Review

Strategies to prevent weight gain in workplace and college settings: A systematic review

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ABSTRACT

Objective. To compare the effectiveness of self-management, dietary, physical activity, and/or environmental strategies for the prevention of weight gain among adults in work and college settings.

Method. We conducted a systematic review of work/college-based studies that intervened on adults using one or more of the above strategies with follow up over at least a 12-month period. We excluded studies with a weight loss component. Our weight outcomes included body mass index (BMI), weight, and waist circumference.

Results. We included 7 work- and 2 college-based interventional studies, which all used combinations of different strategies. There was moderate strength of evidence that work/college-based combination interventions prevented weight gain of ≥0.5 kg over 12 months as compared to control; however, we were unable to perform meta-analysis due to substantial heterogeneity in the intervention strategies and study populations. These programs did not prevent BMI gain or waist circumference increase.

Conclusion. While we found limited evidence that work/college-based interventions employing a combination of strategies prevent adult weight gain, the combination of personalized diet and physical activity counseling for the individual along with the promotion of healthy lifestyle changes in the environment may be a promising strategy to explore in future research.

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Contents

Introduction .................................................................. 0
Objective .................................................................. 0
Methods .................................................................. 0
Data sources and search strategy ..................................................... 0
Study selection ................................................................ 0
Data extraction ................................................................ 0
Data synthesis and rating of strength of evidence .......................... 0
Results ................................................................... 0
Study characteristics ........................................................... 0
Population characteristics ....................................................... 0
Intervention characteristics ...................................................... 0
BMI change at 12 and 24 months..................................................... 0
Weight change at 12 and 24 months................................................... 0
Waist circumference change at 12 and 24 months............................................. 0
Adherence .................................................................. 0
Adverse events ................................................................ 0

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Introduction

Healthy People 2020 identified preventing weight gain and the development of obesity as priority areas (U.S. Department of Health and Human Services). Obesity has been linked to increased risks of diseases such as hypertension, diabetes mellitus, kidney disease, cancer (Flegal et al., 2007), decreased life expectancy (Fontaine et al., 2003), and increased costs (Tsai et al., 2011).

The workplace and college campus may be ideal settings for weight gain prevention programs to occur, given the amount of time adults spend at these locations. The U.S. Bureau of Labor Statistics’ results from the 2011 American Time Use Survey showed that employed persons spent an average of 7.6 h working each day, and that 85% of people did all or some of their work at their workplace (United States Bureau of Labor Statistics). In fact, one of Healthy People 2020s objectives is to increase the proportion of worksites that offer nutrition and weight management counseling (U.S. Department of Health and Human Services).

Similarly, the U.S. Bureau of Labor Statistics estimates from 2006 to 2010 that full-time university and college students spent an average of 3.4 h on educational activities on weekdays (United States Bureau of Labor Statistics). College may also be an important intervention setting, as young adults are at high-risk for rapid weight gain in this setting (Economos et al., 2008; Holm-Denoma et al., 2008).

In addition to the practicality of hours spent at work and school, obesity can negatively influence work performance. Obesity is associated with decreased productivity (Goetzel et al., 2010b; Loeppke et al., 2009; Robroek et al., 2011; Sullivan et al., 2008), increased absenteeism (Goetzel et al., 2010b; Robroek et al., 2011; Sullivan et al., 2008; Tunceli et al., 2006), and increased health-related limitations including physical demands at work (Gates et al., 2008; Klarenbach et al., 2006; Rodbard et al., 2009), which may impose a financial burden on employers. In fact, a recent study estimated that obese employees cost their employers $644 more per year on average as compared their normal weight counterparts (Goetzel et al., 2010b).

Workplace and college settings also offer the opportunity to promote weight gain prevention not only on an individual level, but to also target environmental changes that can facilitate the prevention of weight gain. Environmental strategies modify elements of the physical environment. For example, environmental interventions may include altering the types of foods served in the cafeteria, providing onsite fitness facilities, or making online programs available via shared email domains (Centers for Disease Control and Prevention).

