Participant characteristics associated with greater reductions in waist circumference during a four-month, pedometer-based, workplace health program

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Abstract

Background: Workplace health programs have demonstrated improvements in a number of risk factors for chronic disease. However, there has been little investigation of participant characteristics that may be associated with change in risk factors during such programs. The aim of this paper is to identify participant characteristics associated with improved waist circumference (WC) following participation in a four-month, pedometer-based, physical activity, workplace health program.

Methods: 762 adults employed in primarily sedentary occupations and voluntarily enrolled in a four-month workplace program aimed at increasing physical activity were recruited from ten Australian worksites in 2008. Seventy-nine percent returned at the end of the health program. Data included demographic, behavioural, anthropometric and biomedical measurements. WC change (before versus after) was assessed by multivariable linear and logistic regression analyses. Seven groupings of potential associated variables from baseline were sequentially added to build progressively larger regression models.

Results: Greater improvement in WC during the program was associated with having completed tertiary education, consuming two or less standard alcoholic beverages in one occasion in the twelve months prior to baseline, undertaking less baseline weekend sitting time and lower baseline total cholesterol. A greater WC at baseline was strongly associated with a greater improvement in WC. A sub-analysis in participants with a ‘high-risk’ baseline WC revealed that younger age, enrolling for reasons other than appearance, undertaking less weekend sitting time at baseline, eating two or more pieces of fruit per day at baseline, higher baseline physical functioning and lower baseline body mass index were associated with greater odds of moving to ‘low risk’ WC at the end of the program.

Conclusions: While employees with ‘high-risk’ WC at baseline experienced the greatest improvements in WC, the other variables associated with greater WC improvement were generally indicators of better baseline health. These results indicate that employees who started with better health, potentially due to lifestyle or recent behavioural changes, were more likely to respond positively to the program. Future health program initiators should think innovatively to encourage all enrollees along the health spectrum to achieve a successful outcome.

Keywords: waist circumference, workplace, association, prevention, risk-factor, cardiovascular disease, diabetes, health promotion, physical activity, pedometer
**Background**

Workplace health programs have demonstrated improvements in the leading global risk factors for chronic disease [1,2] which has led to their increasing role in chronic disease prevention [1,2]. The majority of research has focused upon evaluating the program outcomes [1,3-7] and program characteristics [2-5,7,8] which have increased the evidence-base for workplace health programs. However, there has been little evaluation of participant characteristics and process indicators that may be related to subsequent change in risk factors during such programs.

Identifying variables associated with a successful outcome in health promotion programs can help to determine the health program’s reach and its effectiveness at enrolling a variety of participants, including employees with high health risks. The assessment of variables associated with the program can also be used to identify any inequities in the health program through identification of differences in outcome according to characteristics such as education status. Consequently, variables associated with program success can potentially be used to improve the reach and success of a health program, and this can be achieved by addressing any inequities in the targeting of enrolees or response to the program.

A number of workplace health program evaluations have demonstrated immediate improvements in physical activity, blood pressure and anthropometric measures [9]. As a direct intermediary between physical activity and disease [10-13], waist circumference (WC) can be considered a useful marker of the success of such programs. Only one workplace health program evaluation which considered participant characteristics associated with successful outcomes has been identified [14]. To adequately evaluate variables associated with success in workplace health programs, a comprehensive evaluation needs to be undertaken in a large workplace health program with a range of potential association variables including demographic, behavioural, anthropometric, biomedical and process measures, that can be (where appropriate) assessed in accordance to clinically relevant guidelines. We recently performed an evaluation of a four-month, pedometer-based, workplace health program, with a range of measures at baseline. A pre-post analysis of this program found that WC decreased on average by 1.6 cm [9,15].

The aim of this paper is to identify participant characteristics that are associated with greater improvements in waist circumference (WC) following participation in a four-month, pedometer-based, workplace health program.

**Methods**

**Study population**

Melbourne workplaces undertaking the 2008 Global Corporate Challenge® (GCC®) event were approached to be evaluation sites. Following receipt of the Workplace Consent, employees enrolled in the 2008 GCC® event were approached via email. In early 2008, 762 eligible participants were recruited from ten workplaces, providing a variety of sedentary occupations [9,15]. Seventy-nine percent (n = 604) of participants returned directly after the health program for the four-month data collection [9]. Participants who returned for four-month data collection were less likely to report having diabetes and more likely to be older, participate in the GCC® due to health reasons, be a non-smoker and comply with the health program by undertaking 10,000 daily steps on average [9]. Eighty-eight percent (n = 671) of the total sample at baseline completed the WC measurement. Eighty percent (n = 539) of these participants returned to complete the WC measurement at four-months (89% of the total sample who returned at four-months) [9].

**Description of the program**

The GCC® is the provider of a pedometer-based workplace program that is established world-wide and occurs annually. The program involves wearing a visible step-count pedometer with a target of at least 10,000 steps per day for 125 days. Weekly encouragement emails are sent and a website is used for logging daily steps, accessing additional health information, communication amongst participants and comparing team progress. Participation requires an employer or employee financial contribution and is typically competitive.

**Data collection**

Data were collected directly prior to the GCC® 2008 event (baseline) and immediately after completion of the GCC® 2008 event (four-month follow-up). In brief, trained staff visited employees’ workplaces for scheduled morning appointments to collect fasting anthropometric and biomedical measurements. Before measurements, participants were asked to remove outer garments, belts and workplace ID tags from around their waists. To record WC, participants were asked to point out their lower rib margin and the top of the hip (iliac crest) and the measurement was taken midway. Waist was recorded using a Figure Finder Tape Measure (Novel Products Inc 2005 code PE024) and a mirror to ensure that the tape was horizontal. An Internet-based self-report questionnaire was completed by participants at their own convenience. The questionnaire incorporated demographic information [16-18], motivation and support for participation, a health history [16] and behavioural measures [16,18,19]. Meeting alcohol guidelines was defined as consuming two or fewer standard drinks on one occasion in the last twelve months [20]. Other national measurement guidelines for risk assessment are summarised in Table 1, including diabetes type 2 and cardiovascular disease predicted risk scores [9,15].
Step information
Step information was obtained by the GCC® through participation in the program. Participants were asked to enter their step-counts, as indicated on the pedometer, daily into the website diary. Bicycle ride length was also recorded on a daily basis and incorporated into the step-count by the GCC® (6.4 km = 10,000 steps).

Further methodological details of the GCC® Evaluation Study have been described elsewhere [9,15].

Outcome
WC has been shown to be a better predictor of metabolic risk than body mass index, due to the independent association between an increased WC with health [10-13] and mortality [10,21-25]. Reduction in WC can be achieved through lifestyle changes and is an achievable goal for workplace health program initiatives. Recently it was identified that completion of this four-month, pedometer-based, workplace health program was associated with improvements in WC of 1.6 cm on average [9]. WC change for each participant was calculated by subtracting their baseline measurement from their four-month follow-up measurement.

Variable selection
All measured variables at baseline, i.e. participant characteristics present prior to commencing the program, were considered potential “predictors” of WC change in the sense that the characteristics pre-dated the program-related changes. The only exception was the process variable, indicating compliance with the program, as measured by step count. Where possible these variables were considered as having a linear continuous-scale relationship with WC change rather than using categorisations that may be arbitrary. Several variables were assessed in accordance to clinically relevant guidelines as summarised in Table 1 [9,15].

Analysis
All analyses were performed using Stata version 11 (Stata Corporation, TX). Robust standard errors, clustered by workplace, were used in all statistical analyses, including the calculation of confidence intervals. A p-value <0.05 was used to determine statistical significance.

