



NOVA

University of Newcastle Research Online

nova.newcastle.edu.au

Morgan, Philip J.; Collins, Clare E.; Plotnikoff, Ronald C.; Cook, Alyce T.; Berthon, Bronwyn; Mitchell, Simon; Callister, Robin, "The Impact of a Workplace-Based Weight Loss Program on Work-Related Outcomes in Overweight Male Shift Workers". Originally published in Journal of Occupational and Environmental Medicine Volume 54(2), February 2012, p 122-127

**Available from:** <http://dx.doi.org/10.1097/JOM.0b013e31824329ab>

This is a non-final version of an article published in final form in Journal of Occupational and Environmental Medicine Volume 54(2), February 2012, p 122-127

**Accessed from:** <http://hdl.handle.net/1959.13/1036035>

1 RUNNING HEAD: Work impact of a weight loss program for males

2

3 **The impact of a workplace-based weight loss program on work-related outcomes in**  
4 **overweight male shift workers**

5

6 Philip J. Morgan PhD<sup>1</sup>, Clare E. Collins PhD<sup>2</sup>, Ronald C. Plotnikoff PhD<sup>1</sup>, Alyce T. Cook B

7 Ed (HPE)<sup>1</sup>, Bronwyn Berthon BND<sup>1</sup>, Simon Mitchell B Phys.<sup>3</sup> & Robin Callister PhD<sup>4</sup>

8 <sup>1</sup> School of Education, Faculty of Education & Arts, University of Newcastle, Australia;

9 <sup>2</sup> School of Health Sciences, Faculty of Health, University of Newcastle, Australia;

10 <sup>3</sup> Tomago Aluminium, Tomago, Australia;

11 <sup>4</sup> School of Biomedical Sciences and Pharmacy, Faculty of Health, University of Newcastle,  
12 Australia.  
13

14 Corresponding Author:

15 Professor Philip Morgan

16 Priority Research Centre in Physical Activity and Nutrition

17 Faculty of Education & Arts

18 University of Newcastle

19 Callaghan NSW Australia 2308

20 + 61 2 4921 7265 (PH) + 61 2 4921 7407 (Fax)

21 [Philip.Morgan@newcastle.edu.au](mailto:Philip.Morgan@newcastle.edu.au)

22

23

ACKNOWLEDGMENTS

24 This study was supported by the Hunter Medical Research Institute. We are grateful for the  
25 assistance of the Health Services Department at Tomago Aluminium, Pty. Ltd., NSW,  
26 Australia. We thank all study participants.

27

28

DISCLOSURE

29 Simon Mitchell is the Health and Safety Services Leader at Tomago Aluminium. PJM has  
30 worked as consultant to Tomago Aluminium. All other authors declare that they have no  
31 competing interests.

32

33

FUNDING SOURCE

34 This study was funded by Tomago Aluminium and the Hunter Medical Research Institute.  
35 Tomago had no involvement in study design, analysis and interpretation of data or the  
36 decision to submit the manuscript for publication. Simon Mitchell from Tomago Aluminium  
37 reviewed the drafted manuscript for accuracy and also organised the data collection at  
38 Tomago.

39

40 Trial Registration: Australian New Zealand Clinical Trials Registry No:

41 ACTRN12609001003268

ABSTRACT

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25

**Objective:** The aim of this study was to evaluate the impact of a workplace-based weight loss program (Workplace POWER-WP) for male shift workers on a number of work-related outcomes.

**Methods:** 110 overweight/obese (BMI 25-40) (mean [sd] age = 44.3 [8.6] years; BMI = 30.5 [3.6]) male employees at Tomago Aluminium (NSW, Australia) were randomized to either (i) WP program (n = 65) or (ii) a 14-week wait-list control group (n = 45). Men were assessed at baseline and 14-week follow-up for weight, quality of life, sleepiness, presenteeism, absenteeism and workplace injuries.

**Results:** Retention was 81%. Intention-to-treat analysis using linear mixed models revealed a significant intervention effect for weight, quality of life (mental), presenteeism, absenteeism and injuries.

**Conclusions:** The WP weight loss program improved a number of important work-related outcomes in male shift workers.

INTRODUCTION

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25

Internationally, obesity is a serious public health issue with prevalence increasing in many countries (1). Obesity is associated with numerous adverse physical and psychological health consequences (2). In addition, the financial costs of obesity and related conditions are colossal. A recent systematic review identified that the economic burden of obesity worldwide accounted for between 0.7% and 2.8% of a country's total healthcare expenditure (3). It was estimated that obesity and associated diseases cost Australian society and governments \$58.2 billion in 2008 (4) in a population of only 22 million.

The direct and indirect costs of obesity to employers are also substantial (5), partly because overweight and obese people experience more work-related limitations than those who are a healthy weight (6, 7). These limitations include decreased productivity at work (presenteeism), increased absenteeism, more on-the-job injuries, and increased morbidity manifested as higher numbers of health care claims (5, 6). Burkhauser and Cawley (8) found that for every additional unit increase in BMI, the probability of individuals reporting work limitations increased by 1%. In the U.S., Ricci and Chee (7) found that obese people are less likely to be productive at work than healthy weight people. Further, Gates et al. (9) estimated the costs of reduced productivity in obese workers to be \$US506 per person per year greater than that of other workers.

Using nationally representative datasets from the U.S., studies have also demonstrated that obese workers are more likely to be absent from work due to illness or injury compared to healthy weight workers (7). Similarly, in a review of obesity costs in the workplace, Schmier et al. (5) reported that overweight/obese employees had higher levels of both sick leave and workplace injuries. These researchers concluded that obesity is a major factor that is

1 increasing costs in the workplace. Notably, a relationship between obesity and a range of  
2 work-related limitations has been consistently demonstrated across industries and countries  
3 (5), albeit mostly in cross-sectional studies (5, 10). Therefore, experimental studies are  
4 required to improve our understanding of the nature of these relationships and whether  
5 workplace weight loss interventions have any impact on them (5).

