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[Intervention Review]

Non-pharmacological interventions for preventing venous insufficiency in a standing worker population

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ABSTRACT

Background

Chronic venous insufficiency (CVI) is a common problem, affecting up to 50% of the population in industrialised countries. It is a chronic condition which, if untreated, can progress to serious complications that in turn can interfere with working ability. Standing at work is a known risk factor for CVI, yet the true effect of non-pharmacological preventive strategies remains unknown. This is an update of a review first published in 2012.

Objectives

To assess the efficacy of non-pharmacological strategies and devices to prevent CVI in a standing worker population.

Search methods

For this update the Cochrane Peripheral Vascular Diseases Group Trials Search Co-ordinator searched the Specialised Register (last searched September 2013) and CENTRAL (2013, Issue 8). We also handsearched reference lists of relevant studies.

Selection criteria

Randomised and non-randomised controlled trials that recruited standing workers to evaluate non-pharmacological devices or strategies used to prevent CVI were eligible for inclusion. Trials had to report an objective measure of clinical features of CVI or complaints associated with this condition in order to be included.

Data collection and analysis

Selection of the trials, quality assessment and data abstraction were completed independently by two review authors. We resolved disagreements by discussion. Only one trial was eligible for inclusion in the review so we did not perform meta-analyses.

Main results

The primary outcomes of this review were clinical features of CVI and its associated symptoms. No new included studies were identified for this update. One prospective cross-over trial was included in this review. It measured the effect of no compression followed by two phases with different gradients of compression stockings on symptoms in 19 female flight attendants who were required to stand, almost continuously, for long periods of time. The included study provided some evidence that compression stockings improved symptoms of leg fatigue in standing workers. However, the strength of the evidence in this review is weak as it is based on only one very small trial which was at high risk of bias. The included study did not address any of the secondary outcomes including quality of life or economic impact of the interventions. Nor did the study report the length of time that the population were required to stand at work. Furthermore,

no trials were found which measured the effectiveness of other non-pharmacological interventions or strategies aimed at preventing CVI in standing workers.

Authors' conclusions

Due to the extremely limited number of trials, there is insufficient evidence to draw any conclusions about the effectiveness of non-pharmacological interventions for preventing CVI in standing workers. Further large-scale studies examining all possible non-pharmacological interventions and outcomes are required.

PLAIN LANGUAGE SUMMARY

Prevention of poor blood flow in the veins in a standing worker population

Long-term poor blood flow in the leg veins, also known as chronic venous insufficiency (CVI), is a chronic illness. It occurs when the veins in the leg cannot return blood to the heart, resulting in increased blood pressure in the legs. The term CVI encompasses a wide spectrum of symptoms including feelings of heaviness in the legs, itching, tingling, cramps, pain, oedema (swellings), varicose veins, skin pigmentation, signs of skin atrophy and venous ulceration.

CVI causes considerable discomfort, which in turn has a significant impact on ability to work. It is a common condition particularly among people who are required to stand at work. Non-pharmacological interventions such as compression stockings or cushioned flooring and strategies such as taking rest breaks or doing exercises have been postulated to be effective in the prevention of CVI in standing workers. Yet the true effect of such interventions is relatively unknown. One cross-over trial of 19 female flight attendants who were required to stand, almost continuously, for long periods of time, and who did not have any symptoms of CVI at the start of the study, were included in this review.

The trial finding suggested that compression stockings did reduce symptoms associated with CVI including aching of the legs, discomfort, fatigue, swelling and tiredness. However, this evidence was from a very small study. Due to the extremely limited number of trials available, we could not assess the effectiveness of other non-pharmacological interventions in the prevention of this condition. Nor could we ascertain if any intervention had an effect on quality of life or an economic impact such as reducing the number of days of sick leave or work disability. Further research that looks at a broad range of proposed interventions in a clearly defined standing worker population is required.