Prior reviews have included work-based interventions targeting weight loss as well as prevention of weight gain and risk reduction (Anderson et al., 2009; Verweij et al., 2011). Effective work-based strategies to promote weight loss may differ from those beneficial for weight gain prevention. Weight loss and weight gain prevention studies may differ with respect to their goals, study population, study length, outcomes of interest, and public health effects (Fulton et al., 2001). Their content may differ as weight loss studies emphasize achieving a calorie deficit to lose weight. Additional limitations to these prior reviews include: 1) inclusion of studies of <12 months duration; and 2) exclusion of college settings. A systematic review that specifically evaluates work/collage-based strategies for preventing weight gain over at least a 12-month period is lacking.

Objective

We aimed to compare the effectiveness of self-management, dietary, physical activity, and/or environmental strategies for the prevention of weight gain among adults in work and college settings by conducting a systematic review.

Methods

Data sources and search strategy

We searched the following databases for primary studies: MEDLINE®, Embase, and the Cochrane Central Register of Controlled Trials, CINAHL and PsycINFO from inception through May 2011. We developed a search strategy for MEDLINE and comparable searches using the other databases. We also reviewed the reference lists of each included article, relevant review articles and relevant studies identified in ClinicalTrials.gov.

Study selection

Two study team members independently reviewed each identified article against pre-specified inclusion and exclusion criteria (Appendix A). In brief, we included studies in adults (age > 18) that took place in a work or college setting that evaluated the influence of a self-management, dietary, physical activity, and/or environmental intervention or exposure on the outcome of BMI, weight, or waist circumference change at 12 months or greater. We selected these four strategies (self-management, diet, physical activity, and environment) a priori, based upon the analytic framework for worksite nutrition and physical activity interventions developed by Anderson et al. (2009). We excluded studies that included weight loss interventions or evaluated weight maintenance after weight loss. We first screened titles for eligibility, and then completed an abstract review and article review prior to data abstraction. Conflicts were resolved through consensus adjudication. We used the web-based software package, DistillerSR (Evidence Partners, Ottawa, Ontario, Canada), to facilitate title review, abstract review, article inclusion/exclusion, and data abstraction.

Data extraction

We extracted data on study design, setting, intervention characteristics, population characteristics, baseline weight outcomes, weight outcomes at 12, 24, and 60 months, as well as pre-specified intermediate outcomes including adherence to the intervention and adverse events. We created evidence tables containing all information abstracted from eligible studies. Data from included articles was serially abstracted first by a junior reviewer, which was then confirmed by a senior reviewer. Differences in opinion were resolved through consensus adjudication.

Data synthesis and rating of strength of evidence

We first qualitatively synthesized the results of all trials on forest plots by calculating and displaying the mean between group differences with 95% confidence intervals for the individual studies. We compared interventions for preventing weight gain using a meaningful between group difference threshold and a statistically significant threshold (p < 0.05). We defined the meaningful difference between groups as 0.5 kg of weight (Williamson, 1993), 0.2 kg/m² of BMI, or 1 cm of waist circumference gain less per year than the comparison group.

The study team decided a priori that we would quantitatively pool results and perform meta-analyses only if we identified three or more studies with comparable interventions, outcome measures and study populations. In examining these aspects of our included studies, we identified substantial
Results

We identified 24,870 unique citations during our literature search. Fig. 1 shows our study selection process. No observational studies met our inclusion criteria. We included 10 articles, which describe the results of 9 interventional studies (n = 76,465 participants at baseline). Seven interventional trials (n = 76,310) were in the workplace, while 2 interventional trials (n = 155) were in college settings (Table 1).

Study characteristics

Specific workplace settings included the military (Robbins et al., 2006), a chemical company (Goetzel et al., 2009, 2010a), hospitals (Lemon et al., 2010), and combinations of various work sites (Table 1) (Dekkers et al., 2011; Kwak et al., 2010; Linde et al., 2012; McEachen et al., 2011). All seven work-based studies were multicenter trials, where both recruitment and intervention occurred in the workplace. The earliest year of recruitment was 2002 (Robbins et al., 2006), and the latest year of recruitment was 2008 (McEachen et al., 2011). Four work-based trials were randomized at the level of the employee (Dekkers et al., 2011; Lemon et al., 2010; Linde et al., 2012; McEachen et al., 2011) the other three used non-randomized, quasi experimental designs or randomized by site rather than by individual (Goetzel et al., 2009, 2010a; Kwak et al., 2010; Robbins et al., 2006). Four work-based studies were conducted in the United States (Goetzel et al., 2009, 2010a; Lemon et al., 2010; Linde et al., 2012; Robbins et al., 2006) and three in Europe (Dekkers et al., 2011; Kwak et al., 2010; McEachen et al., 2011). Four work-based studies stated their goals were to prevent or reduce weight gain (Kwak et al., 2010; Lemon et al., 2010; Linde et al., 2012; Robbins et al., 2006) while the other studies’ goals were to increase physical activity (McEachen et al., 2011), improve cardiovascular risk factors (Dekkers et al., 2011), and prevent obesity (Goetzel et al., 2009, 2010a).