6  
7 The workplace is a setting with unique potential to target weight loss and improve work-  
8 related outcomes. Most adults spend a large portion of their waking hours at work and  
9 opportunities exist to elicit improvements in physical activity and dietary intake behaviours.  
10 In addition, employers may be amenable to the implementation of workplace-based weight  
11 loss programs that have potential for workplace social and economic benefits. Systematic  
12 reviews of workplace-based health promotion interventions have highlighted the urgent need  
13 for quality research to explore the impact of lifestyle programs on worksite outcomes such as  
14 productivity, absenteeism, injuries, fatigue, and quality of life. There is a paucity of research  
15 exploring worksite outcomes following physical activity (11), dietary (12) and weight loss  
16 (13) interventions and a distinct lack of randomized controlled trials (RCTs) (14). In  
17 particular, there exist few workplace-based weight loss intervention studies that have  
18 measured worksite outcomes, despite the fact that workplace based interventions are often  
19 rationalized on these potential benefits (5, 9, 13).

20  
21 Workplace interventions are also required that target and appeal to specific population sub-  
22 groups, in particular those that have greater obesity prevalence and work-related limitations.  
23 Male shift workers represent one such sub-group, as obesity in this group is prevalent (15)  
24 and associated with major work disadvantages in terms of impaired work-related capacity  
25 and, performance, on-the-job injuries and increased sick leave (16), particularly for those

1 working in heavy industry. Shift workers also have an increased risk of cardiovascular,  
2 gastrointestinal and psychological health problems compared with those who work normal  
3 daytime hours (16). This is of concern in Australia as there has been an increase in the  
4 proportion of the male population who are shift workers (17). However, internationally, no  
5 studies have targeted weight loss in the workplace with male shift workers (18), where  
6 fatigue and injuries are major occupational health and safety issues (16). Using the workplace  
7 as a setting for interventions may be convenient for shift workers, who are notoriously  
8 difficult to engage in weight loss programs (16) and because it has been reported that men  
9 prefer programs that are workplace-based (19) and convenient to access (20).

10

11 No studies have been conducted to evaluate the impact of a workplace-based weight loss  
12 program for shift workers on work-related outcomes. We hypothesized that work-related  
13 outcomes would improve for men in the intervention group following a workplace weight  
14 loss program when compared to a wait-list control group.

15

16

## METHODS AND PROCEDURES

### *Study design*

18 The study was a prospective, two-armed RCT and the methods, weight loss and physical  
19 activity and dietary outcomes have been described in detail elsewhere (21). Briefly, men were  
20 randomly allocated to one of two groups: the Workplace POWER (Preventing Obesity  
21 Without Eating like a Rabbit) program or a 14-week wait-list control group. Men worked in  
22 crews (n = 15) and were randomly allocated to four crew clusters based on the timing and  
23 rotation of shifts worked, to avoid contamination within the worksite. The crew clusters were  
24 then randomized to intervention or control groups. For the primary study (21), , based on  
25 90% power to detect a significant weight loss (primary outcome) difference between groups

1 of 3kg, assuming  $SD=5$  ( $P = 0.05$ , two-sided), and a correlation between pre and post scores  
2  $r=0.80$  (22, 23), a sample size of 41 participants for each group was needed.

3  
4 Outcome measures were obtained from participants at baseline (October, 2009) and at 14-  
5 week follow-up (March, 2010). Measurements were taken in the Health Services Department  
6 of the workplace by trained staff with experience in anthropometric assessments, using the  
7 same instruments at each time point. Participants and assessors were blind to group allocation  
8 at baseline assessment.

9

#### 10 *Participants and recruitment*

11 Overweight or obese (BMI between 25 and  $40\text{kg/m}^2$ ) men aged 18-65 were recruited from  
12 Tomago Aluminium in September 2009. Tomago is one of Australia's largest producers of  
13 aluminium, employing around 1200 staff. The site is located 13km northwest of Newcastle,  
14 NSW in the industrial suburb of Tomago. Crews of shift workers were recruited via a staff  
15 email from the Health Services Department. The Health Service Department informed crew  
16 leaders who also promoted the program at crew meetings. Exclusion criteria included history  
17 of major medical problems such as heart disease in the last five years, diabetes, orthopaedic  
18 or joint problems that would be a barrier to physical activity, recent weight loss of  $\geq 4.5\text{kg}$ , or  
19 taking medications that might affect body weight. The men provided written informed  
20 consent. Ethics approval was obtained from the University of Newcastle Human Research  
21 Ethics Committee and the project supported by Tomago Aluminium management.

#### 22 *The Workplace POWER (WP) program*

23 The 3-month WP program has been described in detail previously (21). Briefly, it consisted  
24 of four major components: a single face-to-face information session (75 minutes) providing  
25 basic education for weight loss; a study website ([www.calorieking.com.au](http://www.calorieking.com.au)) where men were

1 asked to report their weight once a week and submit regular online daily eating and exercise  
2 diaries in order to receive feedback on their entries; resources consisting of a weight loss  
3 handbook, a website user guide and a YamaxSW200 pedometer for self-monitoring and as a  
4 motivational tool; and two crew-based financial incentives consisting of a \$AU50 gift  
5 voucher per crew member to be spent at a local sporting equipment store for the crew with  
6 the highest mean percentage weight loss after one month and at the conclusion of the  
7 program.

8

9 The WP program was modeled on a previous successful male-focused weight loss program  
10 developed by our research team – the SHED-IT program (22). Some elements of the  
11 intervention (information session, booklet, feedback provided) were modified to be more  
12 specific to these men in accounting for the additional challenges of modifying dietary intake,  
13 increasing physical activity and losing weight as a shift worker (16).

14 *Outcome measures*

15 The primary outcome measure of the main study (21) was change in body weight (kg) at 14-  
16 week follow-up. Weight was measured with men wearing light clothing, without shoes on a  
17 digital scale to 0.1kg (Model no. UC-321PC, A&D Company Ltd, Tokyo Japan). Height was  
18 assessed to 0.1 cm using a stadiometer (model KaWe 44440; Medizin Technik, Mentone  
19 Education Centre, Morrabin, Australia) and BMI was calculated using the standard equation  
20 (weight [kg]/height[m]<sup>2</sup>).