BACKGROUND

Description of the condition

Chronic venous insufficiency (CVI) is a widespread problem. The prevalence in industrial countries is estimated to be as high as 50% in the general population (Beebe-Dimmer 2005; Callam 1994; Evans 1999; Pannier-Fischer 2003; Rabe 2003; Scuderi 2002). However, the variation in the reported prevalence is very large, which may be partly due to differences in the definition of venous insufficiency and in the methods used for assessment of the clinical signs and symptoms of chronic insufficiency. In 1994, an International Consensus was formed to define and classify venous disease in a standardised manner (Porter 1995). The classification was based on the clinical signs (C), etiology (E), anatomical distribution (A) and physiological conditions (P), known as CEAP. Prior to the CEAP classification, there was no standard definition of CVI, which accounts for the wide variation in the prevalence of CVI reported in earlier studies.

Chronic venous insufficiency is characterised by chronic, inadequate drainage of venous blood and venous hypertension in the legs. As a result of the increased venous pressure, symptoms such as leg oedema (swelling) and dermatosclerosis (hardening of the skin) often manifest along with feelings of pain, itching, fatigue and tenseness in the lower extremities. Diagnosis of CVI is based on patient history, clinical examination and specific diagnostic tests such as Doppler ultrasound. Image-directed doppler ultrasound is used to determine the exact site of valvular incompetence and is widely recognised as the method of choice in diagnosing CVI of the lower limb (Gaitini 1994).

The prevalence of CVI is higher in females than in males and depends on race, family history, parity (the number of children to which a woman has given birth) and a standing or sitting occupation (Fowkes 2001; Jawien 2003; Krijnen 1997b; Pannier-Fischer 2003).

In occupational health, physicians are often confronted with populations of workers who have to stand for several hours a day. Standing is a risk factor for CVI of the lower limb because of the increased hydrostatic pressure and diminished activity of the calf muscle during standing. The prevalence of CVI has been estimated to be about 30% to 40% in the standing industrial population (Flore 2004; Krijnen 1997a; Tomei 1999). However, prevalence of CVI in the general population is higher than in the industrial population because the incidence increases with age and, generally, the age limit of the industrial population is 65 years. A key issue in measuring symptoms in a standing worker population is the duration of time spent standing at work. This a continuing source of debate and clarification is required before meaningful conclusions can be drawn from the populations studied.

Venous insufficiency is a chronic illness with a slow progression. Initially, it seems only a cosmetic problem. In later stages, CVI can cause symptoms that can interfere with working ability. In the study of Krijnen (Krijnen 1997a) 7% of the males with a standing occupation had been temporarily unfit for work because of venous disorders.

Description of the intervention

The most commonly used treatment for CVI is compression stockings. Another strategy is to avoid prolonged standing. This can be

done by providing alternative postures for those who stand at work, including the use of chairs or rails for resting the feet, or by taking regular rest breaks with active movements and exercises. If this is not possible, other options are to adapt the workplace itself by installing specially designed resilient surfaces, including softer flooring and cushioned mats, or by wearing shoe inserts.

How the intervention might work

Stockings decrease the effects of the hydrostatic pressure and, if used while walking, help the effects of the calf muscle pump function. Soft-shoe soles and floor mats stimulate the calf muscle pump function.

There are also preventive measures, where standing and other postures are varied, that can diminish the hydrostatic pressure and increase the use of the calf muscle during work hours.

Why it is important to do this review

A systematic review on this topic is very useful because CVI is a common problem that can lead to severe complications. These complications can in turn have a huge economic impact both in terms of provision of healthcare resources and days off work due to disability. Several reviews have examined the treatment of CVI with compression stockings (Amsler 2008; O'Meara 2012) and various drugs (Martinez-Zapata 2005; Pittler 2012) but none have examined interventions for standing workers. Many preventive strategies that could be readily available and administered with relative ease have been proposed, yet the true efficacy of such non-pharmacological interventions is unknown. This is an update of a review first published in 2012 (Robertson 2012).

OBJECTIVES

To assess the efficacy of non-pharmacological strategies and devices to prevent chronic venous insufficiency (CVI) in a standing worker population.