Variables related to WC change were assessed by univariable and multivariable linear regression analyses with WC change as the outcome variable. This analysis was repeated in participants with high-risk WC, as defined in Table 1, at baseline that had also completed four-month data collection. Also in participants with high-risk WC at baseline, univariable and multivariable logistic regression analyses were fitted to high/low risk WC at follow-up.

To distinguish associated variables having an indirect influence on WC from participants exerting a more direct influence, two multiple regression approaches were taken. Potential association variables were formed into 10 separate and non-overlapping groups as follows.

1 Age (continuous), sex

Table 1 Guideline recommendation summary table [15]

| Guideline recommendation | Not meeting recommended guideline |
|--------------------------|----------------------------------|
| **BEHAVIOURAL**          |                                  |
| Physical activity* [29-31] | <150mins moderate intensity activity per week |
| Fruit Intake [29,31,32]   | <2 serves per day |
| Vegetable Intake [29,31,32] | <4 serves per day |
| Tobacco                  | ≥1 tobacco cigarette(s) per day |
| **ANTHROPOMETRIC**       |                                  |
| Blood pressure [31,33]    | ≥140 mmHg |
| Systolic                 | ≥90 mmHg |
| Diastolic                | ≥25 kg/m² |
| Body Mass Index (BMI) [31,34-36] |                                  |
| **BIOMEDICAL**           |                                  |
| Fasting Glucose [31,34-36] | ≥ 7.0 mmol/L |
| Cholesterol (total) [37] | ≥ 5.5 mmol/L |
| Triglycerides [38]       | ≥1.5 mmol/L |
| **RISK MODELS**          |                                  |
| Diabetes type 2 5-year risk (assessed by The Australian Type 2 Diabetes Risk Assessment Tool - AUSDRISK) [31,39,40] | intermediate 1/100-1/20; high ≥1/20 |
| Cardiovascular disease (CVD) 10-year risk (assessed by the Absolute cardiovascular disease risk assessment tool) [31,41-43] | intermediate 1/100-1/5; high ≥1/5 |

*Physical activity was preferably accrued over at least five sessions per week, with vigorous activity given double weighting.
In the first approach, the first two groups (baseline demographics) were used for adjustment in separate models containing one of the remaining 8 groups of variables (Multivariable Approach 1 in Tables 2, 3 and 4). In the second approach, these groups of variables were entered sequentially into the regression model, adjusting for the previous group as confounders (Multivariable Approach 2 in Tables 2, 3 and 4). Baseline WC was not included in the models in either approach due to its potential for introducing bias [26]. Consequently, as the diabetes type-2 predicted risk score included WC in the calculation, it was also excluded from the models. Instead, as described above, additional analyses were performed in a subset of participants identified as having high-risk baseline WC.

Glucose and triglyceride variables followed skewed distributions and were log-transformed before inclusion in regression models. Pregnant participants (n = 13) were excluded from analyses. Each analysis used participants with complete data on the relevant variable/s.

Ethics
The study, project number CF08/0271-2008000125, was approved by Monash University Human Research Ethics through the standing committee on ethics in research-involving humans.

Results
Distribution of waist circumference change
The change in waist circumference (WC) followed an approximately normal distribution with an average reduction of 1.6 cm (±5.9SD), Figure 1a. Males and females were similar in their mean WC reduction (-1.3 ± 5.5SD for males compared to -1.8 ± 6.2SD for females, p = 0.4), Figure 1b.

Predictors of waist circumference improvement
Between baseline and four-months, variables associated with WC improvement identified through univariable analyses included having completed tertiary education and less weekend or weekday sitting time at baseline, Table 2. Participants who were not meeting guidelines for WC at baseline (as defined in Table 1) responded positively to the program and had a 2.9 cm larger reduction in WC than participants who were meeting guidelines for WC at baseline. For every extra centimetre of WC at baseline, a 0.12 cm loss in WC at four-months was observed. Similarly, participants with high baseline diabetes type-2 risk had a 2.2 cm larger reduction in WC than participants with low baseline diabetes type-2 risk.

Multivariable approaches 1 and 2 produced similar results, Table 2. Between baseline and four-months, participants who had completed tertiary education at baseline had a 2.1 cm larger reduction in WC than participants who had not completed tertiary education at baseline. On average, participants who reported at baseline that they did not consume more than two alcoholic standard drinks in one occasion in the past twelve months reduced their WC by 0.7 cm more than participants who did not meet alcohol recommended guidelines. For every hour less per day of baseline weekend sitting time, a 0.3 cm greater loss in WC at four-months was observed. For every millimole per litre less of total cholesterol at baseline, a 0.4 cm greater loss in WC at four-months was observed.

High-risk versus low-risk baseline waist circumference
To investigate whether variables associated with WC change alter for participants most at risk, further analyses were undertaken in this sub-group. Fifty-three percent (n = 288) of participants were categorised as having a high-risk WC at baseline. Participants who had a high-risk WC at baseline were more likely to be older; be female; have a managerial, clerical or service occupation; work for a publically owned company; participate in the program due to health, fitness or appearance reasons; and have poorer health indicators when compared to baseline low-risk WC participants who returned at four-months, Table 3.

Predictors of continuous waist circumference improvement in participants with high-risk waist circumference at baseline
Within the baseline high-risk WC group, variables associated with WC improvement identified through univariable analyses included having completed tertiary education, eating two or more serves of fruit per day, having greater physical functioning at baseline and meeting the goal of at least 10,000 steps per day on average during the health program, Table 4. Within the high WC risk baseline group, a weak association between baseline WC and improved WC was observed, however it was not statistically significant nor was it of the same magnitude of the observed association in all participants. An additional analysis within the high-risk WC group comparing the BMI in the obese group to the BMI in the normal group in regards to WC change indicated weak evidence of a relationship (2.8 cm greater loss in the normal
Table 2 Linear regression analyses assessing potential baseline and step-data predictors of waist circumference change