21 *Socio-demographic information:* Age and socioeconomic status (SES) data were also  
22 collected. SES was based on postal code of residence using the Index of Relative  
23 Socioeconomic Advantage and Disadvantage from the Australian Bureau of Statistics census-  
24 based Socio-Economic Indexes for Areas (SEIFA) (24).



1 The following measures of work-related outcomes were of primary interest for this  
2 investigation:

3 *Sleepiness*: Daytime Sleepiness was assessed using the Epworth sleepiness scale which is a  
4 valid measure of general daytime sleepiness (25).

5 *Quality of life*: Health-related quality of life was assessed using the SF-12 physical and  
6 mental scales (26).

7 *Workplace productivity or presenteeism*: The Work Limitations Questionnaire (WLQ) short-  
8 form was used and is designed to measure the degree to which health problems interfere with  
9 the performance of job tasks and to estimate the related productivity loss. The WLQ  
10 generically assesses presenteeism. Presenteeism occurs when an employee is both mentally  
11 and physically unwell, but still goes to work, albeit at limited capacity. It has been validated  
12 in a range of different employee populations and demonstrated high reliability (10, 27). The  
13 WLQ short-form uses 8 representative items from the long version and a 2-week recall  
14 period, and consists of four scales addressing job-related (i) physical demands i.e. a person's  
15 ability to perform job tasks that involve sitting and standing in one position and repeating the  
16 same motion repeatedly; (ii) time-management demands: two items addressing the difficulty  
17 of performing a job easily at the beginning of the workday and starting the job soon after  
18 arriving at work; (iii) mental and interpersonal demands: two items relating to difficulty  
19 concentrating on work and a person's ability to interact with other people at work; and (iv)  
20 output demands: two items concerning the person's ability to complete work. Each scale  
21 provides a summary of the amount of time in the prior 2 weeks that the employee was limited  
22 in each job task dimension. For each of the scales the score may range from 0 (limited none  
23 of the time) to 100 (limited 100% of the time). The responses on all four WLQ scales are also  
24 used to generate an estimated percentage of at-work productivity loss due to health, reflecting

1 the difference, reported as a percentage, in output between ‘limited’ employees and a  
2 benchmark of employees with no limitations (27).

3 *Injuries at work:* Injury data were sourced from an on-site incident and injury recording  
4 system at Tomago Aluminium for the 12-month period before and after program  
5 commencement. All work-related injuries are reported by employees and recorded in an  
6 electronic database. Injuries can be the result of a single work place exposure or event, or the  
7 result of a cumulative exposure over time. Injuries excluded were those that occurred on the  
8 journey to and from work.

9 *Absenteeism:* All absences due to a personal illness or non work-related injury were recorded  
10 in an electronic database. Absenteeism that related to time off to care for a family member,  
11 known as ‘carers leave’ was excluded from the analysis. Absences for the 3-month period  
12 before and after program commencement were analysed. That is, absenteeism data was  
13 collected for the time period of intervention implementation. Absenteeism data are presented  
14 as hours of leave.

15  
16 *Statistical analyses*

17 Analyses were performed using PASW Statistics 17 (SPSS Inc. Chicago, IL). Prior to  
18 analysis, normality and equal variance of the data were assessed using a Kolmogorov–Smirnov  
19 test (with Lilliefors’ correction) and Levene median test, respectively. Means and standard  
20 deviations were calculated for all normally distributed variables. The significance level was  
21 set at 0.05 for all analyses. Mixed models were used to assess all outcomes. The one  
22 exception was the number of injuries for which the generalised linear mixed modelling  
23 approach was used with the Poisson distribution and identity link function in SAS using proc  
24 GLIMMIX (SAS Institute, 2008, V9.2 (TS2M2), NC, US). Mixed models were used to  
25 assess worksite outcomes for the impact of group (Intervention and Control), time (treated as

1 categorical with levels baseline and 14-weeks), and the group-by-time interaction, these three  
2 terms forming the base model. This approach was preferred to using baseline scores as  
3 covariates, as the baseline scores for subjects who dropped out at 14-weeks were retained  
4 making this an intention-to-treat analysis. To examine potential clustering of effects at the  
5 crew level, crew was nested within both the treatment and treatment-by-time terms as fixed  
6 effects and these terms were used in the final models. Age and SES were examined as  
7 covariates to see if they contributed significantly to the models. If a covariate was significant,  
8 two-way interactions with time and treatment were also examined and all significant terms  
9 were added to the final model to adjust the results for these effects. Differences of means and  
10 95% confidence intervals (CIs) were determined using the linear mixed models. Analyses  
11 included all randomized participants. Effect sizes were determined using Cohen's  $d$  (28) and  
12 calculated using mean differences from the mixed model and the pooled standard deviation of  
13 the two groups at baseline ( $d = (M_1 - M_2) / \sigma_{\text{pooled}}$ ).

14

## 15 RESULTS

### 16 *Participant flow*

17 As reported previously, 15 crews ( $n = 127$ ) were recruited and 110 overweight or obese men  
18 attended baseline assessments and were randomized by crew into Intervention ( $n=65$ ) or  
19 Control groups ( $n=45$ ). Seven men did not attend the information session. There was no  
20 difference in retention between the WP and control groups ( $\chi^2 = .48$ ,  $df = 1$ ,  $P = .49$ ). Data  
21 for all randomized participants at baseline were analyzed for outcomes at 14-week follow-up.  
22 There were no significant differences ( $P > .05$ ) in baseline characteristics between those lost  
23 to follow-up and those retained for any of the outcomes.

24

### 25 *Baseline data*

1 Table 1 presents the baseline characteristics. There were no significant differences in baseline  
2 scores for any variables between intervention and control men ( $P > .05$ ). Mean BMI was 30.5  
3 ( $3.6 \text{ kg/m}^2$ ) with 45.5% of the sample considered obese ( $\text{BMI} > 30$ ). The ability to perform the  
4 physical demands of the job was impaired on average about 21% of the time in the previous 2  
5 weeks. The ability to meet output (10%), mental/interpersonal (14%) and time (25%)  
6 demands were all affected, on average, to varying degrees. According to the WLQ  
7 productivity loss percentage, the average man was estimated to have lost about 4%  
8 productivity due to illness. Men had an average of 11.3 hours sick leave in the previous 3  
9 months and 0.4 injuries per person during the previous year.