Both college-based studies were conducted in randomized trials at a single university, where both recruitment and intervention occurred on campus (Table 1) (Hivert et al., 2007; Matvienko et al., 2001). The earliest year of recruitment was 1997 (Matvienko et al., 2001) and the latest year of recruitment was 2002 (Hivert et al., 2007). One college-based trial occurred in the United States (Matvienko et al., 2001) and the other trial took place in Canada (Hivert et al., 2007). The stated study goal for both of college-based studies was the prevention of weight gain.

Population characteristics

In the work-based interventions, the number of women that were included in each study varied considerably between studies depending on the workplace (Table 1). Women were less than 15% of the military study population (Robbins et al., 2006) and 30% of the chemical company study population (Goetzel et al., 2009, 2010a) while the population of hospital workers was more than 75% women (Lemon et al., 2010). The mean age of the participants that were included in each work-based study reflected the age distribution of that worksite. For example, the mean age was in the early thirties for the military population (Robbins et al., 2006) and in the mid forties for the chemical company population (Goetzel et al., 2009, 2010a). Race/ethnicity was not reported in all trials; however, the populations were predominantly Caucasian (≥ 75% of

The strength of evidence was assessed by evaluating the risk of bias, consistency of results, directness of study goal towards prevention of weight gain, and precision. The risk of bias was assessed using the Downs and Black methodologic quality assessment checklist (Downs and Black, 1998). Two reviewers independently assessed the risk of bias of each article and came to consensus regarding the bias rating for each item on the checklist. We determined that results were consistent if the point estimates for interventions either all favored intervention or all favored control. We labeled a study as direct if the stated goal was prevention of weight gain, otherwise we labeled it as indirect. Finally, we assessed precision based on whether estimates of variability were reported for the outcome of interest. To be rated as high strength of evidence, the body of evidence would need to be rated as low risk of bias, consistent, direct and precise. We rated the strength of evidence as moderate, if one of these elements was downgraded. We rated the strength of evidence as low, if two or more of these elements were downgraded.

Heterogeneity between the studies’ populations and interventions. Therefore, we did not perform any meta-analyses.

Fig. 1. Flow chart of the study selection process for systematic review on strategies to prevent weight gain among adults in workplace and college settings. Displays the flow chart of our study selection process, and provides details on the reasons that articles were excluded at the article review level.

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Table 1
Characteristics of studies included in the systematic review of strategies to prevent weight gain among adults in workplace and college settings.

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Setting</th>
<th>Location</th>
<th>Years of recruitment</th>
<th>Study design</th>
<th>Study goal</th>
<th>Baseline sample characteristics</th>
<th>Participants, N</th>
<th>Women, %</th>
<th>Age, mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dekkers et al. (2011)</td>
<td>Workplace</td>
<td>Europe</td>
<td>2004</td>
<td>Multisite randomized trial</td>
<td>Improve cardiovascular risk factors including obesity prevention</td>
<td>276</td>
<td>C: 92</td>
<td>31</td>
<td>44.0</td>
</tr>
<tr>
<td>Goetzel et al. (2009, 2010a)</td>
<td>Workplace</td>
<td>U.S.</td>
<td>2006</td>
<td>Multisite non-randomized trial</td>
<td>Prevent obesity</td>
<td>3152</td>
<td>C: 634</td>
<td>27</td>
<td>45.8</td>
</tr>
<tr>
<td>McEachen et al. (2011)</td>
<td>Workplace</td>
<td>Europe</td>
<td>2007–2008</td>
<td>Multisite randomized trial</td>
<td>Increase physical activity</td>
<td>1,260</td>
<td>C: 598</td>
<td>723</td>
<td>42.5</td>
</tr>
</tbody>
</table>

Abbreviations: U.S. United States; C control group; I intervention group; NR not reported.

a Significant difference reported by group.
b Age not reported as a mean, only by age groups.

participants) in the studies where it was reported (Goetzel et al., 2009, 2010a; Lemon et al., 2010; Linde et al., 2012; McEachen et al., 2011). Education and smoking status were not consistently reported across studies.