| Group | Predictor Variable | n  | Crude WC change | Univariate | Multivariable Approach 1a | Multivariable Approach 2b |
|-------|--------------------|----|-----------------|------------|--------------------------|--------------------------|
|       |                    |    | WC change (cm)  | P-value    | WC change (cm)           | P-value                  |
|       |                    |    |                 |            |                         |                          |
|       |                    |    |                 |            |                         |                          |
|       |                    |    |                 |            |                         |                          |
|       |                    |    |                 |            |                         |                          |
| DEMOGRAPHICS | Age (year) | 539 | - | 0.02 | 0.5 | 0.02 | 0.5 | 0.02 | 0.5 |
|            | Sex             |    |               |            |                         |                          |
|            | Female          | 305 | -1.78 | reference |          | 0.04 | 0.4 | 0.08 | 0.4 |
|            | Male            | 234 | -1.33 | 0.45 | 0.4 | 0.48 | 0.4 | 0.48 | 0.4 |
|            | Socio Economic Status (by SEIFA %) |    |       |       |       |       |       |       |
|            | Most Advantaged | 189 | -1.46 | reference |          | 0.04 | 0.4 | 0.08 | 0.4 |
|            | Advantaged      | 224 | -1.50 | -0.04 | 0.9 | 0.09 | 0.4 | 0.08 | 0.4 |
|            | Disadvantaged   | 92  | -1.83 | -0.37 | 0.8 | 0.09 | 0.4 | 0.08 | 0.4 |
|            | Most Disadvantaged | 33  | -2.68 | -1.21 | 0.5 | 0.09 | 0.4 | 0.08 | 0.4 |
| Occupation | Professional | 221 | -1.61 | reference |          | 0.04 | 0.4 | 0.08 | 0.4 |
|            | Associate professional | 97  | -2.41 | -0.80 | 0.09 | 0.09 | 0.4 | 0.08 | 0.4 |
|            | Manager         | 96  | -1.71 | -0.10 | 0.9 | 0.09 | 0.4 | 0.08 | 0.4 |
|            | Clerical or Service | 76  | -1.10 | 0.51 | 0.7 | 0.09 | 0.4 | 0.08 | 0.4 |
| Marital Status | Married/de facto | 366 | -1.38 | reference |          | 0.04 | 0.4 | 0.08 | 0.4 |
|            | Widowed/separated/divorced | 46  | -3.21 | -1.84 | 0.07 | 0.09 | 0.4 | 0.08 | 0.4 |
|            | Never married   | 120 | -1.85 | -0.47 | 0.7 | 0.09 | 0.4 | 0.08 | 0.4 |
| BASELINE MEASURES | Prior GCC Participation | 532 | -1.62 | 0.08 | 0.9 | 0.08 | 0.9 | 0.08 | 0.9 |
| Reasons for Participation | Health | 531 | -1.94 | -0.93 | 0.09 | 0.09 | 0.4 | 0.08 | 0.4 |
|            | To look my best | 531 | -1.82 | -0.45 | 0.1 | 0.09 | 0.4 | 0.08 | 0.4 |
|            | Fitness         | 531 | -1.75 | -0.36 | 0.2 | 0.09 | 0.4 | 0.08 | 0.4 |
|            | Colleagues      | 531 | -1.72 | -0.20 | 0.6 | 0.09 | 0.4 | 0.08 | 0.4 |
|            | Friends or family | 531 | -2.14 | -0.52 | 0.6 | 0.09 | 0.4 | 0.08 | 0.4 |
| Behavioural Measures | Fruit Intake | 531 | -1.21 | reference |          | 0.04 | 0.4 | 0.08 | 0.4 |
|            | Meeting guidelines | 168 | -2.58 | -1.37 | 0.06 | 0.09 | 0.4 | 0.08 | 0.4 |
| Vegetable Intake | Not meeting guidelines | 455 | -1.49 | reference |          | 0.04 | 0.4 | 0.08 | 0.4 |
|            | Meeting guidelines | 77  | -2.56 | -1.08 | 0.06 | 0.09 | 0.4 | 0.08 | 0.4 |
Table 2 Linear regression analyses assessing potential baseline and step-data predictors of waist circumference change (Continued)

| Takeaway Dinner       | 246 | -1.68 | reference |
|-----------------------|-----|-------|-----------|
| Once or less per month|     |       |           |
| About once a week      | 214 | -1.63 | 0.05      |
| More than once a week  | 72  | -1.56 | 0.12      |
| Alcohol               |     |       |           |
| Not meeting guidelines | 307 | -1.42 |           |
| Meeting guidelines     | 225 | -1.95 | -0.54     |
| Tobacco               |     |       |           |
| Smoker                | 50  | -1.00 |           |
| Non-smoker            | 482 | -1.71 | -0.71     |
| Physical Activity     |     |       |           |
| Not meeting guidelines | 322 | -1.49 |           |
| Meeting guidelines     | 209 | -1.87 | -0.38     |
| Sitting Time (per hour per day) |     |       |           |
| Weekday               | 530 | -     | 0.19      |
| Weekend               | 529 | -     | 0.12      |
| Psychosocial Measures |     |       |           |
| Physical Functioning (SF12) | 523 | -     | -0.06     |
| Mental Functioning (SF12) | 523 | -     | 0.00      |
| Anthropometric Measures<sup>d</sup> |     |       |           |
| Blood Pressure (mmHg) |     |       |           |
| Systolic              | 517 | -     | -0.01     |
| Diastolic             | 517 | -     | 0.03      |
| Heart rate (Mean, SD) | 517 | -     | -0.03     |
| Weight (Mean, SD)<sup>e</sup> | 537 | -     | -0.02     |
| Body Mass Index       |     |       |           |
| Body Mass Index       | 222 | -     | -0.07     |
| Waist circumference<sup>f</sup> |     |       |           |
| Waist circumference   | 539 | -     | -0.12     |
| Biomedical Measures (fasting)<sup>d</sup> |     |       |           |
| Total Cholesterol     |     |       |           |
| Total Cholesterol     | 535 | -     | 0.20      |
| Not meeting guidelines | 150 | -1.66 |           |

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Table 2 Linear regression analyses assessing potential baseline and step-data predictors of waist circumference change (Continued)

|                                                                 | Meeting guidelines | 385  | -1.63 | 0.03 | 1.0 |
|-----------------------------------------------------------------|--------------------|------|-------|------|-----|
| Glucose                                                         |                    |      |       |      |     |
| Glucose                                                         |                    | 535  |       | 0.12 | 0.3 | 0.06 | 0.2 | 0.02 | 0.09 |
| Not meeting guidelines                                         |                    | 20   | 0.05  |      |     |
| Meeting guidelines                                             |                    | 535  | 1.49  | 4.23 | 0.3 |
| Triglycerides                                                  |                    |      |       |      |     |
| Triglycerides                                                  |                    | 535  |       | 0.83 | 0.7 | 0.49 | 0.1 | 0.99 | 1.0 |
| Not meeting guidelines                                         |                    | 109  | 0.10  |      |     |
| Meeting guidelines                                             |                    | 426  | 2.43  | 2.33 | 0.1 |
| Predicted risk scores<sup>d</sup>                              |                    |      |       |      |     |
| Cardiovascular disease risk (next 10 years)                    |                    |      |       |      |     |
| CVD risk (continuous)                                          |                    | 504  |       | -0.03| 0.6 | -0.08| 0.2 | -0.11| 0.04|
| Low-risk                                                       |                    | 452  | -1.61 |      |     |
| Intermediate-risk                                              |                    | 45   | -1.76 | -0.14| 0.9 |
| High-risk                                                      |                    | 7    | -2.91 | -1.30| 0.056|
| Diabetes risk (next 5 years)<sup>f</sup>                      |                    |      |       |      |     |
| Diabetes risk (continuous)                                     |                    | 529  |       | -0.09| 0.09|
| Low-risk                                                       |                    | 202  | -1.26 |      |     |
| Intermediate-risk                                              |                    | 276  | -1.55 | -0.28| 0.6 |
| High-risk                                                      |                    | 51   | -3.45 | -2.19| 0.004|
| WORKPLACE CHARACTERISTICS<sup>g</sup>                          |                    |      |       |      |     |
| 9 Public ownership (vs. private)                               |                    | 539  | -2.00 | -0.67| 0.4 | -0.57| 0.2 | -0.37| 0.5 |
| Outer city location (vs. inner city)                           |                    | 539  | -2.22 | -0.37| 0.7 | 0.16 | 0.8 | 0.06 | 1.0 |
| PROCESS MEASURES                                              |                    |      |       |      |     |
| Step data<sup>d</sup>                                          |                    |      |       |      |     |
| Step average per day (per 10,000 steps)                        |                    | 538  |       | -0.20| 0.7 | -0.25| 0.8 | 0.12 | 0.9 |
| <10,000 steps average (per day)                                |                    | 179  | -1.48 |      |     |
| Meeting ≥10,000 steps average (per day)                        |                    | 359  | -1.65 | -0.17| 0.7 |