#### 10 *Change in primary outcome*

11 There was a significant treatment effect for change in weight at 14-week follow-up ( $P < .001$ ;  
12  $d = .34$ ) with a mean difference between groups of 4.4kg. There was also a significant  
13 difference in percentage weight loss between groups ( $P < .001$ ). At follow-up, significantly  
14 more participants (33.3%) in the WP group had lost more than 5% of their baseline weight  
15 compared to the control group (0%) ( $\chi^2 = 13.6$ ,  $df = 1$ ,  $P < .001$ ).

#### 16 *Change in work-related outcomes*

17 Significant treatment effects were also found from baseline to 14-weeks for quality of life  
18 (mental) ( $P = .01$ ), work-based physical demands ( $P = .04$ ), overall productivity loss or  
19 presenteeism ( $P = .01$ ), absenteeism ( $P = .01$ ) and injuries in the workplace ( $P = .04$ ).  
20 Medium-to-large effect sizes (range from  $d = .34 - .74$ ) were found for these outcomes. No  
21 group-by-time effect was found for sleepiness, quality of life (physical) or the three other  
22 work limitations scales (time, mental or output demands) ( $P > .05$ ).

23

24

## DISCUSSION

1 The main aim of this investigation was to evaluate the impact of a workplace-based weight  
2 loss program on key work-related outcomes in overweight male shift workers. To the  
3 authors' knowledge, this is the first study that has demonstrated a number of work-related  
4 benefits following a weight loss intervention within the workplace. The Workplace POWER  
5 program targeted blue collar workers and resulted in significant medium-to-large intervention  
6 effect sizes, not only for weight (21), but also for the work domains of presenteeism,  
7 absenteeism, quality of life (mental), and on-the-job injuries.

8

9 No previous studies have been conducted to determine the impact of obesity interventions on  
10 work-related outcomes of shift workers (13), which means there are no findings with which  
11 to make direct comparisons. Most of the current evidence relating to obesity and worksite  
12 outcomes is from cross-sectional studies (5, 10) or from non-randomized worksite health  
13 promotion programs, consequently the evidence base is severely limited (14). In a recent  
14 meta-analysis of workplace physical activity interventions, only a few studies examined  
15 work-related outcomes, and of those that did, findings for improved attendance, job  
16 satisfaction and stress reduction were mixed (11). For example, Puig et al. demonstrated the  
17 potential to improve presenteeism through walking interventions, although improvements  
18 were only observed in the least active group of university employees (29). Similarly, in a  
19 recent systematic review examining the association between physical activity and indicators  
20 of workplace well-being, findings were inconclusive but only one study examined  
21 presenteeism (30). In a review described in Proper et al. 2008 (14) the effectiveness of  
22 worksite physical activity and diet programs was examined, only nine studies were located  
23 that evaluated the impact on work-related outcomes. Overall, the findings were inconsistent  
24 with more than half showing a null effect and most only evaluated the effect on sick leave.

1 No RCTs have examined the effect of dietary or weight loss interventions on work-related  
2 outcomes to date (12).

3

4 Our positive findings for reductions in presenteeism (or productivity losses), injuries and  
5 absenteeism are important. Our results suggest the WP program reduced the degree to which  
6 health problems interfered with the performance of job tasks of the shift workers and reduced  
7 absenteeism and injuries, which may have been a result of the clinically important weight  
8 loss (31) and/or improved lifestyle behaviours. We have previously reported significant  
9 intervention effects for WP on physical activity levels and resting heart rate (as a proxy of  
10 aerobic fitness), represented by large effect sizes (32). However, we are not able to discern  
11 whether the worksite outcome improvements were a direct result of weight loss (albeit  
12 moderate) or due to the improvements in physical activity and general fitness (independent or  
13 even in the absence of weight loss). Further research is required to determine whether weight  
14 loss and/or lifestyle behaviour change were the mediators for change in the work-related  
15 outcomes. The change in weight and change in work-related outcomes were concurrent and a  
16 mediation analysis may help determine causality.

17

18 In relation to workplace health, presenteeism has been described as being physically present  
19 at work but in poor health and performing below average with poor quality output (30).

20 Presenteeism represents a substantial indirect cost to employers, and has been estimated to be  
21 greater than that for absenteeism and other medical costs (33). In a U.S. study, productivity  
22 losses of 4.9% for staff at a large telecommunications firm, as measured by the WLQ,  
23 translated into losses of approx \$US2,000 per employer per year respectively (34). The shift  
24 workers in the current study reported a 4% health-related loss in productivity at baseline and  
25 a 2% mean group difference at post-test. This 2% mean difference can be translated to

1 \$AU1,600 per employer per year of on-the-job productivity losses (based on a salary of  
2 \$AU80,000 per year in 2011). Studies of large cohorts (n >28,000) have demonstrated that  
3 self-reported behavioural and psychological health risks are strongly associated with self-  
4 reported presenteeism (33). A recent systematic review demonstrated an emerging  
5 relationship between body weight and presenteeism (10).

6  
7 In relation to the specific scales of the Work Limitations Questionnaire, we only found a  
8 statistically significant treatment effect for the physical demands scale, although all scales  
9 (time, mental and output) were quantified as medium effect sizes. In Gates et al.'s (9) study  
10 of the relationship between obesity and presenteeism, they found that the job limitations most  
11 affected by obesity were physical and time demands rather than mental demands or output  
12 demands. The physical demand scale of the WLQ examines an individual's difficulty to  
13 move to perform essential work tasks. A possible explanation for our positive findings for the  
14 physical demands scale is that some of the negative physical consequences of excess weight  
15 (such as pain, musculoskeletal joint-related pain, decreased balance and coordination, sleep  
16 apnoea, shortness of breath, weakness) may have improved following weight loss. In  
17 particular, a worker's ability to move with fewer physical limitations due to weight loss could  
18 result in increased productivity in job functions that are more physically demanding, such as  
19 those performed by shift workers in heavy industry. The work typical at Tomago Aluminium  
20 requires men to engage in various physical movements including bending, stretching,  
21 squatting, pushing and walking and thus being overweight, obese or unfit may represent a  
22 physical limitation and affect the quality of performance and output. Hence, this group  
23 potentially have more work performance-related potential benefits from participation in  
24 programs of this nature.