The college-based interventions had similar populations (Table 1). The mean age was 19 years for both interventions. One study examined only women (Matvienko et al., 2001), while the other study included both women and men (Hivert et al., 2007). In both studies, the majority of participants were Caucasian and included only freshman and sophomore college students.

Intervention characteristics

All studies used a combination of strategies in their interventions to prevent weight gain (Table 2). The duration of the work-based interventions ranged from 3 to 24 months. The duration of the college-based interventions ranged from 4 to 24 months.

The work-based interventional study in the setting of a U.S. chemical company evaluated the effectiveness of site specific environmental changes to promote healthy eating and physical activity in combination with a workplace health promotion program that provided individually tailored programming on self-management, diet, and exercise (Goetzel et al., 2009, 2010a). The study considered this worksite health promotion program as usual care, as it was in place at both the control and intervention sites. The environmental changes were considered the intervention.

The work-based interventional study in U.S. workplaces evaluated the effects of a combined individual and environmental program (Lemon et al., 2010). Environmental changes included promotional materials and group events to promote healthy eating and physical activity, along with individual education on diet and exercise through displays, workshops, and newsletters. The control hospitals for this study received no intervention.

Another work-based interventional study occurred in a variety of U.S. workplaces (Linde et al., 2012). This intervention used a combination of self-management, diet, and physical activity interventions, as well as environmental interventions. The participants were encouraged to self-weigh, received healthy eating newsletters, and received pedometers. Environmental strategies focused on modifying the food and physical activity environments, which included increased availability and decreased price of healthy foods, formation of walking groups, and motivational materials to promote stair use.

There were two work-based interventional studies that were implemented in a variety of worksites in the Netherlands. One combined individual level self-management interventions with environmental changes (Kwak et al., 2010). The self-management intervention emphasized education, skills training, goal setting, and self monitoring with respect to energy balance, which was supported via a web-based tool. The environmental changes implemented varied between worksites. Each intervention was selected and implemented by key personnel at each site. The control group received no intervention. The other work-based intervention in the Netherlands combined individual diet and exercise counseling (Dekkers et al., 2011). This study did not include an environmental component. The counseling was provided either by telephone or Internet by four trained counselors.

The work-based interventional study in the United Kingdom was also implemented in a variety of worksites (McEachen et al., 2011). This intervention combined individual and environmental approaches. On the individual level, the intervention focused on self-management and physical activity education. The environmental changes include posters and team challenges targeting exercise.

The work-based interventional study in the military evaluated the effects of a self-management intervention that included completion of two personal energy plan workbooks supplemented with weekly educational emails on healthy eating habits and physical activity (Robbins et al., 2006). This study did not include an environmental component. The control group in this study received no intervention.

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Table 2

Descriptions of the key intervention components of the studies included in systematic review of strategies to prevent weight gain among adults in workplace and college settings.

