)	97.5 (6.1)
Systolic blood pressure (mmHg)	123.8 (12.7)
Diastolic blood pressure (mmHg)	79.0 (10.4)
Total cholesterol (mg/dL)	217.0 (31.6)
HDLC (mg/dL)	50.8 (10.1)
LDLC (mg/dL)	136.9 (27.0)
Triglycerides (mg/dL)	162.2 (93.7)
Fasting blood glucose (mg/dL)	94.2 (11.2)
HbA1c (%)	5.3 (0.6)
1,5-anhydroglucitol (mg/mL)	24.8 (10.2)

n = 53 (Group A: n = 25, Group B: n = 28).
Values are presented as mean (standard deviation) or number (percentages). BMI, body mass index; HbA1c, hemoglobin A1c; HDLC, high-density lipoprotein cholesterol; LDLC, low-density lipoprotein cholesterol; SD, standard deviation.

Figure 2 shows the group-specific trends in body weight changes during the randomized crossover trial and the post-trial follow-up (Group A: 3-15 months after trial initiation; Group B: 6-18 months after trial initiation). The mean body weight changes during the weight reduction program were similar in both groups. However, the mean weight loss immediately after the program was larger in Group B than in Group A. After merging the participants of both groups (n = 53), we found no significant difference in mean body weight between the beginning and end of the 12-month post-trial follow-up period (mean difference: −0.11 kg, 95% CI: −0.70-0.49 kg).

Figure 3 shows the box plots of the changes in the anthropometric and laboratory measures of obesity between the beginning and end of the follow-up period. As with body weight, there was no significant difference in waist circumference (−0.21 cm, 95% CI: −0.79-0.36 cm). Similarly non-significant results were also observed in the cardiovascular risk factors (SBP: −0.76 mmHg, 95% CI: −3.81-2.28 mmHg; total cholesterol: 0.45 mg/dL, 95% CI: −6.18-7.09 mg/dL; HDLC: 0.74 mg/dL, 95% CI: −1.19-2.66 mg/dL; LDLC: 2.57 mg/dL, 95% CI: −3.18-8.31 mg/dL; TG: 8.96 mg/dL, 95% CI: −6.60-24.53 mg/dL; HbA1c: 0.02%, 95% CI: −0.02-0.07%; and 1.5-AG: −1.61 mg/mL, 95% CI: −2.34-0.88 mg/mL).

Compared with four components of MetS at baseline, seven participants (17.0%) improved central obesity, three participants (5.7%) improved high blood pressure, and seven participants (13.2%) improved hyperlipidemia at 1-year post-trial follow-up. However, three participants (5.7%) exacerbated high blood pressure, three participants (5.7%) exacerbated hyperlipidemia, and six participants (11.3%) exacerbated high FBG at 1-year post-trial follow-up.

4 | DISCUSSION

In a follow-up study of 53 overweight Japanese men who participated in a worksite-based weight reduction program, our results demonstrated that both body weight and cardiovascular risk factors were generally unchanged 1 year after program completion. To our knowledge, this study is the first to examine the 1-year weight loss maintenance effects of a