25

1 The relationship between BMI and presenteeism has been described as non-linear and is  
2 represented by a threshold effect where moderately and extremely obese workers are  
3 significantly less productive than mildly obese workers (9). It is of interest that our values for  
4 all WLQ scales were comparable to the moderately/extremely obese male and female  
5 manufacturing workers in Gates' study (9). They reported that those with a BMI between 25-  
6 35 did not experience any adverse productivity effects (9). However, the shift workers in our  
7 study had higher productivity losses, at a lower mean BMI, possibly explained by being male  
8 shift workers, where even at a lower BMI, being overweight is associated with a poorer  
9 health profile (15). This is supported by Gates et al.'s (9) findings that plant workers have  
10 significantly higher mean scores for the physical demand scale than office workers. It is  
11 important to note that presenteeism was self-reported and social desirability and resentful  
12 demoralisation are potential sources of bias. The control group reported worse scores at post-  
13 test for some quality of life and work limitations variables even in the absence of weight loss.  
14 While the exact reasons are unable to be discerned, these findings may be explained by the  
15 control group feeling disenfranchised with lower morale as a result of being allocated to a  
16 control group, or by the nature of the work environment at that time.

17

18 Notably, a significant treatment effect for absenteeism was also found, when comparing leave  
19 hours in the 3 months prior to commencing the program with leave hours throughout the  
20 program. Absenteeism increases in line with increasing levels of obesity (5), although there is  
21 some inconsistency across studies to date which may relate to most studies being cross-  
22 sectional (35). For example, in a recent systematic review there was inconclusive evidence  
23 for a relationship between overweight and sick leave (36). A review examining the financial  
24 impact of general worksite health promotion programs found that 11 studies reported a  
25 reduction in absenteeism, but many had methodological limitations (14).



1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18

Our findings are somewhat in contrast to the few studies examining obesity treatment effects on absenteeism (37-39). These intervention studies differed substantially in design, reported smaller changes in BMI (albeit with longer term follow-up) and absenteeism data were collected over a longer period. However, none of these studies targeted an at-risk population group such as male shift workers. In one of the only worksite weight loss RCTs that measured worksite outcomes, the Work, Weight and Wellness (3W) study targeted weight loss in Hawaiian hotel employees (40). While the 3W program resulted in reduced BMI after 2 years, no benefit from reduced absenteeism was reported (38). The reported change in BMI units ( $0.47 \text{ kg/m}^2$ ) in the 3W program was substantially less than in WP ( $1.3 \text{ kg/m}^2$ ) and may explain our positive findings. It is noted that the 3W study included a 2 year follow-up. In addition, in a secondary longitudinal analysis of the WAY to Health study, the authors found no evidence that overweight employees who lost at least 5% of their weight experienced decreased absenteeism during the 12-month intervention or after 2 years, although participants self-reported absenteeism (39). It is important to highlight that the WAY to Health study included mostly women (80%) and it was noted that men showed statistically lower rates of absenteeism by reporting fewer workdays missed than women.

19 It is important to point out that other worksite interventions have targeted improved lifestyle  
20 behaviours in at-risk groups and also demonstrated improved absenteeism. For example, in a  
21 lifestyle intervention to prevent cardiovascular disease in an at-risk sub group of the  
22 Scandinavian workforce, reduced sick days was found over a 4-month period favouring the  
23 intervention group (41), following a BMI reduction of  $0.7 \text{ kg/m}^2$ . Another possible  
24 explanation for the worksite benefits observed in the WP program may have been the nature  
25 of the intervention, the use of competition between crews for prizes and the focus on social

1 support within crews, which may have increased the motivation of men and also increased  
2 feelings of commitment to colleagues and led to additional social and emotional workplace  
3 benefits. This may have positively influenced mental health, productivity, and ultimately  
4 absenteeism.

5

6 Our findings for on-the-job injuries are also significant as shift workers in heavy industry  
7 experience considerable occupational health and safety risks as a result of the tasks they are  
8 required to perform at work. Few studies have been conducted examining the relationship  
9 between work-related injuries and obesity (35), but some studies have found a higher BMI to  
10 be associated with increased workplace injuries (5, 42). Our findings for worksite injuries  
11 may be a result of improvements in both mental health and physical functioning following  
12 weight loss and improved physical activity levels. In addition, our significant treatment effect  
13 and large effect size for quality of life in the mental domain is noteworthy as obesity has been  
14 found to reduce quality of life (43).

15

16 We did not find an intervention effect for sleepiness, although a trend favouring the  
17 intervention group was evident. Shift work is a major cause of sleepiness as it requires  
18 workers to be awake at times which are different to those dictated by their ‘body clock’ (16).  
19 Sleepiness can lead to deterioration in performance and is associated with an increased risk of  
20 error and injury (44). We may have been underpowered to detect significant differences in  
21 sleepiness.

22

### 23 *Implications*

24 Our findings for the short-term positive impact of a workplace-based weight loss program on  
25 key worksite outcomes may help policy makers and employers consider the implementation

1 of similar programs as an investment and opportunity to improve the overall health and  
2 productivity of their employees. However, the WP program only had a 14-week follow-up  
3 and we have not established if any improvements were maintained in the longer term. Future  
4 research is required to evaluate this program in a long term effectiveness trial to ensure a  
5 stronger evidence base for policy change or a possible roll out.

6

7 Given that the effect of obesity on work-related outcomes may vary depending on the  
8 industry and characteristic of the workforce (5), weight loss programs are particularly  
9 important for shift working men in heavy industry, given they are at increased health risk  
10 (15). Blue collar workers often have less access and are less likely to participate in worksite  
11 health programs and also exhibit poorer lifestyle behaviours (18). In addition, blue collar  
12 workers are more likely to be injured or get sick as a result of workplace hazards, and display  
13 a poorer health profile (15) when compared to those in white collar occupations (45).

14

15 Workplace-based weight loss interventions have the potential to lower costs in relation to  
16 medical care, presenteeism and absenteeism which may improve both company profits and  
17 staff well being. Presenteeism is always an issue of importance in the workplace, as workers  
18 will receive full pay despite reduced productivity and decreasing absenteeism would lead to  
19 further costs saving.