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Duration of intervention</th>
<th>Control</th>
<th>Key intervention components</th>
<th>Details of intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dekkers et al. (2011)</td>
<td>6 months</td>
<td>Printed materials</td>
<td>Diet, Physical activity</td>
<td>Nutritional and exercise counseling via phone or internet</td>
</tr>
<tr>
<td>Goetzel et al. (2009, 2010a)</td>
<td>24 months</td>
<td>Usual care</td>
<td>Diet, Physical activity, Environment</td>
<td>Workplace changes to support employees’ increased physical activity, improved eating habits, and weight management through environmental prompts and point-of-choice messaging</td>
</tr>
<tr>
<td>Kwak et al. (2010)</td>
<td>12 months</td>
<td>No intervention</td>
<td>Self-management, Environment</td>
<td>Key personnel recruited to set worksite health goals and train worksite leaders on health promotion</td>
</tr>
<tr>
<td>Lemon et al. (2010)</td>
<td>24 months</td>
<td>No intervention</td>
<td>Diet, Physical activity, Environment</td>
<td>Weekly e-newsletter that included health education, recipes, and quick tips</td>
</tr>
<tr>
<td>Linde et al. (2012)</td>
<td>24 months</td>
<td>No intervention</td>
<td>Self-management, Diet, Physical activity, Environment</td>
<td>Monthly strength training workshops where individuals were given a simple routine and a resistance band</td>
</tr>
<tr>
<td>McEachen et al. (2011)</td>
<td>3 months</td>
<td>Usual care</td>
<td>Self-management, Physical activity, Environment</td>
<td>Personal reminders and fridge magnets to track physical activity</td>
</tr>
<tr>
<td>Robbins et al. (2006)</td>
<td>12 months</td>
<td>Usual care</td>
<td>Self-management, Diet, Physical activity</td>
<td>Team challenges targeting physical activity</td>
</tr>
<tr>
<td>Hivert et al. (2007)</td>
<td>24 months</td>
<td>No intervention</td>
<td>Self-management, Diet, Physical activity</td>
<td>Small group sessions focused on increasing knowledge on weight gain, problem solving, goal setting, monitoring strategies, national dietary recommendations, and national recommendations for exercise</td>
</tr>
<tr>
<td>Matvienko et al. (2001)</td>
<td>4 months</td>
<td>No intervention</td>
<td>Diet, Physical activity</td>
<td>College course with lectures to increase knowledge of nutrition, exercise science, physiology and metabolism, as well as laboratory exercises including body composition measurements, serving sizes, food sensory exercises, and food preparation methods</td>
</tr>
</tbody>
</table>

One college-based trial evaluated the effects of a 24 month weight gain prevention program using small groups to increase knowledge on diet and exercise, as well as self-management principles including problem solving, goal setting, and monitoring strategies (Hivert et al., 2007). The control group participants for both of these trials received no information or intervention. The other college-based trial evaluated the effects of a 4 month college course on the science of nutrition, exercise, physiology, and metabolism on weight gain prevention (Matvienko et al., 2001). The course included both lectures and laboratory exercises on these topics.

**BMI change at 12 and 24 months**

Five work-based interventions evaluated change in BMI. Fig. 2 shows the mean difference in BMI change from baseline to 12 and 24 months. Using our predefined criteria for BMI change of 0.2 kg/m² over 12 months, one work-based study met our between group difference threshold and was statistically significant (Goetzel et al., 2009). This intervention included individual diet and physical activity along with an environmental component. This study resulted in statistically significant prevention of BMI gain at 24 months (Goetzel et al., 2010a). Three other work-based interventions demonstrated no significant difference between intervention and control (Kwak et al., 2010; Lemon et al., 2010; Linde et al., 2012), and one work-based intervention resulted in a statistically significant and meaningful BMI increase of 0.2 kg/m² over 12 months (McEachen et al., 2011).

Both college-based interventions evaluated BMI change. Fig. 2 shows the mean difference in BMI change from baseline to 12 and 24 months. Using our predefined criteria for BMI change of 0.2 kg/m² over 12 months, both college-based studies met our between group difference threshold (Hivert et al., 2007; Matvienko et al., 2001). However, only one trial achieved a statistically significant effect on prevention of BMI gain (Hivert et al., 2007). This college-based intervention used small group sessions to promote self-management, diet and physical activity in order to prevent weight gain.

With respect to BMI change, we graded the strength of evidence for the seven work/college-based interventions as low given risk of bias from non-randomized interventions and lack of binding of outcome assessors, as well as the interventions’ inconsistent effects on BMI (Table 3).

**Weight change at 12 and 24 months**

Four work-based interventions reported on weight change. Fig. 3 shows the mean difference in weight change from baseline to 12 and 24 months. Using our predefined criteria for weight change of 0.5 kg over 12 months, one work-based study met our between group
difference threshold and was statistically significant (Goetzel et al., 2009). This intervention included individual diet and physical activity along with an environmental component. This study resulted in statistically significant prevention of weight gain at 24 months (Goetzel et al., 2010a). In another study, one arm that used internet-based diet and physical activity counseling resulted in statistically significant weight gain prevention as compared to control at 24 months (−2.1 kg difference) (Dekkers et al., 2011). The other arm of this study used phone-based diet and physical activity counseling which did not result in meaningful, statistically significant weight gain prevention as compared to control at 24 months (Matvienko et al., 2001). Another study demonstrated no meaningful or statistically significant difference between intervention and control at 12 months (Robbins et al., 2006), which are presented in the subgroups section below.