METHODS

Criteria for considering studies for this review

Types of studies

Randomised controlled clinical trials (RCTs) in which participants were randomly allocated to a non-pharmacological intervention designed to prevent CVI or a control group. We anticipated that there would not be many RCTs on this subject therefore we planned to include any relevant controlled clinical trials (CCTs) that met our inclusion criteria. We planned to include studies that were already published and those that were in progress if preliminary results were available. For non-English studies, we planned to seek translations if the study was appropriate for inclusion in the review.

Types of participants

Men and women who were required to work standing for at least two hours a day and who had no symptoms of CVI at the start of the study. If there were very few trials in working populations, we considered people between 16 and 65 years who stood at least two hours a day but not at their work.

If it was unclear how long the participants were required to stand, we planned to contact the authors for further information or we rejected the article.

Types of interventions

Non-pharmacological interventions on the person

- Compression stockings
- Soft-shoe soles

Non-pharmacological interventions in the work place

- Floor mats
- Floorings

Non-pharmacological interventions in the work design

- Not standing, or any other alternative postures
- Frequent rest breaks with an alternative position e.g. sitting or lying down
- Exercises during standing
- Other forms of exercise

In addition to interventions on the person, interventions on the workplace and interventions in the work design, we planned to include any other non-pharmacological device or intervention designed to prevent CVI in a standing worker population.

We planned to compare interventions with each other and with no intervention.

Types of outcome measures

Primary outcomes

- Clinical features of CVI including oedema and skin changes such as eczema, hyperdermatitis and venous ulceration
- Complaints of CVI, which included at least oedema, itching, a tired or heavy feeling in the legs, or pain

Secondary outcomes

- Number of days of sick leave due to CVI or venous leg ulcer
- Work disability due to venous insufficiency or venous leg ulcer
- Outcomes with objective quantitative measures for CVI such as the venous clinical severity score or the CEAP classification
- Outcomes for the quality of life and health status of participants with CVI measured by questionnaires such as Short Form (SF)-12, SF-36
- The economic impact of prevention of CVI by the intervention
- Adverse effects of treatment

Search methods for identification of studies

We did not apply date or language restrictions.

Electronic searches

For this update the Cochrane Peripheral Vascular Diseases Group Trials Search Co-ordinator (TSC) searched the Specialised Register (last searched September 2013) and the Cochrane Central Register of Controlled Trials (CENTRAL) 2013, Issue 8, part of *The Cochrane Library*, (www.thecochranelibrary.com). See (Appendix 1) for details of the search strategy used to search CENTRAL. The Specialised Register is maintained by the TSC and is constructed from week-

ly electronic searches of MEDLINE, EMBASE, CINAHL and AMED, and through handsearching relevant journals. The full list of the databases, journals and conference proceedings which have been searched, as well as the search strategies used are described in the (Specialised Register) section of the Cochrane Peripheral Vascular Diseases Group module in *The Cochrane Library* (www.thecochranelibrary.com).

Searching other resources

We performed additional searches by handsearching citations of studies identified by the search.

Data collection and analysis

Selection of studies

One review author (LR) used the selection criteria to identify trials for inclusion and assessed the titles and abstracts of all identified studies for relevance and design. The second review author (SEY) independently confirmed the selection. Full versions of articles were obtained for those trials which appeared to satisfy the inclusion criteria. If studies were published in duplicate, we planned to include the studies only once. We checked the full papers to identify those that fitted the criteria. We resolved any disagreements by discussion.

Data extraction and management

Two review authors (LR and SEY) independently extracted the data using standard data extraction forms.

We collected information about the trial design, descriptions of the interventions and definitions for standing and baseline characteristics of study participants. In particular, the following information was gathered:

- method of randomisation;
- objective outcome, method of assessment and whether blinded;
- length of follow up;
- number of participants (or limbs) randomised;
- inclusion criteria;
- exclusion criteria;
- description of non-pharmacological interventions and co-interventions;
- baseline characteristics of groups for important variables (e.g. man or women);
- definition of standing;
- method of measuring CVI.