20

21 Given the current findings regarding weight loss and worksite injuries, another strategy with  
22 potential to improve uptake and interest from employees is to integrate workplace health  
23 interventions with occupational health and safety programs. This has been identified as a way  
24 to promote and protect worker health, particularly for blue collar workers (46) as evidence

1 exists that exposure to job hazards is correlated with health behaviours among blue collar  
2 workers (46).

3

4 As a possibly promising public health strategy, interventions of this kind in an at risk  
5 subgroup of the working population need to be further evaluated and considered as a novel  
6 way to reduce obesity prevalence in men. Importantly, compared to many previous programs  
7 (13, 18) ours required minimal time commitment from the workplace and used an innovative  
8 and potentially cost effective delivery medium.

9

10 Our study addressed many of the weaknesses identified in the literature (13, 18). Its strengths  
11 included a randomized design, waiting list control group, high retention rate, intention-to-  
12 treat analysis, and measurement of novel and rarely reported worksite outcomes. Study  
13 limitations need to be acknowledged. First, the WP program only had a 14-week follow-up; a  
14 longer follow-up is required in future studies. Second, we only targeted one employer, so the  
15 generalisability of our findings may be limited. Third, it is difficult to assess productivity  
16 objectively and the study's self-reported measures may have some limitations.

17

### 18 *Conclusion*

19 In summary, a weight loss program that achieved clinically important weight loss in  
20 overweight male shift workers was associated with improved health-related quality of life,  
21 workplace productivity, absenteeism and injuries at work. Our findings provide preliminary  
22 evidence for both social and economic benefits for employers from a worksite weight loss  
23 program targeting an at-risk sub group of the population.

24

25

26

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27

REFERENCES

1. Ogden CL, Yanovski SZ, Carroll MD, Flegal KM. The epidemiology of obesity. *Gastroenterology*. 2007;132(6):2087-102.
2. Bray GA. Medical Consequences of Obesity. *The Journal of Clinical Endocrinology & Metabolism*. 2004;89(6):2583-9.
3. Withrow D, Alter DA. The economic burden of obesity worldwide: a systematic review of the direct costs of obesity. *Obes Rev*. 2010;12:131-41.
4. Access Economics. The growing cost of obesity in 2008: three years on. Canberra: Report for Diabetes Australia 2008.
5. Schmier JK, Jones ML, Halpern MT. Cost of obesity in the workplace. *Scandinavian Journal of Work Environment & Health*. [Review]. 2006 Feb;32(1):5-11.
6. Ostbye T, Dement JM, Krause MA. Obesity and workers' compensation. *Arch Intern Med*. 2007;167:766-73.
7. Ricci JA, Chee E. Lost productive time associated with excess weight in the U.S. workforce. *J Occup Environ Med*. 2005;47(12):1227-34.
8. Burkhauser RV, Cawley J. Beyond BMI: The value of more accurate measures of fatness and obesity in social science research 2006 Contract No.: 12291.
9. Gates DM, Succop P, Brehm BJ, Gillespie GL, Sommers BD. Obesity and presenteeism: The impact of body mass index on workplace productivity. *J Occup Environ Med*. 2008;50(1):39-45.
10. Schultz AB, Edington DW. Employee health and presenteeism: A systematic review. *J Occup Rehabil*. [Review]. 2007 Sep;17(3):547-79.
11. Conn VS, Hafdahl AR, Cooper PS, Brown LM, Lusk SL. Meta-Analysis of Workplace Physical Activity Interventions. *Am J Prev Med*. [Review]. 2009 Oct;37(4):330-9.
12. Mhurchu CN, Aston LM, Jebb SA. Effects of worksite health promotion interventions on employee diets: a systematic review. *BMC Public Health*. [Review]. 2010 Feb;10(62).

- 1 13. Benedict MA, Arterburn D. Worksite-Based weight loss programs: A systematic  
2 review of recent literature. *Am J Health Promot.* [Review]. 2008 Jul-Aug;22(6):408-16.
- 3 14. Proper K, van Mechelen W. Effectiveness and economic impact of worksite  
4 interventions to promote physical activity and healthy diet. Geneva, Switzerland2008.
- 5 15. Karlsson BH, Knutsson AK, Lindahl BO, Alfredsson LS. Metabolic disturbances in  
6 male workers with rotating three-shift work. Results of the WOLF study. *Int Arch Occup*  
7 *Environ Health.* 2003 Jul;76(6):424-30.
- 8 16. Atkinson G, Fullick S, Grindey C, Maclaren D. Exercise, energy balance and the shift  
9 worker. *Sports Med.* [Review]. 2008;38(8):671-85.
- 10 17. Australian Bureau of Statistics. 6105.0 Australian Labour Market Statistics. Canberra:  
11 ABS; 2010.
- 12 18. Anderson LM, Quinn TA, Glanz K, Ramirez G, Kahwati LC, Johnson DB, et al. The  
13 effectiveness of worksite nutrition and physical activity interventions for controlling  
14 employee overweight and obesity: a systematic review. *Am J Prev Med.* 2009 Oct;37(4):340-  
15 57.
- 16 19. Sabinsky MS, Toft U, Raben A, Holm L. Overweight men's motivations and  
17 perceived  
18 barriers towards weight loss. *Eur J Clin Nutr.* 2007;61:526-31.
- 19 20. Morgan PJ, Warren JM, Lubans DR, Collins CE, Callister R. Engaging men in weight  
20 loss: Experiences of men who participated in the male only SHED-IT pilot study. *Obesity*  
21 *Research and Clinical Practice.* in press;Accepted March,  
22 2011(doi:10.1016/j.orcp.2011.03.002 ).
- 23 21. Morgan PJ, Collins CE, Plotnikoff RC, Cook AT, Berthon B, Mitchell S, et al.  
24 Efficacy of a workplace-based weight loss program for overweight male shift workers: the