<sup>a</sup> Associated risk-factor subgroups adjusted only for baseline demographic confounders
<sup>b</sup> Associated risk-factor subgroups adjusted for all potential predictors within the analysis step and above
<sup>c</sup> The reference group for this binary variable is 'no'. The reference group data is not shown.
<sup>d</sup> Continuous variables chosen over categorical variables
<sup>e</sup> Excluded due to the inclusion of body mass index (BMI)
<sup>f</sup> Excluded from model as baseline WC was not considered as a predictor.
<sup>g</sup> The reference group for this binary variable is shown in brackets. The reference group data is not shown.
Table 3 Linear regression assessing baseline variables associated with WC change in participants not meeting WC guidelines

| Group | Predictor Variable | n  | Crude WC change | Univariate | Multivariable Approach 1a | Multivariable Approach 2b |
|-------|--------------------|----|-----------------|------------|---------------------------|---------------------------|
|       |                    |    | WC change (cm)  | P-value    | WC change (cm)            | P-value                   | WC change (cm)            | P-value                   |
|       |                    |    |                 |            |                           |                           |                           |                           |
|       | DEMOGRAPHICS       |    |                 |            |                           |                           |                           |                           |
| 1     | Age (year)         | 288| -               | 0.03       | 0.03                      | 0.03                      | 0.03                      | 0.03                      |
|       | Sex                |    |                 |            |                           |                           |                           |                           |
|       | Female             | 185| -2.94           | reference  | reference                 | reference                 | reference                 | reference                 |
|       | Male               | 103| -2.73           | 0.21       | 0.16                      | 0.7                       | 0.16                      | 0.7                       |
| 2     | Socio Economic Status (by SEIFA %) |    |                 |            |                           |                           |                           |                           |
|       | Most Advantaged    | 95 | -2.84           | reference  | reference                 | reference                 | reference                 | reference                 |
|       | Advantaged         | 122| -2.61           | 0.23       | 0.32                      | 0.6                       | 0.32                      | 0.6                       |
|       | Disadvantaged      | 52 | -2.82           | 0.02       | 0.31                      | 0.9                       | 0.31                      | 0.9                       |
|       | Most Disadvantaged | 18 | -5.78           | -2.94      | -2.11                     | 0.3                       | -2.11                     | 0.3                       |
|       | Tertiary Education |    |                 |            |                           |                           |                           |                           |
|       | Not completed      | 69 | -1.08           | reference  | reference                 | reference                 | reference                 | reference                 |
|       | Completed          | 219| -3.43           | -2.35      | 0.018                     | -2.35                     | 0.017                     | -2.35                     |
|       | Occupation         |    |                 |            |                           |                           |                           |                           |
|       | Professional       | 105| -2.34           | reference  | reference                 | reference                 | reference                 | reference                 |
|       | Associate professional |     | -4.13           | -1.79      | -1.89                     | 0.1                       | -1.89                     | 0.1                       |
|       | Manager            | 55 | -3.52           | -1.18      | -1.00                     | 0.2                       | -1.00                     | 0.2                       |
|       | Clerical or Service| 48 | -2.84           | -0.50      | -1.06                     | 0.4                       | -1.06                     | 0.4                       |
|       | Marital Status     |    |                 |            |                           |                           |                           |                           |
|       | Married/de facto   | 200| -2.45           | reference  | reference                 | reference                 | reference                 | reference                 |
|       | Widowed/separated/divorced |     | -4.82           | -2.37      | -2.42                     | 0.2                       | -2.42                     | 0.2                       |
|       | Never married      | 60 | -3.48           | -1.02      | -0.36                     | 0.6                       | -0.36                     | 0.6                       |
|       | BASELINE MEASURES  |    |                 |            |                           |                           |                           |                           |
| 3     | Prior GCC® Participationc |    | -2.86           | 0.08       | 0.04                      | 0.9                       | -0.04                     | 0.9                       |
|       | Reasons for Participationc |    |                 |            |                           |                           |                           |                           |
|       | Health             | 286| -2.82           | 0.27       | 0.14                      | 0.9                       | 0.14                      | 0.9                       |
|       | To look my best    | 286| -2.80           | 0.32       | 0.32                      | 0.6                       | 0.32                      | 0.6                       |
|       | Fitness            | 286| -2.75           | 0.49       | 0.07                      | 0.9                       | 0.07                      | 0.9                       |
|       | Colleagues         | 286| -3.24           | -0.81      | -0.72                     | 0.3                       | -0.72                     | 0.3                       |
|       | Friends or family  | 286| -4.01           | -1.15      | -1.10                     | 0.3                       | -1.10                     | 0.3                       |
|       | Behavioural Measures |     |                 |            |                           |                           |                           |                           |
| 4     | Fruit Intake       |    |                 |            |                           |                           |                           |                           |
|       | Not meeting guidelines |   | -2.42           | reference  | reference                 | reference                 | reference                 | reference                 |
|       | Meeting guidelines | 98 | -3.77           | -1.34      | 0.027                     | -0.96                     | 0.027                     | -0.96                     |
|       | Vegetable Intake   |    |                 |            |                           |                           |                           |                           |
|       | Not meeting guidelines |   | -2.77           | reference  | reference                 | reference                 | reference                 | reference                 |
|       | Meeting guidelines | 42 | -3.52           | -0.75      | 0.40                      | 0.8                       | 0.32                      | 0.8                       |
### Table 3 Linear regression assessing baseline variables associated with WC change in participants not meeting WC guidelines (Continued)