Both college-based trials reported on weight change. Fig. 3 shows the mean difference in weight change from baseline to 12 and 24 months. Using our predefined criteria for BMI change of 0.5 kg over 12 months, both studies met our between group difference threshold (Hivert et al., 2007; Matvienko et al., 2001). However, only one college-based trial achieved a statistically significant effect on prevention of weight gain (Hivert et al., 2007). This intervention used small group sessions with college students to promote self-management, diet and physical activity in order to prevent weight gain. The college course intervention had a between group difference of 3.2 kg at 16 months; however, this result was not statistically significant (Matvienko et al., 2001).

With respect to weight change, we graded the strength of evidence for the six work/college-based interventions as moderate given risk of bias from non-randomized interventions and lack of blinding of outcome assessors (Table 3).

**Waist circumference change at 12 and 24 months**

Two work-based studies evaluated waist circumference as an outcome. Fig. 4 shows the mean difference in weight change from baseline to 24 months. Using our predefined criteria for waist circumference change of 1.0 cm over 12 months, one work-based study met our between group difference threshold and was statistically significant (Kwak et al., 2010). This intervention combined a self-management intervention with an environmental intervention. This study resulted in statistically significant prevention of waist circumference increase at 24 months (Kwak et al., 2010). The other study found no statistically significant differences between intervention and control groups with respect to prevention of waist circumference increase at 24 months (Kwak et al., 2010). The other study found no statistically significant differences between intervention and control groups with respect to prevention of waist circumference increase at 24 months (Kwak et al., 2010). The other study found no statistically significant differences between intervention and control groups with respect to prevention of waist circumference increase at 24 months (Kwak et al., 2010). The other study found no statistically significant differences between intervention and control groups with respect to prevention of waist circumference increase at 24 months (Kwak et al., 2010). The other study found no statistically significant differences between intervention and control groups with respect to prevention of waist circumference increase at 24 months (Kwak et al., 2010). The other study found no statistically significant differences between intervention and control groups with respect to prevention of waist circumference increase at 24 months (Kwak et al., 2010). The other study found no statistically significant differences between intervention and control groups with respect to prevention of waist circumference increase at 24 months (Kwak et al., 2010). The other study found no statistically significant differences between intervention and control groups with respect to prevention of waist circumference increase at 24 months (Kwak et al., 2010).
Table 3

<table>
<thead>
<tr>
<th>Number of studies, participants</th>
<th>Consistency</th>
<th>Risk of bias</th>
<th>Lack of blinding in studies</th>
<th>Risk of bias - three randomized interventions</th>
<th>Low</th>
<th>Moderate risk of bias - two randomized trials, lack of blinding in studies</th>
<th>Moderate risk of bias - three randomized interventions, lack of blinding in studies</th>
<th>Directness</th>
<th>Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adherence</td>
<td>Inconsistent</td>
<td>Consistent</td>
<td>Inconsistent</td>
<td>Inconsistent</td>
<td>Inconsistent</td>
<td>Inconsistent</td>
<td>Consistent</td>
<td>Inconsistent</td>
<td>Inconsistent</td>
</tr>
<tr>
<td>Weight change</td>
<td>Consistent</td>
<td>Consistent</td>
<td>Consistent</td>
<td>Consistent</td>
<td>Consistent</td>
<td>Consistent</td>
<td>Consistent</td>
<td>Consistent</td>
<td>Consistent</td>
</tr>
<tr>
<td>Adverse events</td>
<td>Inconsistent</td>
<td>Inconsistent</td>
<td>Inconsistent</td>
<td>Inconsistent</td>
<td>Inconsistent</td>
<td>Inconsistent</td>
<td>Inconsistent</td>
<td>Inconsistent</td>
<td>Inconsistent</td>
</tr>
</tbody>
</table>

We found moderate strength of evidence that workcollege-based interventions prevent weight gain in adults. Strategies that lead to a meaningful, and statistically significant difference in preventing weight gain as compared to control included a work-based intervention that combined diet, physical activity, and environmental components, an internet-based diet and exercise counseling program in the workplace, outcome assessors, as well as the indirect nature of one of trials as the goal was not prevention of weight gain (Table 3).