- 1 Workplace POWER (Preventing Obesity Without Eating like a Rabbit) randomized  
2 controlled trial. *Prev Med.* in press.
- 3 22. Morgan PJ, Lubans DR, Collins CE, Warren JM, Callister R. The SHED-IT  
4 Randomized Controlled Trial: Evaluation of an Internet-based Weight Loss Program for  
5 Men. *Obesity.* 2009;17(11):2025-32.
- 6 23. Morgan PJ, Lubans DR, Callister R, Okely AD, Burrows T, Fletcher R, et al. The  
7 'Healthy Dads Healthy Kids' randomized controlled trial: Efficacy of a healthy lifestyle  
8 program for overweight fathers and their children. *Int J Obes.* 2011;35:436-47.
- 9 24. Australian Bureau of Statistics. Socio-economic Indexes for Areas (SEIFA) Australia-  
10 2006: Postal Areas, Index of Relative Socio-economic Advantage and Disadvantage.  
11 Canberra: Commonwealth of Australia: 2008. Report No.: ABS catalogue 2033.0.55.001.
- 12 25. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness  
13 scale. *Sleep.* 1991 Dec;14(6):540-5.
- 14 26. Ware J, Jr., Kosinski M, Keller SD. A 12-Item Short-Form Health Survey:  
15 construction of scales and preliminary tests of reliability and validity. *Med Care.* 1996  
16 Mar;34(3):220-33.
- 17 27. Lerner D, Rogers WH, Chang H. Scoring the Short Form of the Work Limitations  
18 Questionnaire (WLQ-SF)2009 Revised January 23, 2009.
- 19 28. Cohen J. *Statistical power analysis for the behavioral sciences.* 2nd ed. Hillsdale, NJ:  
20 Lawrence Earlbaum Associates; 1988.
- 21 29. Puig-Ribera A, McKenna J, Gilson N, Brown W. Change in work day step counts,  
22 wellbeing and job performance in Catalan university employees: a randomised controlled  
23 trial. *Promotion & Education.* 2008;15(4):11.

- 1 30. Brown HE, Gilson ND, Burton NW, Brown WJ. Does Physical Activity Impact on  
2 Presenteeism and Other Indicators of Workplace Well-Being? . Sports Med. 2011;41(3):249-  
3 62.
- 4 31. Diabetes Prevention Program Research Group. Reduction in the Incidence of Type 2  
5 Diabetes with Lifestyle Intervention or Metformin. N Engl J Med. 2002;346(6):393-403.
- 6 32. Morgan PJ, Collins CE, Plotnikoff RC, Cook AT, Berthon B, Mitchell S, et al.  
7 Efficacy of a workplace-based weight loss program for overweight male shift workers: the  
8 Workplace POWER (Preventing Obesity Without Eating like a Rabbit) randomized  
9 controlled trial. Prev Med. 2011;52:317-25.
- 10 33. Burton WN, Chen CY, Conti DJ, Schultz AB, Pransky G, Edington DW. The  
11 association of health risks with on-the-job productivity. J Occup Environ Med.  
12 2005;47(8):769-77.
- 13 34. Ozminkowski RJ, Goetzel RZ, Chang S, Long S. The application of two health and  
14 productivity instruments at a large employer. J Occup Environ Med. 2004 Jul;46(7):635-48.
- 15 35. Schulte PA, Wagner GR, Ostry A, Blanciforti LA, Icutlip RG, Krajnak KM, et al.  
16 Work, obesity, and occupational safety and health. Am J Public Health. [Review]. 2007  
17 Mar;97(3):428-36.
- 18 36. van Duijvenbode DC, Hoozemans MJM, van Poppel MNM, Proper KI. The  
19 relationship between overweight and obesity, and sick leave: a systematic review.  
20 International Journal of Obesity. 2009:807-16.
- 21 37. Williams AE, Vogt TM, Stevens VJ, Albright CA, Nigg CR, Meenan RT, et al. Work,  
22 weight, and wellness: The 3W program: A worksite obesity prevention and intervention trial.  
23 Obesity. 2007 Nov;15:16S-26S.



- 1 38. Meenan RT, Vogt TM, Williams AE, Stevens VJ, Albright CL, Nigg C. Economic  
2 Evaluation of a Worksite Obesity Prevention and Intervention Trial Among Hotel Workers in  
3 Hawaii. *J Occup Environ Med.* 2010;52(1):S8-S13.
- 4 39. Finkelstein EA, Linnan LA, Tate DF, Leese PJ. A Longitudinal Study on the  
5 Relationship Between Weight Loss, Medical Expenditures, and Absenteeism Among  
6 Overweight Employees in the WAY to Health Study. *J Occup Environ Med.*  
7 2009;51(12):1367-73.
- 8 40. Williams AE, Vogt TM, Stevens VJ, Albright CA, Nigg CR, Meenan RT, et al. Work,  
9 weight, and wellness: the 3W program. A worksite obesity prevention and intervention trial.  
10 *Obesity.* 2007;15:16S-26S.
- 11 41. Nilsson P, Klasson E, Nyberg P. Life-style intervention at the worksite-reduction of  
12 cardiovascular risk factors in a randomized study. *Scandinavian Journal of Work  
13 Environment and Health.* 2001;27(1):57-62.
- 14 42. Chau N, Mur JM, Touron C, Benamghar L, Dehaene D. Correlates of occupational  
15 injuries for various jobs in railway workers: a case-control study. *Journal of Occupational  
16 Health.* 2004;46:272-80.
- 17 43. Heo M, Allison DB, Faith MS, Zhu S, Fontaine KR. Obesity and quality of  
18 life:mediating effects of pain and comorbidities. *Obes Res.* 2003;11:209-16.
- 19 44. Folkard S, Lombardi DA, Tucker PT. Shiftwork: Safety, Sleepiness and Sleep. *Ind  
20 Health.* 2005;43:20-3.
- 21 45. National Institute for Occupational Safety and Health. Worker health chartbook 2000.  
22 Washington DC2000.
- 23 46. Quintiliani L, Sattelmair J, Sorensen G. The workplace as a setting for interventions  
24 to improve diet and promote physical activity. Geneva, Switzerland: World Health  
25 Organisation2008.
- 26

**Table 1**      **Baseline characteristics of men randomized to the Workplace POWER intervention and control group**

**Table 2**      **Changes in variables for participants by group from baseline to 14-weeks and differences in outcomes among the groups at 14-weeks (ITT analysis)**