| Variable                        | Parameter | Estimate | p-value | Standard Error | Estimate | p-value | Standard Error | Estimate | p-value | Standard Error | Estimate | p-value | Standard Error |
|---------------------------------|-----------|----------|---------|----------------|----------|---------|----------------|----------|---------|----------------|----------|---------|----------------|
| **Takeaway Dinner**             |           |          |         |                |          |         |                |          |         |                |          |         |                |
| Once or less per month          |           | 132      | -0.55   | reference      |          |         |                |          |         |                |          |         |                |
| About once a week                |           | 117      | -1.34   | -0.79          | 0.2      | 0.7     | -0.63          | 0.2      | 0.7     | -0.52          | 0.2      | 0.7     | -0.73          |
| More than once a week            |           | 37       | -3.11   | -2.55          | 0.7      | 0.7     | -0.85          | 0.7      | 0.7     | -0.73          | 0.7      | 0.7     | -0.73          |
| **Alcohol**                      |           |          |         |                |          |         |                |          |         |                |          |         |                |
| Not meeting guidelines           |           | 159      | -2.95   | reference      |          |         |                |          |         |                |          |         |                |
| Meeting guidelines               |           | 127      | -2.80   | 0.15           | 0.8      | 0.7     | -0.28          | 0.6      | 0.6     | -0.28          | 0.6      | 0.6     | -0.28          |
| **Tobacco**                      |           |          |         |                |          |         |                |          |         |                |          |         |                |
| Smoker                           |           | 32       | -1.30   | reference      |          |         |                |          |         |                |          |         |                |
| Non-smoker                       |           | 254      | -3.03   | -1.73          | 0.2      | 0.7     | 0.38           | 0.7      | 0.7     | 0.49           | 0.6      | 0.7     | 0.6            |
| **Physical Activity**            |           |          |         |                |          |         |                |          |         |                |          |         |                |
| Not meeting guidelines           |           | 178      | -2.45   | reference      |          |         |                |          |         |                |          |         |                |
| Meeting guidelines               |           | 108      | -3.60   | -1.15          | 0.2      | 0.7     | 0.33           | 0.3      | 0.3     | 0.23           | 0.3      | 0.3     | 0.23           |
| **Sitting Time (per hour per day)** |         |          |         |                |          |         |                |          |         |                |          |         |                |
| Weekday                          |           | 286      | -0.15   | 0.2            | 0.11     | 0.3     | 0.12           | 0.4      | 0.4     |                |          |         |                |
| Weekend                          |           | 282      | -0.26   | 0.2            | 0.23     | 0.3     | 0.23           | 0.3      | 0.3     |                |          |         |                |
| **Psychosocial Measures**        |           |          |         |                |          |         |                |          |         |                |          |         |                |
| Physical Functioning (SF12)      |           | 282      | -0.11   | 0.049          | 0.02     | 0.5     | 0.02           | 0.2      | 0.2     |                |          |         |                |
| Mental Functioning (SF12)        |           | 282      | 0.00    | 1.0            |          |         |                |          |         |                |          |         |                |
| **Anthropometric Measures**      |           |          |         |                |          |         |                |          |         |                |          |         |                |
| Blood Pressure (mmHg)            |           |          |         |                |          |         |                |          |         |                |          |         |                |
| Systolic                         |           | 273      | 0.02    | 0.4            | 0.00     | 1.0     | 0.00           | 0.9      | 0.9     |                |          |         |                |
| Diastolic                        |           | 273      | 0.02    | 0.6            | -0.01    | 0.8     | -0.02          | 0.6      | 0.6     |                |          |         |                |
| Not meeting guidelines           |           | 56       | -2.21   | reference      |          |         |                |          |         |                |          |         |                |
| Meeting guidelines               |           | 217      | -3.03   | -0.82          | 0.3      |          |                |          |         |                |          |         |                |
| Heart rate (Mean, SD)            |           | 288      | -0.02   | 0.6            | -0.02    | 0.7     | -0.02          | 0.7      | 0.7     |                |          |         |                |
| Weight (Mean, SD)                |           | 288      | 0.02    | 0.5            |          |         |                |          |         |                |          |         |                |
| Body Mass Index                  |           |          |         |                |          |         |                |          |         |                |          |         |                |
| Body Mass Index                  |           | 288      | 0.13    | 0.2            | 0.12     | 0.3     | 0.08           | 0.5      | 0.5     |                |          |         |                |
| Not meeting guidelines           |           | 238      | -2.49   | reference      |          |         |                |          |         |                |          |         |                |
| Meeting guidelines               |           | 50       | -4.63   | -2.14          | 0.1      |          |                |          |         |                |          |         |                |
| Waist circumference              |           |          |         |                |          |         |                |          |         |                |          |         |                |
| Waist circumference              |           | 288      | -0.05   | 0.2            |          |         |                |          |         |                |          |         |                |
| Not meeting guidelines           |           | 288      | n/a     |                |          |         |                |          |         |                |          |         |                |
| Meeting guidelines               |           | 0        |         |                |          |         |                |          |         |                |          |         |                |
| Biomedical Measures (fasting)    |           |          |         |                |          |         |                |          |         |                |          |         |                |
| Total Cholesterol                |           | 285      | -2.71   | reference      |          |         |                |          |         |                |          |         |                |
| Not meeting guidelines           |           | 89       | -2.71   | reference      |          |         |                |          |         |                |          |         |                |

Freak-Poli et al. BMC Public Health 2011, 11:824 http://www.biomedcentral.com/1471-2458/11/824
Table 3 Linear regression assessing baseline variables associated with WC change in participants not meeting WC guidelines (Continued)

|                | Meeting guidelines | 196 | -2.94 | -0.23 | 0.7 |
|----------------|--------------------|-----|-------|-------|-----|
| Glucose        | Metabolic syndrome | 285 | -     | 2.29  | 0.8 | 0.22 | 0.6 | 0.03 | 0.3 |
| Glucose        | Not meeting guidelines | 18  | 0.06  | reference |
| Glucose        | Meeting guidelines | 267 | 1.07  | 1.02  | 1.0 |
| Triglycerides  | Metabolic syndrome | 285 | -     | 1.31  | 0.6 | 0.47 | 0.2 | 0.45 | 0.2 |
| Triglycerides  | Not meeting guidelines | 73  | 0.03  | reference |
| Triglycerides  | Meeting guidelines | 212 | 1.96  | 1.93  | 0.4 |
| Predicted risk scores<sup>d</sup> | Cardiovascular disease risk (next 10 years) | 8   |       |       |     |
| CVD risk        | Low-risk            | 267 | -     | 0.09  | 0.2 | 0.03 | 0.7 | 0.02 | 0.9 |
| CVD risk        | Intermediate-risk   | 33  | -2.79 | 0.09  | 0.9 |
| CVD risk        | High-risk           | 7   | -2.91 | -0.03 | 1.0 |
| Diabetes risk   | Low-risk            | 285 | -     | 0.06  | 0.3 |
| Diabetes risk   | Intermediate-risk   | 67  | -3.79 | reference |
| Diabetes risk   | High-risk           | 173 | -2.34 | 1.45  | 0.033 |
| Diabetes risk   |                       | 45  | -3.55 | 0.24  | 0.6 |
| Workforce CHARACTERISTICS<sup>g</sup> | Public ownership (vs. private) | 9   | 288   | -2.66 | 0.36 | 0.6 | 0.09 | 0.9 | 0.06 | 0.9 |
| Outer city location (vs. inner city) | 288   | -3.08 | -0.68 | 0.4 | -0.96 | 0.3 | -1.34 | 0.2 |
| PROCESS MEASURES | Step data<sup>d</sup> | 10  |       |       |     |
| Step average per day (per 10,000 steps) | 288   | -     | -1.04 | 0.08 | -1.40 | 0.07 | -0.55 | 0.6 |
| <10,000 steps average (per day) | 190   | -2.13 | reference |
| Meeting ≥10,000 steps average (per day) | 190   | -3.24 | -1.11 | 0.049 |

<sup>a</sup> Associated risk-factor subgroups adjusted only for baseline demographic confounders

<sup>b</sup> Associated risk-factor subgroups adjusted for all potential predictors within the analysis Group and above

<sup>c</sup> The reference group for this binary variable is ‘no’. The reference group data is not shown.

<sup>d</sup> Continuous variables chosen over categorical variables

<sup>e</sup> Excluded due to the inclusion of body mass index (BMI)

<sup>f</sup> Excluded from model as baseline WC was not considered as a predictor.

<sup>g</sup> The reference group for this binary variable is shown in brackets. The reference group data is not shown.

Note: For participants not meeting WC guidelines at baseline
### Table 4: Assessment of variables associated with improving WC to meet recommended guidelines at follow-up