Where presented, we also planned to collect secondary outcome data (number of days of sick leave or work disability due to venous insufficiency; outcomes of objective quantitative measures such as the venous clinical severity score or the CEAP classification; outcomes for the quality of life and health status of participants with CVI, measured by questionnaires; the economic impact of the prevention of CVI by the intervention; and finally the adverse effects of treatment).

We resolved disagreements in data extraction and management by discussion.

Assessment of risk of bias in included studies

Two review authors (LR and SEY) independently assessed the quality of the included studies by using the 'Risk of bias' tool developed by The Cochrane Collaboration (Higgins 2009a). This tool provides a standard protocol for allowing judgements to be made on sequence generation, allocation methods, blinding, incomplete outcome data, selective outcome reporting and any other relevant biases. For each of these six items we assessed the risk of bias as 'low risk', 'high risk' or 'unclear risk', with the 'unclear risk' of bias indicating either a lack of information or uncertainty over the potential for bias.

We resolved disagreements by discussion.

Measures of treatment effect

For dichotomous outcomes, for example clinical features of CVI or its associated symptoms, we planned to calculate risk ratio (RR) with 95% confidence interval (CI) for each trial individually, and pooled if considered appropriate.

For continuous outcomes, for example number of days of sick leave due to CVI, we planned to calculate the mean difference (MD) between treatments with 95% confidence interval for each trial individually. Where appropriate, we planned to pool trials using the mean difference as the primary measure of treatment effect. When trials assessed the same outcome using different scales, for example quantitative measures of CVI using the venous clinical severity score or the CEAP classification, but otherwise did not appear to be methodologically, clinically or statistically heterogeneous, we planned to pool estimates using the standardised mean difference (SMD).

Unit of analysis issues

The inclusion of non-randomised controlled trials, particularly cross-over trials, gives rise to unit of analysis errors. We planned to use the *Cochrane Handbook for Systematic Reviews of Interventions* to aid in the analysis of cross-over trials (Higgins 2009b).

Dealing with missing data

Where data were missing, we planned to contact authors in an attempt to obtain the missing information.

Assessment of heterogeneity

We planned to describe any heterogeneity between the study results and test this to see if it reached statistical significance using the Chi² test. We planned to consider heterogeneity to be significant when the P value was less than 0.10 (Higgins 2009a).

Assessment of reporting biases

We intended to assess the likelihood of publication bias via a funnel plot, using the *Cochrane Handbook for Systematic Reviews of Interventions* to guide interpretation of the results (Sterne 2009).

Data synthesis

Two review authors independently extracted the data. One author (LR) entered the information into RevMan (RevMan 2008) and the other author (SEY) verified correct data entry. We resolved discrepancies by discussion.

We intended to conduct a meta-analysis using the fixed-effect model for combining data where it was reasonable to assume that the studies were estimating the same underlying treatment effect. Where there was clinical heterogeneity suggesting that the underlying treatment effects differed between studies, or if substantial statistical heterogeneity was detected that could not be explained readily, we planned to use a random-effects model meta-analysis to produce an overall summary only if an average treatment effect across studies was considered to be clinically meaningful. We intended to treat the random-effects model summary as the average range of possible treatment effects and we planned to discuss the clinical implications of treatment effects that differed between studies. We planned not to pool the studies if the average treatment effect was not clinically meaningful.

Subgroup analysis and investigation of heterogeneity

We intended, where possible, to analyse relevant subgroups based on the length of time the workers stood each day and the type of intervention, including compression, shoes, flooring, exercise or rest breaks.

We intended to use the I² statistic to measure the degree of inconsistency between studies, where a result of over 50% represented moderate to substantial statistical heterogeneity (Deeks 2009).

Sensitivity analysis

We planned sensitivity analyses to assess the robustness of the review results.

RESULTS

Description of studies

Results of the search

See Figure 1.

Figure 1. Study flow diagram.

Included studies

No additional studies are included in this update.

See: [Characteristics of included studies](#).