Adherence

The majority of trials did not report any evaluation of adherence to the intervention. Three work-based studies reported an assessment of participation in or adherence to the intervention. One study created a participation score (with a range of 0–100, where higher scores indicate greater participation) that was based on survey responses to questions regarding awareness and use of the environmental interventions (Lemon et al., 2010). The 12 month mean participation score was 15.8 and the 24 month mean participation score was 18.1 among intervention sites. The other two studies examined several process measures related to individual participation in the intervention and implementation of environmental changes. One of these studies compared participation in the intervention arms (telephone-based versus Internet-based counseling) (Dekkers et al., 2011). In this study, 64% of those randomized to telephone intervention completed all counseling modules versus 17% randomized to Internet intervention. The other study focused heavily on environmental changes (Linde et al., 2012). No worksites met the goal of reducing the price of healthy foods, while a majority of sites enhanced their stairwells and stocked their local food sources with healthier foods. Adherence to the intervention was reported in one college-based trial (Hivert et al., 2007). This study defined adherence as attending more than 60% of seminars during a 12 month period. During year 1, adherence was 53% and fell to 26% during year 2.

With respect to adherence, we graded the strength of evidence for the four workcollege-based interventions as low given risk of bias from a lack of blinding of outcome assessors, the interventions inconsistent effects on adherence, and imprecise estimates as variability was not reported on these measures (Table 3).

Adverse events

No studies reported on adverse effects such as burden of intervention, nutritional deficiencies, eating disorders, or activity related injury.

Subgroups

The work-based study in the military setting reported the 12 month mean change in weight among subgroups of men and women (Robbins et al., 2006). Women in the intervention group lost a mean of 0.1 kg, whereas women in the control group gained 0.4 kg. This 0.5 kg difference met our predefined criteria for weight maintenance and was statistically significant. There was no difference in weight among men. The worksite-based study in the chemical company setting performed a stratified analysis by gender, which did not reveal any significant interaction between the intervention and gender (Goetzel et al., 2009). One college-based study evaluated the effects of the intervention among those with BMI ≤24 kg/m² and higher BMIs (>24 kg/m²) at baseline (Matvienko et al., 2001). There were no differences in 16 month BMI change between control and intervention participants who had lower BMIs at baseline. However, the higher BMI intervention group (n = 11) lost 1.4 kg as compared with higher BMI controls (n = 6) who gained 9.2 kg, which was statistically significant. No other subgroup analyses were performed in the other studies.

Discussion

We found moderate strength of evidence that workcollege-based interventions prevent weight gain in adults. Strategies that lead to a meaningful, and statistically significant difference in preventing weight gain as compared to control included a work-based intervention that combined diet, physical activity, and environmental components, an internet-based diet and exercise counseling program in the workplace,
and a seminar-based self-management, diet and physical activity counseling program for college students. We found low strength of evidence that work/college-based interventions prevent BMI gain in adults or increase in adult waist circumference. We found that few studies assessed adherence to the intervention, and methods of adherence assessment varied widely between these studies. No studies reported on adverse effects from the interventions. Given the interest in the primary prevention of obesity by organizations such as the Centers for Disease Control and the
World Health Organization, our review highlights the potential for work/college-based interventions to prevent weight gain.