| Group | Predictor Variable | n | % meeting WC guidelines at four-months | Univariate OR | Multivariable Approach 1 | Multivariable Approach 2 |
|-------|-------------------|---|--------------------------------------|---------------|--------------------------|--------------------------|
|       |                   |   |                                     | P-value       | P-value                  | P-value                  |
| 1     | Age (year)        | 288 | -                                    | 0.97          | 0.08                     | 0.039                    | 0.97          | 0.039 |
|       | Sex               |    |                                      |               |                          |                          |               |       |
|       | Female            | 185 | 21.08                                | reference     | reference                | reference                |               |       |
|       | Male              | 103 | 26.21                                | 1.33          | 0.4                      | 1.43                     | 0.3           |       |
| 2     | Socio Economic Status (by SEIFA %) | | | | | | | |
|       | Most Advantaged   | 95  | 21.05                                | reference     | reference                | reference                |               |       |
|       | Advanced          | 122 | 22.13                                | 1.07          | 0.9                      | 1.03                     | 0.9           |       |
|       | Disadvantaged     | 52  | 26.92                                | 1.38          | 0.6                      | 1.39                     | 0.5           |       |
|       | Most Disadvantaged| 18  | 27.78                                | 1.44          | 0.4                      | 1.63                     | 0.2           |       |
|       | Tertiary Education | | | | | | | |
|       | Not completed     | 69  | 20.29                                | reference     | reference                | reference                |               |       |
|       | Completed         | 219 | 23.74                                | 1.22          | 0.3                      | 1.07                     | 0.8           | 1.07  | 0.8  |
|       | Occupation        |    |                                      |               |                          |                          |               |       |
|       | Professional      | 105 | 22.66                                | reference     | reference                | reference                |               |       |
|       | Associate professional | | | | | | | |
|       | Manager           | 55  | 23.64                                | 1.04          | 0.9                      | 1.04                     | 0.9           |       |
|       | Clerical or Service | | | | | | | |
|       | Married/de facto  | 200 | 23                                   | reference     | reference                | reference                |               |       |
|       | Widowed/separated/divorced | | | | | | | |
|       | Never married     | 60  | 23.33                                | 1.02          | 1.0                      | 0.71                     | 0.4           | 0.71  | 0.4  |
| 3     | Prior GCC® Participation | | | | | | | |
|       | Health            | 286 | 22.54                                | 0.96          | 0.9                      | 0.88                     | 0.6           | 1.13  | 0.6  |
|       | To look my best   | 286 | 19.23                                | 0.76          | 0.4                      | 1.22                     | 0.6           | 1.22  | 0.6  |
|       | Fitness           | 286 | 20.57                                | 0.61          | 0.2                      | 0.93                     | 0.9           | 0.93  | 0.9  |
|       | Colleagues        | 286 | 23.9                                 | 1.11          | 0.7                      | 0.89                     | 0.7           | 0.89  | 0.7  |
|       | Friends or family | 286 | 14.29                                | 0.55          | 0.6                      | 0.69                     | 0.8           | 0.69  | 0.8  |
|       | Behavioural Measures | | | | | | | |
|       | Not meeting guidelines | 188 | 19.15                                | reference     | reference                | reference                |               |       |
|       | Meeting guidelines | 98  | 30.61                                | 1.86          | 0.028                    | 2.42                     | <0.001        | 3.05  | 0.001|
| 4     | Fruit Intake      |    |                                      |               |                          |                          |               |       |
|       | Not meeting guidelines | 244 | 23.36                                | reference     | reference                | reference                |               |       |
|       | Meeting guidelines | 42  | 21.43                                | 0.89          | 0.8                      | 0.62                     | 0.4           | 0.61  | 0.4  |

**Note:** OR = Odds Ratio, P-value = Probability value
Table 4 Assessment of variables associated with improving WC to meet recommended guidelines at follow-up (Continued)

| Takeaway Dinner                          | 132  | 20.45 | reference |
|------------------------------------------|------|-------|-----------|
| Once or less per month                   | 117  | 24.79 | 1.28 0.4 1.35 0.4 1.31 0.5 |
| About once a week                        | 37   | 27.03 | 1.44 0.3 1.44 0.6 1.49 0.5 |
| More than once a week                    |      |       |           |
| Alcohol                                  | 159  | 24.53 | reference |
| Not meeting guidelines                   | 127  | 21.26 | 0.83 0.6 0.71 0.3 0.64 0.2 |
| Meeting guidelines                       |      |       |           |
| Tobacco                                  | 32   | 21.88 | reference |
| Smoker                                   | 254  | 23.23 | 1.08 0.8 0.71 0.5 0.61 0.4 |
| Non-smoker                               |      |       |           |
| Physical Activity                        | 178  | 20.79 | reference |
| Not meeting guidelines                   | 108  | 26.85 | 1.40 0.002 1.42 0.1 1.48 0.2 |
| Meeting guidelines                       |      |       |           |
| Sitting Time (hrs per day)               | 286  | -     | 0.94 0.1 0.99 0.9 1.00 0.9 |
| Weekday                                  | 286  | -     | 0.80 0.025 0.78 0.053 0.75 0.023 |
| Psychosocial Measures                    |      |       |           |
| Physical Functioning (SF12)              | 282  | -     | 1.07 <0.001 1.08 <0.001 1.06 0.004 |
| Mental Functioning (SF12)                | 282  | -     | 1.00 0.6 1.03 0.022 1.03 0.2 |
| Physical Measures^d                      |      |       |           |
| Blood Pressure (mmHg)                    |      |       |           |
| Systolic                                 | 273  | -     | 0.97 <0.001 0.99 0.8 1.01 0.7 |
| Diastolic                                | 273  | -     | 0.95 <0.001 0.96 0.4 0.93 0.2 |
| Not meeting guidelines                   | 56   | 7.14  | reference |
| Meeting guidelines                       | 217  | 26.73 | 4.74 <0.001 |
| Heart rate (Mean, SD)                    | 273  | -     | 0.99 0.8 0.99 0.8 1.00 0.9 |
| Weight (Mean, SD)^f                      | 288  | -     | 0.94 <0.001 |
| Body Mass Index                          |      |       |           |
| Body Mass Index                          | 288  | -     | 0.64 <0.001 0.55 <0.001 0.51 <0.001 |
| Not meeting guidelines                   | 238  | 15.13 | reference |
| Meeting guidelines                       | 50   | 60    | 8.42 <0.001 |
| Waist circumference                      |      |       |           |
| Waist circumference                      | 288  | -     | 0.91 <0.001 |
| Biomedical Measures (fasting)^d          |      |       |           |
| Total Cholesterol                        | 285  | -     | 0.60 0.001 0.66 0.018 0.63 0.1 |
| Not meeting guidelines                   | 89   | 14.61 | reference |
| Meeting guidelines                       | 196  | 26.53 | 2.11 0.040 |
| Glucose                                  |      |       |           |
Table 4 Assessment of variables associated with improving WC to meet recommended guidelines at follow-up (Continued)

|                  | 285 | -   | 1.40 | 0.5 | 2.60 | 1.0 | 3.00 | 1.0 |
|------------------|-----|-----|------|-----|------|-----|------|-----|
| Glucose          |     |      |      |     |      |     |      |     |
| Not meeting guidelines | 18 | 22.22 | reference |
| Meeting guidelines          | 267 | 22.85 | 1.04 | 1.0 |
| Triglycerides      |     |      |      |     |      |     |      |     |
| Triglycerides     | 285 | -   | 1.48 | 0.001 | 1.54 | 0.012 | 3.12 | 0.7 |
| Not meeting guidelines | 73 | 16.44 | reference |
| Meeting guidelines          | 212 | 25   | 1.69 | 0.1 |

**Predicted risk scores**

8 Cardiovascular disease risk (next 10 years)

|                  | 267 | -   | 0.93 | 0.1 | 0.89 | 0.1 | 1.26 | 0.2 |
|------------------|-----|-----|------|-----|------|-----|------|-----|
| CVD risk (continuous) |     |      |      |     |      |     |      |     |
| Low-risk         | 227 | 23.35 | reference |
| Intermediate-risk | 33  | 12.12 | 0.45 | 0.2 |
| High-risk        | 7   | 42.86 | 2.46 | 0.4 |

Diabetes risk (next 5 years)

|                  | 285 | -   | 0.88 | 0.031 |
|------------------|-----|-----|------|-------|
| Diabetes risk (continuous) |     |      |      |       |
| Low-risk         | 67  | 40.3 | reference |
| Intermediate-risk | 173 | 19.08 | <0.001 |
| High-risk        | 45  | 11.11 | 0.19 | 0.013 |

**WORKPLACE CHARACTERISTICS**

9 Public ownership (vs. private)

|                  | 288 | 21.77 | 0.89 | 0.6 | 1.30 | 0.4 | 1.31 | 0.6 |
|------------------|-----|-------|------|-----|------|-----|------|-----|
| Outer city location (vs. inner city) |     |       |      |     |      |     |      |     |

**PROCESS MEASURES**

10 Step average per day

|                  | 288 | -   | 1.00 | 0.2 | 1.00 | 0.2 | 1.00 | 0.3 |
|------------------|-----|-----|------|-----|------|-----|------|-----|
| <10,000 steps average (per day) | 98  | 19.39 | reference |
| Meeting ≥10,000 steps average (per day) | 190 | 24.74 | 1.37 | 0.4 |

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*a* Associated risk-factor subgroups adjusted only for baseline demographic confounders

*b* Associated risk-factor subgroups adjusted for all potential predictors within the analysis Group and above

*c* The reference group for this binary variable is 'no'. The reference group data is not shown.