The included study was a prospective cross-over trial of 19 female flight attendants who had no symptoms of CVI and were required to stand, almost continuously, for long periods of time (Weiss 1999). All participants were asked not to wear any compression hose for a period of two weeks prior to the study. Participants then wore 8 to 15 mmHg compression stockings over a four-week period (Phase

1) before wearing 15 to 20 mmHg compression stockings over another four-week period (Phase 2), with a minimum period of two weeks between Phases 1 and 2. Participants completed questionnaires at the beginning of the trial following no compression, and then again after Phases 1 and 2. Participants rated their leg symptoms, including fatigue, ache, discomfort, tightness and swelling, on a visual analogue scale ranging from none (0) to severe (5). Eighteen of the 19 participants self-reported having spider or varicose veins, subsequently confirmed by physical examination. None of the participants had clinical evidence of CVI upon examination.

Excluded studies

One additional study (Mosti 2011) was excluded from this update, making a total of four excluded studies, with the reasons stated in the table [Characteristics of excluded studies](#). In three of the excluded studies participants were not standing workers (Derman 1989; Kraemer 2000; Mosti 2011). In the study by Derman 1989, only 61% of participants spent at least five hours per day on their feet. Da-

ta were not presented according to time spent standing and therefore this study was excluded from the review. The second study by Kraemer 2000 looked at the physiological effects of compression in women who did not stand at work but simply had to follow four different standing protocols for the duration of the study. In the third excluded study participants were not standing workers but were included on the basis of having C2-C5 CVI (Mosti 2011). Finally the fourth excluded study was not a controlled clinical trial (Flore 2007). The four different groups of participants all had different occupations and the length of time that they stood on their feet varied within each of the groups. Furthermore, this study measured reduction in oxidative stress, which was not an intended outcome of this review.

Risk of bias in included studies

See: 'Risk of bias' tables in the [Characteristics of included studies](#) and [Figure 2](#)

Figure 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

Allocation

In the cross-over trial included in this review (Weiss 1999), participants were not randomised but instead were assigned to follow the three study phases in the same order, thus introducing a high level of bias into the study.

Blinding

Blinding of the participants was not performed. While it is impossible to blind participants to no compression versus compression, authors could have blinded the participants to the two different

gradients of stockings. However, given that the lighter weight compression stocking was sheer and the heavier weight compression stocking was opaque, it was clear that participants were aware of which stocking they were wearing. Clearly this could have introduced bias, particularly as the primary outcome of the study was subjective reporting of leg symptoms.

Incomplete outcome data

There was no information provided as to why 49 flight attendants were initially enrolled in the cross-over trial but only 19 actually completed the first phase.

Selective reporting

The primary outcome of the study was leg symptoms, which comprised five different complaints including fatigue, ache, swelling, discomfort and tightness. Data were presented on all five symptoms after Phase 1 but after the second phase of the trial the data on aching were missing. Furthermore, authors presented the improvement in leg symptoms as shown by the scores on the visual analogue scale of symptoms but only data for swelling and discomfort were reported.

Other potential sources of bias

Only 10 of the 19 study participants completed Phase 2 of the trial. Whilst authors stated that this was due to the fact that the opaque stockings did not meet the uniform requirements of the study participants, this issue should have been raised during the design of the study.

Effects of interventions

The primary outcomes of this review were clinical features of CVI and complaints of its associated symptoms. We found only one study which met the inclusion criteria. Whilst it did not measure the effects of CVI, it did examine changes in leg symptoms that are associated with CVI. As only one study was found, pooling of data and meta-analyses were not possible, so individual estimates from the study are reported in the narrative synthesis.

The included study measured the effect of no compression versus two different gradients of compression on symptoms of CVI. The number of participants who reported symptoms and improvements following each phase of the study are shown in [Table 1](#). Results showed that wearing 8 to 15 mmHg compression stockings resulted in a significant improvement in leg symptoms. Individually, discomfort, aching and fatigue were improved with statistically significant effects ($P < 0.001$); swelling and tightness also improved but to a lesser although statistically significant degree ($P < 0.01$). The study demonstrated that wearing 15 to 20 mmHg compression stockings also improved symptoms in the leg although to a lesser extent. The heavier support stocking was most effective in reducing discomfort and aching ($P < 0.01$). Tightness and fatigue also showed a statistically significant improvement ($P < 0.05$) with the 15 to 20 mmHg stocking but swelling did not show any statistically significant improvement ($P > 0.05$). The study found no significant difference between the two compression stockings.