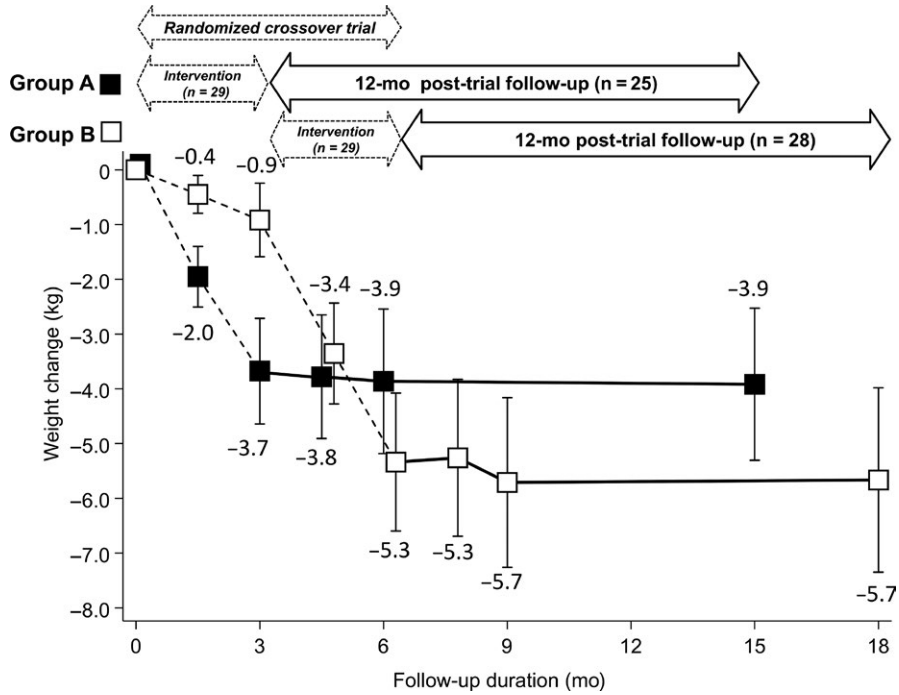

FIGURE 2 Mean changes in body weight during the randomized crossover trial and 12-month post-trial follow-up. Dashed lines: body weight changes during the randomized crossover trial; Solid lines: body weight changes during the 12-month post-trial follow-up. Group A (black boxes) first participated in the 3-month weight reduction program, and underwent post-trial follow-up for 12 months without any additional interventions. Group B (white boxes) first underwent a 3-month observational period before participating in a delayed intervention of the same 3-month weight reduction program. Group B then underwent post-trial follow-up for 12 months without any additional interventions. The error bars indicate the 95% confidence intervals of each mean weight change

weight reduction program developed for Japanese worksites. Notably, our weight reduction program demonstrated 1-year weight loss maintenance effects without subsequent interventions. As this program was designed to be implemented in the workplace, it enables Japanese workers to participate during working hours. Another strength of this weight reduction program is that it can be managed with a small number of health care practitioners and materials. Our program does not require large numbers of specialists, sophisticated facilities and equipment (eg, gymnasiums or web systems), or large financial investments.

Only one study has previously examined weight maintenance in Japanese subjects after a weight reduction program.[18] Nakata et al compared the 2-year weight maintenance outcomes after a 6-month hospital-based randomized controlled trial between Japanese adults who received an education-only intervention and those who received group-based support.[18] When compared with our study subjects, the participants of that study were almost 7 years older, including women, and had a higher (approximately 1.1 kg/m^2) mean BMI. The weight reductions in the education-only and group-based support groups were 4.7 kg (95% CI: 3.7-5.7) and 7.7 kg (95% CI: 6.7-8.8), respectively. However, the 2-year weight maintenance outcome was identical (3.3 kg) in both groups. That program involved a more intensive intervention that was 3 months longer than our weight reduction program. Although our follow-up duration was shorter at only 1 year, our simple and shorter program was able to produce similar weight reduction effects as those reported by Nakata et al.[18] Moreover, our worksite-based program was designed to be more practical and economical as it was conducted during working hours.

Regular self-monitoring can be an effective way for participants to remain motivated in maintaining their weight. Some studies have reported daily self-weighing to be strongly associated with weight maintenance,[9-11] where participants in weight reduction programs use their recorded weight data to effectively regulate their eating and exercise behaviors. In this study, many participants indicated that self-monitoring (weight, daily step counts, and daily lifestyle modifications) was a useful tool for changing their lifestyle and reducing their weight (data not shown). The clinical guidelines of the US National Heart, Lung, and Blood Institute also note that "regular self-monitoring of weight is critical for long-term maintenance."[12] In addition, our findings indicate that a combined diet-plus-exercise program is effective in supporting 1-year weight loss maintenance.[13-16] This is consistent with the findings of previous studies such as Franz et al, which reported that weight loss interventions utilizing a reduced-energy diet and exercise were associated with moderate weight loss in