*d* Continuous variables chosen over categorical variables

*e* Excluded due to the inclusion of body mass index (BMI)

*f* Excluded from model as baseline WC was not considered as a predictor.

*g* The reference group for this binary variable is shown in brackets. The reference group data is not shown.

Note: For participants not meeting WC guidelines at baseline
Participants with moderate baseline diabetes type-2 risk had a 1.4 cm larger reduction in WC when compared to participants with low baseline diabetes type-2 risk, however no relationship with high diabetes type-2 risk was identified.

In participants who had a high-risk WC at baseline, participants who had completed tertiary education at baseline had a 2.4 cm larger reduction in WC when compared to participants who had not completed tertiary education at baseline. For every millimole per litre less of total cholesterol at baseline, a 0.9 cm greater loss in WC at four-months was observed.

Predictors of improving waist circumference to meet low-risk guidelines at four-months
Between baseline and four-months, 22.9% of participants who had high-risk WC at baseline improved their WC enough to meet low-risk guidelines at four-months, Table 5. Through univariable analysis, new baseline variables associated with reducing WC to meet low-risk guidelines at four-months, included not participating in the program for appearance reasons, meeting fruit intake guidelines, meeting physical activity guidelines, less weekend sitting time, higher physical functioning, lower systolic and diastolic blood pressure, meeting guidelines for blood pressure, lower baseline weight, lower BMI, meeting BMI guidelines, smaller WC, lower total cholesterol, meeting total cholesterol guidelines, more elevated triglycerides and higher diabetes risk, Table 5.

Although all participants in this sub-analysis had high-risk WC at baseline, a few were meeting guidelines for body composition when assessed by BMI. Within the high-risk WC group at baseline, participants who were meeting guidelines for BMI at baseline responded positively to the program and had 8.4 increased odds of improving their WC to meeting guidelines at four-months than participants not meeting baseline BMI guidelines, p < 0.001. Participants with low baseline diabetes type-2 risk had 5.4 increased odds of improving their WC to meeting guidelines at four-months than participants who were at high baseline diabetes risk, p = 0.013.

Within the high-risk baseline WC group, for every year increase in age at baseline, it was 3% less likely that the participant would improve their WC to meet low-risk guidelines at four-months. Employees participating in the program for reasons other than appearance had 2.6 increased odds of improving their WC to meet guidelines than employees participating for other reasons. Participants eating two or more pieces of fruit per day at baseline were 3.1 times more likely to improve their WC to meet guidelines than participants eating less than two pieces per day. For every hour decrease of weekend sitting time at baseline, it was 33% more likely that the participant would improve their WC to meet guidelines at four-months. For every BMI unit decrease at baseline, it was twice as likely that the participant would improve their WC to meet guidelines at four-months.

Discussion
In this study analysing variables associated with waist circumference (WC) change following participation in a four-month, pedometer-based, workplace health program, employees with a high-risk WC at baseline experienced the greatest improvements in WC. Strong predictors of improved WC during the program for all employees and employees with high-risk baseline WC were having completed tertiary education, undertaking less baseline weekend sitting time and having lower total cholesterol at baseline. An additional predictor of improvement in WC for all employees was not consuming more than two standard alcoholic beverages in one occasion during the twelve months prior to baseline. Unique baseline predictors were identified for improving WC to meet guidelines at four-months and these included participating for reasons other
Table 5 Comparison of baseline characteristics between high-risk and low risk waist circumference at baseline

| Category                                      | Low-risk WC (Mean ± SD or Percentage) | High-risk WC (Mean ± SD or Percentage) | P-value |
|-----------------------------------------------|---------------------------------------|----------------------------------------|---------|
| Low-risk WC                                  | 251                                   | 288                                    |         |
| High-risk WC                                 |                                       |                                        |         |
| P-value                                       |                                       |                                        |         |
| WORKPLACE CHARACTERISTICS<sup>b</sup>         |                                       |                                        |         |
| Public ownership (vs. private)               | 32.7                                  | 43.1                                   | <0.001  |
| Inner city location (vs. outer city)         | 70.9                                  | 67.7                                   | 0.4     |
| DEMOGRAPHICS                                  |                                       |                                        |         |
| Age (year)                                    | 38 ± 10                               | 43 ± 10                                | <0.001  |
| Male                                          | 52.2                                  | 35.8                                   | <0.001  |
| Socio Economic Status (by SEIFA)             |                                       |                                        |         |
| Most Advantaged                               | 37.5                                  | 33.1                                   | 0.3     |
| Advantaged                                    | 40.6                                  | 42.5                                   |         |
| Disadvantaged                                 | 15.9                                  | 18.1                                   |         |
| Most Disadvantaged                            | 6.0                                   | 6.3                                    |         |
| Completion of tertiary education              | 81.6                                  | 76.0                                   | 0.2     |
| Occupation                                    |                                       |                                        |         |
| Professional                                  | 50.7                                  | 40.2                                   | 0.022   |
| Associate professional                        | 19.2                                  | 20.3                                   |         |
| Manager                                       | 17.9                                  | 21.1                                   |         |
| Clerical or Service                           | 12.2                                  | 18.4                                   |         |
| Marital Status                                |                                       |                                        |         |
| Married or de facto                           | 67.5                                  | 69.9                                   | 0.6     |
| Widowed, separated or divorced                | 8.1                                   | 9.1                                    |         |
| Never married                                 | 24.4                                  | 21.0                                   |         |
| BASELINE MEASURES                             |                                       |                                        |         |
| Prior GCC® Participation<sup>c</sup>          | 21.54                                 | 24.83                                  | 0.06    |
| Motivation for Participation<sup>c</sup>      |                                       |                                        |         |
| Health                                        | 56.7                                  | 76.6                                   | <0.001  |
| To look my best                               | 43.3                                  | 72.7                                   | <0.001  |
| Fitness                                       | 60.8                                  | 73.1                                   | 0.038   |
| Colleagues                                    | 58.4                                  | 55.6                                   | 0.4     |
| Friends or family                             | 2.5                                   | 2.5                                    | 1.0     |
| Behavioural Measures                          |                                       |                                        |         |
| Self reported hypertension                    | 10.3                                  | 24.6                                   | 0.001   |
| Self reported diabetes                        | 2.1                                   | 8.4                                    | 0.001   |
| Fruit Intake (meeting guidelines)             | 28.5                                  | 34.3                                   | 0.5     |
| Vegetable Intake (meeting guidelines)         | 14.2                                  | 14.7                                   | 0.9     |
| Takeaway Dinner                               |                                       |                                        |         |
| Once or less per month                        | 46.3                                  | 46.2                                   | 0.9     |
| About once a week                             | 39.4                                  | 40.9                                   |         |
| More than once a week                         | 14.2                                  | 12.9                                   |         |
| Alcohol (meeting guidelines)                  | 39.8                                  | 44.4                                   | 0.1     |
| Non tobacco smoker                            | 92.7                                  | 88.8                                   | 0.2     |
| Physical Activity (meeting guidelines)        | 41.2                                  | 37.8                                   | 0.018   |
| Sitting Time (hrs per day)                    |                                       |                                        |         |
| Weekday                                       | 8.3 ± 3.6                             | 8.2 ± 3.6                              | 0.8     |
| Weekend                                       | 5.7 ± 3.1                             | 4.0 ± 2.6                              | 0.001   |
| Physical Measures                             |                                       |                                        |         |
| Systolic Blood Pressure (mmHg)                | 116.1 ± 14.0                          | 120.9 ± 15.0                           | 0.010   |
| Diastolic Blood Pressure (mmHg)               | 77.2 ± 10.0                           | 81.8 ± 10.1                            | 0.001   |
| Blood Pressure (meeting guidelines)           | 86.1                                  | 79.5                                   | 0.036   |
| Heart rate (beats per minute)                 | 67.3 ± 10.2                           | 69.5 ± 9.3                             | 0.007   |
| Weight (kg)                                   | 68.7 ± 11.1                           | 84.1 ± 15.4                            | <0.001  |
than appearance, eating at least two serves of fruit per day, higher physical functioning and lower BMI.