The improvement in swelling and discomfort, as reflected by a reduction in the mean score assigned by participants, is shown in [Table 2](#). There was no significant difference in the reduction of symptoms between the two stockings although it should be noted that only 10/19 participants completed Phase 2.

The secondary outcomes of this review included number of days of sick leave or work disability due to CVI, change in outcomes of objective quantitative measures for CVI, outcomes for quality of life, economic impact and adverse effects of treatment. The included study did not, however, measure any of these secondary outcomes. Furthermore, as the one included study examined the effectiveness

of compression stockings, other interventions outlined in this review are not discussed.

As only one study was deemed eligible for inclusion in this review, it was not possible to measure heterogeneity or publication bias. Furthermore, subgroup and sensitivity analyses could not be conducted.

DISCUSSION

Summary of main results

Only one study was found which fulfilled the eligibility criteria for inclusion in this systematic review. The study was a prospective cross-over trial in 19 women who worked as flight attendants ([Weiss 1999](#)) and measured changes in leg symptoms including aching, tiredness, discomfort, fatigue and swelling after wearing compression stockings. The participants had mild venous disease including spider or varicose veins but no symptoms of CVI. The fact that some participants had varicose veins would suggest that venous reflux was present, but this was not confirmed by ultrasound of the leg veins. Given that CVI can be related to reflux in the deep, superficial or perforating veins, it is impossible to determine if the symptoms reported by the population were attributed to CVI or were merely the result of the standing nature of the work undertaken in the population studied. The authors stated that the population studied were required to stand, almost continuously, for long periods of time. However, exact measurements on standing duration were not reported. Results of the study showed that wearing 8 to 15 mmHg compression stockings did improve all five symptoms to a statistically significant degree. Wearing a heavier weight compression stocking (15 to 20 mmHg) also improved some of the symptoms although to a lesser extent. When the two different compression stockings were compared, no difference was found with respect to improving symptoms.

No other studies on non-pharmacological interventions for the prevention of CVI met the inclusion criteria of this review.

Overall completeness and applicability of evidence

There is a severe lack of evidence regarding the use of non-pharmacological interventions to prevent CVI in standing workers. The one study in this review included female participants only, thus the little evidence available is only applicable to females. Furthermore, it would be useful to know about the reflux status in the population studied to determine if the symptoms reported were associated with development of CVI. Duration of standing at work is a key issue here, which has not been fully addressed by the authors. There is considerable debate about what constitutes standing occupations and this needs to be clarified in future studies.

With any cross-over trial, it is important to assess whether there is a likelihood of serious carry-over, where the effects of an intervention persist into a subsequent period ([Higgins 2009b](#)). The cross-over trial included in this review involved three phases, the first phase comprising no compression and the latter two phases comprising two periods of different levels of compression. The authors did allow a minimum period of two weeks between the two phases of compression. However, no justification is provided as to why a wash-out period of two weeks was used. Therefore, it cannot be concluded that there was no carry-over effect between the lighter and heavier weight compression phases. In this case, evidence should be based on the first period, from no compression to 8

to 15 mmHg compression, where authors found that all five symptoms had improved to a statistically significant degree following the period of lighter weight compression.

Quality of the evidence

The quality of reporting in the included study was poor. The study was very small and the risk of selection, attrition and reporting bias was determined to be high. Furthermore, the issue of accurately measuring subjective symptoms needs to be addressed. The simple act of applying compression could produce a subjective perception of therapeutic effect, causing the participant to feel that their condition had improved. This study addressed symptoms which could be attributed to CVI but could also be the result of standing for long periods of time. Definitive CVI symptoms according to the CEAP classification should have been measured and data on the length of time standing should have been reported.

Potential biases in the review process

None of the authors of this report were involved in any of the included or excluded studies. Furthermore, none have any commercial or other conflict of interest.