**Table 1 Baseline characteristics of men randomized to the Workplace POWER intervention and control group**

	<i>Control (n =45)</i>		<i>Intervention (n =65)</i>		<i>Total (n = 110)</i>	
	<i>Mean</i>	<i>(sd)</i>	<i>Mean</i>	<i>(sd)</i>	<i>Mean</i>	<i>(sd)</i>
Age (years)	43.7	9.1	44.8	8.3	44.4	8.6
Weight (kg)	92.9	14.1	96.3	12.9	94.9	13.4
Height (m)	1.75	.07	1.77	.06	1.76	.06
BMI (kg/m <sup>2</sup> )	30.2	3.5	30.7	3.6	30.5	3.6
Sleepiness score <sup>a</sup>	6.8	3.8	6.6	3.9	6.7	3.8
<i>Quality of life<sup>a</sup></i>						
SF-12 physical health	50.7	7.2	49.5	6.4	50.0	6.7
SF-12 mental health	51.0	8.6	51.5	9.2	51.2	8.9
<i>Work Limitations<sup>a</sup></i>						
Time demands	24.3	23.3	25.5	26.5	25.0	25.1
Physical demands	17.9	23.3	24.5	20.2	21.7	21.7
Mental demands	12.8	15.4	14.5	18.3	13.8	17.0
Output demands	9.1	12.7	11.0	14.8	10.2	13.9
Productivity loss %	3.9	3.0	4.4	3.6	4.2	3.4
Absenteeism (leave hours) <sup>bc</sup>	10.7	10.9	11.8	11.8	11.3	11.4
Injuries in the workplace <sup>d</sup>	0.4	0.8	0.4	0.7	0.4	0.7
	<i>n</i>	<i>(%)</i>	<i>n</i>	<i>(%)</i>	<i>n</i>	<i>(%)</i>
<i>SES<sup>e</sup></i>						
1-2 (lowest)	1	2.2	6	9.3	7	3.6
3-4	7	15.5	9	13.8	16	14.5
5-6	23	51.1	24	36.9	47	42.7
7-8	6	13.3	10	15.4	16	14.5
9-10 (highest)	0	0.0	3	4.6	3	2.7
<i>BMI category</i>						
Overweight, n (%)	27	50.8	33	50.8	60	54.5
Obese, n (%)	18	49.2	32	49.2	50	45.5

Abbreviations: sd = standard deviation; SES = socioeconomic status; BMI = Body Mass Index.

<sup>a</sup>N = 86 (n = 49 Intervention; n = 37 Control) - for each scale the score may range from 0 (limited none of the time) to 100 (limited 100% of the time); <sup>b</sup>N = 103 (n = 58 Intervention; n = 45 Control); <sup>c</sup>Leave hours in the 3 months before and after program commencement (n=103); <sup>d</sup> Injuries in the 12 months before and after program commencement; <sup>e</sup>Socioeconomic status by population decile for SEIFA Index of Relative Socioeconomic Advantage and Disadvantage.

**Table 2** Changes in variables for participants by group from baseline to 14-weeks and differences in outcomes among the groups at 14-weeks (ITT analysis)

Outcome	Treatment group		Mean difference between groups (95% CI) <sup>b</sup>	Group x time P-value	Effect size (Cohen's d)
	Mean change from baseline (95% CI) <sup>a</sup>				
	Control	WP program			
Weight (kg) <sup>c</sup>	0.3 (-0.1, 1.7)	-4.0 (-5.1, -2.9)	4.4 (2.6, 6.1)	<0.001	0.34
BMI (kg/m <sup>2</sup> ) <sup>d</sup>	0.1 (-0.3, 0.6)	-1.3 (-1.6, -0.9)	1.4 (0.9, 2.0)	<0.001	0.41
Sleepiness score	0.2 (-0.9, 1.3)	-0.8 (-1.8, 0.2)	1.0 (-0.4, 2.5)	0.17	0.26
<i>Quality of life</i>					
SF-12 physical health	-1.5 (-3.8, 0.8)	1.3 (-0.8, 3.3)	2.8 (-0.3, 5.9)	0.08	0.42
SF-12 mental health	-3.1 (-5.9, -0.3)	2.5 (-0.1, 5.0)	5.6 (1.8, 9.3)	0.01	0.74
<i>Work Limitations<sup>e</sup></i>					
Time demands	0.8 (-8.0, 9.7)	-6.9 (-14.8, 1.1)	7.7 (-4.2, 19.6)	0.20	0.37
Physical demands	5.8 (-1.2, 12.8)	-4.0 (-10.4, 2.4)	9.8 (0.3, 19.3)	0.04	0.41
Mental demands	1.0 (-3.5, 5.5)	-4.0 (-8.2, 0.1)	5.0 (-1.1, 11.2)	0.11	0.35
Output demands	6.2 (-1.4, 13.9)	0.1 (-6.8, 6.9)	6.1 (-4.1, 16.4)	0.23	0.29
Productivity loss %	1.0 (-0.2, 2.1)	-1.0 (-2.0, 0.0)	2.0 (0.5, 3.5)	0.01	0.56
Absenteeism (leave hours) <sup>f</sup>	5.1 (0.5, 9.6)	-3.1 (-7.1, 0.9)	8.2 (2.1, 14.2)	0.01	0.72
Injuries in the workplace <sup>g</sup>	0.1 (-0.1, 0.3)	-0.2 (-0.3, -0.0)	0.3 (0.0, 0.6)	0.04	0.50

Abbreviations: ITT = intention to treat; - = minus; CI = confidence interval; WP = Workplace POWER; BMI = body mass index;

<sup>a</sup> Time differences were calculated as (14 week - baseline); <sup>b</sup> Between group differences at 14 weeks for mean change (Control – Treatment); <sup>c</sup> model adjusted for age; <sup>d</sup> model adjusted for SES; <sup>e</sup> for each scale the score may range from 0 (limited none of the time) to 100 (limited 100% of the time) <sup>f</sup> Leave hours in the 3 months before and after program commencement (n=103); <sup>g</sup> Injuries in the 12 months before and after program commencement .