Our finding that employees with a high-risk WC at baseline experienced the greatest improvements in WC confirms findings from a similar workplace health program evaluation [14]. However, the relationship between baseline WC and WC change seems to be contradictory to the relationships observed with the other predictors, which mainly indicated better health. The finding that employees with larger WC at baseline improved the most during the program may be because they had the greatest opportunity to improve. In addition, some unique variables associated with improved WC that indicated better health were restricted to the high-risk baseline WC group.

The finding that employees with better health benefited the most from the program may indicate that healthier employees may find it easier to make the small changes required for a visible outcome. Whilst others, who need to make a greater change, may need additional support or motivation that may not be available through a workplace health program alone. However, a horse-racing effect [26] may be also present and as we did not assess behavioural change status, employees who are defined as ‘healthier’ at baseline may actually have recently made positive changes and be on a pathway to reducing their health risks. Hence, the workplace health program could be supporting employees to continue making the healthier behavioural changes. An alternate theory is that the markers of better health may be indicators of better socio-economic status. However, when several socio-economic confounders were included in the model, only adequate fruit intake in the high-risk baseline WC sub-analysis became non-significant.

Regardless of the reasoning for the healthier employees responding better to the program, the result highlights a possible need for these programs to respond to the enrollees and encourage change based on their individual baseline characteristics. Program initiators may need to think innovatively about how to further promote change in employees with multiple baseline risk factors.

### Table 5 Comparison of baseline characteristics between high-risk and low risk waist circumference at baseline

(Continued)

| Characteristic                            | High-Risk | Low-Risk | p-value     |
|-------------------------------------------|-----------|----------|-------------|
| Body Mass Index (kg/m²)                   | 23.6 ± 2.4| 29.2 ± 4.5| <0.001      |
| Body Mass Index (meeting guidelines)      | 69.1      | 17.4     | <0.001      |
| Waist circumference (cm)                  | 79.4 ± 8.1| 95.2 ± 10.2| <0.001      |
| Waist circumference (meeting guidelines)  | 100.0     | 0.0      | <0.001      |

**Biomedical Measures (fasting)**

| Characteristic                | High-Risk | Low-Risk | p-value     |
|------------------------------|-----------|----------|-------------|
| Total Cholesterol (mmol/L)    | 4.8 ± 0.9 | 5.0 ± 1.0| 0.1         |
| Total Cholesterol (meeting guidelines) | 75.6     | 68.8     | 0.025       |
| Glucose (mmol/L)              | 4.9 ± 0.7 | 5.2 ± 1.1| 0.004       |
| Glucose (meeting guidelines)  | 99.2      | 93.7     | 0.025       |
| Triglycerides (mmol/L)        | 1.0 ± 0.5 | 1.3 ± 1.0| 0.003       |
| Triglycerides (meeting guidelines) | 85.6     | 74.4     | <0.001      |

**Predicted risk scores**

| Risk Score                      | High-Risk | Intermediate-risk | p-value     |
|---------------------------------|-----------|------------------|-------------|
| CVD risk (next 10 years)        | 2.9 ± 4.2 | 5.5 ± 5.2        | 0.001       |
| High-risk                       | 0.00      | 2.62             | 0.002       |
| Intermediate-risk               | 5.06      | 12.36            |             |
| Diabetes risk (next 5 years)    | 5.5 ± 3.3 | 9.3 ± 5.1        | <0.001      |
| High-risk                       | 2.5       | 15.8             | <0.001      |
| Intermediate-risk               | 42.2      | 60.7             |             |

**PROCESS MEASURES**

**Step data**

| Measurement                  | High-Risk | Low-Risk | p-value     |
|------------------------------|-----------|----------|-------------|
| Steps average (per day)      | 11815 ± 3661| 11491 ± 3690| 0.5         |
| Meeting 10,000 steps average (per day) | 67.6     | 66.0     | 0.08        |

**FOUR-MONTH MEASURES**

| Measurement                  | High-Risk | Low-Risk | p-value     |
|------------------------------|-----------|----------|-------------|
| Waist circumference (cm)     | 79.3 ± 8.8| 92.3 ± 11.32| <0.001     |
| Waist circumference (meeting guidelines) | 91.2     | 22.9     | <0.001     |

*In participants who attended both baseline and four-month follow-up data collections.

b The reference group for this binary variable is shown in brackets. The reference group data is not shown.

c The reference group for this binary variable is ‘no’. The reference group data is not shown.
The strengths of this evaluation included the range and quality of measurements, the large sample size and the variety of sedentary occupations within the sample [15]. The main limitation is the lack of assessment and evaluation of program and workplace characteristics. We recommend that future health programs not only evaluate a wide range of participant predictors (behavioural, anthropological and biological), but also the program and workplace characteristics as predictors. Another limitation is that the potential selection bias associated with workplace recruitment, individual recruitment and participant retention [9,15]. Workplaces electing evaluation may have been recruitment, individual recruitment and participant retention as predictors. Another limitation is the lack of assessment and evaluation of the quality of measurements, the large sample size and the direction to the mean effect in this sample. However, selection bias is likely to substantially affect the interrelationships between predictors and WC change. A potential limitation is not having an explicit measure of the potential regression to the mean effect for waist circumference. However, as waist circumference decreased over time in both the low and high baseline risk groups there was no evidence of the regression to the mean effect in this sample.

Conclusions

While employees with high-risk WC at baseline experienced the greatest improvements in WC, the other predictors of WC improvement were generally indicators of better health at baseline. These results indicate that employees who started with better health, potentially due to lifestyle or recent behavioural changes, were more likely to respond positively to the program. The results from this paper can be used to inform employees during recruitment for workplace physical activity programs that there are benefits for participants who are in the healthier spectrum, as well as employees who have a higher WC risk. However, we suggest that these programs may need to promote additional support and motivation for participants who are at greatest health risk. We encourage future health program initiators to think innovatively about how to encourage all enrollees along the health spectrum to achieve clinically relevant improvement.

Authors’ contributions

RFP and AP undertook the study design and oversaw the data collection for the project. RFP takes responsibility for the integrity of the data and the accuracy of the data analysis. RFP, RW, HW, KB & AP contributed to the statistical data analysis. RFP, RW, HW, KB & AP contributed to the critical interpretation of the data. All authors contributed to the final version of the paper and have read, as well as, approved the final manuscript.

Competing interests

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