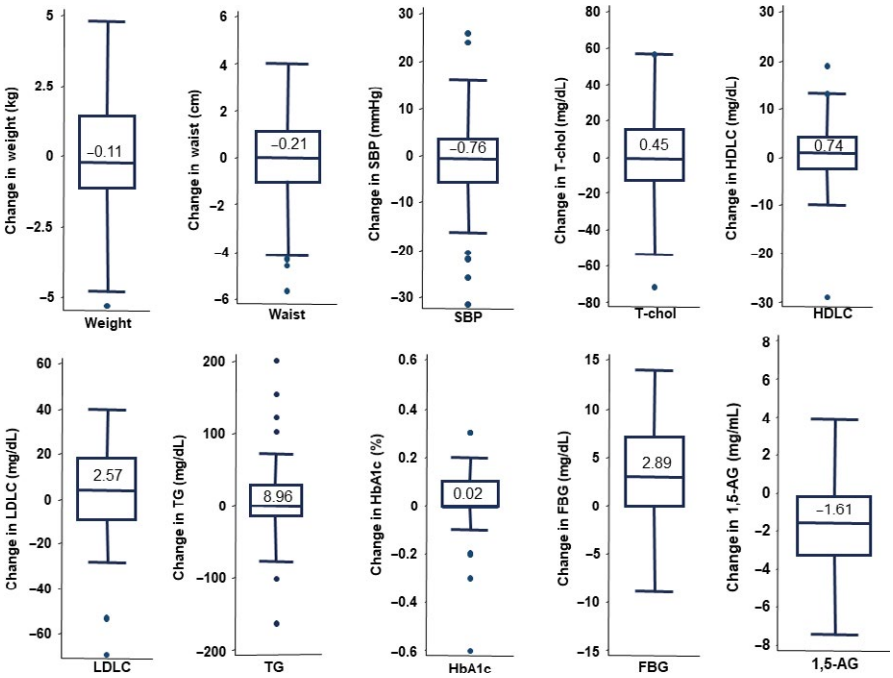

FIGURE 3 Box plots of the changes in the anthropometric and laboratory measures of obesity in the 12-month post-trial follow-up (n = 53). The 12-month post-trial follow-up was conducted from the 3rd to 15th months in Group A and from the 6th to 18th months in Group B. The central line, lower edge, and upper edge of each box indicate the median, 25th percentile, and 75th percentile, respectively. The whiskers extend to the most extreme data points not considered outliers, and outliers are plotted individually. Abbreviations: 1,5-AG, 1,5-anhydroglucitol; FBG, fasting blood glucose; HbA1c, hemoglobin A1c; HDLC, high-density lipoprotein cholesterol; LDLC, low-density lipoprotein cholesterol; SBP, systolic blood pressure; T-chol, total cholesterol; TG, triglycerides; Waist, waist circumference

the first 6 months.[13] Although some participants in that study regained body weight after the program, many were able to successfully maintain their weight.[13] Similarly, Curioni and Lourenço reported that programs that included both diet and exercise resulted in greater weight loss than diet-only interventions in obese and overweight individuals soon after the intervention period and after 1 year of follow-up.[16]