Previously, Anderson et al. (2009) found that work-based interventions led to a significant decrease in weight of 1.3 kg (n = 9 trials) and decrease in BMI of 0.5 kg/m² (n = 6 trials) at 6 to 12 months of follow up. Based on these findings, the Task Force on Community Preventive Services (2009) recommended the implementation of worksite programs that promote changes in diet and/or physical activity as a means to reduce weight among employees. Verweij et al. (2011) found that work-based interventions targeting physical activity and diet led to a significant decrease in weight of 1.2 kg (n = 9 trials) and reduction in BMI of 0.3 kg/m² (n = 11 trials). It is important to note that the inclusion criteria for both these reviews were more liberal than our study, as they included studies of less than 12 months duration and pooled studies aiming to prevent weight gain with studies that also promoted weight loss. As a result, we excluded almost all articles included in the prior reviews except for one trial (Goetzl et al., 2009). Neither the Anderson et al. (2009) nor Verweij et al. (2011) review had sufficient power to evaluate for differences between weight loss and weight gain prevention trials. We were unable to perform meta-analyses due to the heterogeneity of included trials in our study; therefore, we cannot make any direct comparison with the results of these prior reviews.

We elected different eligibility criteria from these prior reviews to specifically examine the evidence for long-term weight gain prevention strategies. First, we felt that it was important to distinguish trials with a weight gain prevention goal from those who promote weight loss. Weight loss studies typically have different characteristics as compared to weight gain prevention studies (Fulton et al., 2001). For example, a weight loss study may aim to induce a healthy weight loss among those who need to lose weight over a short period, while a weight gain prevention study aims to prevent the development of obesity over the long-term. In addition, a weight loss program’s structure and contents may not appeal to an audience of varied weight, and furthermore, weight loss strategies may not be appropriate for underweight or normal weight employees. Concern exists that encouraging healthy weight individuals to focus on weight may lead to body image issues or eating disorders (Bacon and Aparmar, 2011). Second, we wanted to emphasize the importance of weight maintenance in the prevention of adult weight gain, and therefore, required that trials include at least 12 months of follow up to ensure that the weight benefits persisted. The prior reviews included studies with follow up periods as short as 2 months (Anderson et al., 2009; Verweij et al., 2011). By including these brief trials, their results may overestimate the effect of work-based interventions. Prior studies have demonstrated that weight regain may begin between months 6-12 (Appel et al., 2011) and is common between months 12-24 (The Look AHEAD Research Group, 2010); therefore, assessing weight outcomes after 12 months is critical. Finally, the prior reviews focus only on work-based interventions. We know of no systematic reviews evaluating the effectiveness of college-based interventions on weight gain prevention. We believe that college is an important intervention setting, as young adults are at high-risk for rapid weight gain (Economos et al., 2008; Holm-Denoma et al., 2008) and they spend a substantial part of their days engaged in educational activities (United States Bureau of Labor Statistics). Our review contributes uniquely to the literature on college and workplace settings. Of note, not all combinations of diet, physical activity, and environmental strategies successfully prevented weight gain. It is unclear if these interventions were unsuccessful due to non-adherence, as this was not measured or poorly measured in our studies. Ultimately, future studies may need to evaluate the determinants within work and college settings that facilitate effective weight gain prevention interventions. We hope that additional studies will provide a basis for employers and colleges to develop new policies and implement programs that specifically target the prevention of weight gain.

**Study limitations**

Our study has several limitations. First, the strength of evidence was low for both BMI and waist circumference outcomes due to issues with study quality. Many trials were downgraded for lack of blinding, failure to report the blinding of outcome assessors, or not accounting for losses to follow up. In addition, not all studies reported standard errors or confidence intervals for the between group differences in change in weight-related outcomes over time. We excluded many studies that were included in prior reviews, because they explicitly mentioned that at least some of the patients had a goal of weight loss. We may have inadvertently included some trials that had a goal of weight loss, but that did not say so explicitly in the article. Second, controls had better weight maintenance than we expected. The weight maintenance in some control groups was better than is expected in a general population. In the U.S. population, adults typically gain about 0.5 kg per year (Williamson, 1993). It is possible that the knowledge that one will be evaluated on weight regularly may help individuals to maintain weight without an intensive intervention. This may support the use of weight surveillance interventions in work or college settings.

**Conclusion**

We conclude that low to moderate strength evidence exists that combining multiple strategies such as self-management, diet, exercise, and/or environmental change in workplace and college setting prevents weight gain in adults. The strength of evidence was limited due to issues with study quality and few studies that met our eligibility criteria. However, future researchers may choose to study the successful interventions that we identified when testing combination strategies to prevent weight gain in workplace and college settings.

**Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ypmed.2013.03.004.**

**Conflict of interest statement**

The authors declare that there are no conflicts of interests.

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