Our results suggest that light aerobic exercise (stretching and walking) and resistance exercises (dumbbell exercises) can affect the 1-year maintenance of weight loss. Light resistance exercises (eg, low-speed muscle contractions and extensions during dumbbell exercises) are effective in increasing blood flow and promoting protein and amino acid synthesis.[21] The combination of aerobic and resistance exercises may lead to improved metabolic rates, thereby increasing lipid oxidation and reducing body and fat mass.[22] A previous study reported that the improvements in glycemic control in obese patients with type 2 diabetes were greater when combining aerobic and resistance training than in either type of training alone.[17] Furthermore, the less-intensive training sessions in our program may encourage more people to participate when compared to more intensive programs.[8,14] We have previously reported that male workers with low initial physical activity levels had increased their activities over 3 months,[6] indicating that adherence to these light aerobic and resistance exercises was relatively manageable. Our weight reduction program also focused on decreasing excessive food intake, and we found that reducing the excessive intake of energy-dense foods resulted in larger weight reductions when compared with a focus on nutrition balance and snack reduction.[6] This suggests that reducing excessive food intake may be easier than achieving overall nutrition balance. The 3-month effects of this weight reduction program were the same or greater than those of previous studies in Japanese subjects.[7,8] The results of the present study also showed that it is feasible to enact 1-year changes in dietary habits through worksite-based interventions.

The present study has several limitations. First, there was a lack of a control group composed of non-participants in the weight reduction program. Second, we did not observe any significant changes in blood pressure or lipid and glucose outcomes after the 3-month weight reduction program. Moreover, there were no significantly favorable changes observed in SBP, total cholesterol, HDLC, LDLC, and TG after the 12-month post-trial follow-up. Because this study focused on participants with one or more cardiovascular risk factors (hypertension, dyslipidemia, or hyperglycemia), it is difficult to identify the differential effects of these individual factors. However, our primary endpoint was the change in body weight, whereas the changes in cardiovascular risk factors were secondary endpoints. Third, the mean change

in body weight from baseline was larger in Group B than in Group A. This study was designed as a combination of an open-label randomized crossover trial and an observational study at a single worksite, and there was a temporal lag between the two groups. Accordingly, Group B participants may have been aware of the intervention conducted in Group A during the first 3 months, which may have contributed to increased weight loss in the former. Nevertheless, the mean change in body weight after the weight reduction program was similar between the groups. Fourth, none of the study participants experienced weight gain following the weight reduction program. All participants had voluntarily applied to take part in our weight reduction program, and may therefore have been highly motivated to reduce their body weight and maintain any weight loss. Therefore, our findings have limited external validity. The program staff also included the participants' workplace occupational health specialists, who may have inadvertently encouraged the participants to maintain their weight.

5 | CONCLUSION

The results of the present study demonstrated that our 3-month worksite-based weight reduction program had 1-year weight loss maintenance effects on weight maintenance in Japanese men without any additional post-trial interventions. The combination of self-monitoring, light aerobic and resistance exercise, and reduction in excess food intake was useful in achieving and maintaining weight loss in the participants. As a result, it is easy to implement and manage in the community and at worksites.

ACKNOWLEDGEMENTS

We thank Dr. Takashi Kimura (the occupational physician of Shiga Based factory) and the research staff of Shiga University of Medical Science for their support in this study.

This study was supported in part by Grants-in-Aid from the Ministry of Health, Labour and Welfare of Japan (H18-Junkankitou[Seishuu]-Ippan-034 and 20 Kou-6) and a Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of Science (C:JP 17K12555).

DISCLOSURE

Approval of the research protocol: Approval of this study was obtained from the Institutional Ethics Committee of Shiga University of Medical Science (Approval number: 18-21-1). *Informed consent*: All participants were provided informed consent to participate in this follow-up study. *Registry and the registration no. of the study/trial*: The registration No. of this study is UMIN 000030083(UMIN-CTIR). *Animal studies*: This study is not an Animal Study.

CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

All authors contributed to the design of the study and protocol of the weight reduction program. RT, TO, NO, AK, and MY conducted both the weight reduction program and the follow-up study. RT, TO, NO, and YM analyzed the data and drafted the manuscript. All authors read, critically revised, and approved the final manuscript.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

How to cite this article: Tsukinoki R, Okamura T, Okuda N, et al. One-year weight loss maintenance outcomes following a worksite-based weight reduction program among Japanese men with cardiovascular risk factors. *J Occup Health*. 2019;61:189–196. https://doi.org/10.1002/1348-9585.12039