The search was as comprehensive as possible, and all studies were independently assessed for inclusion by two review authors. We are confident that we have included all relevant studies and attempted to reduce bias in the review process. However, the possibility remains that we may have missed studies which have not been published.

Agreements and disagreements with other studies or reviews

Three other systematic reviews have been conducted which have examined the effect of compression stockings on chronic venous disease (Amsler 2008; O'Meara 2012; Palfreyman 2009), however none have examined the effect in standing workers.

In a systematic review on the effectiveness of compression in the treatment of varicose veins, Palfreyman found that some studies did report an improvement in leg symptoms with compression (Palfreyman 2009). However, this review did not address the issue of standing at work as a risk factor for development of CVI.

O'Meara conducted a systematic review on the clinical effectiveness of compression bandaging in the treatment of venous leg ulceration and concluded that ulcers healed more rapidly with compression than without, but this review was based on the healing rather than the prevention of CVI (O'Meara 2012).

Finally, in a meta-analysis of randomised controlled trials examining compression therapy for leg symptoms and chronic venous disorders, compression was found to improve oedema and leg discomfort (Amsler 2008), but this review included studies in which participants were not required to stand at work or they already had clinical signs of CVI.

Clearly, there is evidence that compression does improve the symptoms and healing of CVI. However, our review specifically examined the effect of compression in those who are required to stand at work, an issue which has not yet been addressed in other reviews.

AUTHORS' CONCLUSIONS

Implications for practice

From the one study which met our inclusion criteria for this review, we found evidence that compression stockings do improve symptoms of leg fatigue in standing workers. However, this evidence is based on a very small underpowered study with a high risk of bias. Few studies have measured the effectiveness of other non-pharmacological interventions, such as floor mats or soft shoes, and strategies such as rest periods or exercises. Furthermore, other outcomes associated with interventions, such as adverse side effects, disability or quality of life, are unknown. Therefore, until adequate evidence regarding the efficacy and acceptability of interventions is available, definitive recommendations cannot be made.

Implications for research

The results of this systematic review confirm the necessity for methodologically sound and large sample studies to determine the effectiveness of non-pharmacological interventions in preventing CVI in standing workers. Future research should test the broad range of proposed interventions in order to find the most effective strategy and use the CEAP classification to measure symptoms of CVI. Moreover, the acceptability of such interventions needs to be measured and thus any future studies should analyse the secondary effects of such interventions, including number of days of sick leave, effect on quality of life and adverse side effects.

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CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Weiss 1999

Methods	Study design: A prospective cross-over trial Duration: 12 weeks
Participants	Country: United States of America Setting: International flights from USA Number enrolled: 49 Number analysed: 19 Mean age: 48.6 years Sex: Females Inclusion criteria: Active flight attendants assigned to international flights and flying during the course of the study, and with no CVI. Exclusion criteria: Flight attendants not flying at the time of the study, e.g. on sick leave or vacation. Definition of standing: Stand almost continuously for hours at a time.
Interventions	Phase 0: No compression hosiery for 2 weeks

Weiss 1999 (Continued)

Phase 1: 8 to 15 mmHg sheer compression stockings for 4 weeks

Phase 2: 15 to 20 mmHg opaque compression stockings for 4 weeks

All subjects waited a minimum of 2 weeks between Phases 1 and 2.

Questionnaires were completed at the beginning of the trial following no compression, after Phase 1, and again after Phase 2.

Outcomes

Five leg symptoms including fatigue, ache, discomfort, tightness and swelling rated on a visual analogue scale, ranging from none to severe. Changes in scores on the scale reflected improvement in symptoms.

Notes
Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Quote: "Once enrolled after a period of no compression, participants were asked to wear each type of stocking during waking hours, particularly when flying, over a 4-week period" Comment: Sequence generation was not random as all participants were assigned to the same intervention, in the same order, at the same time.
Allocation concealment (selection bias)	High risk	Quote: "Beginning of the trial no compression (Phase 0), wearing sheer 8 to 15 mmHg compression stockings (Phase 1) and wearing opaque 15 to 20 mmHg gradient stockings (Phase 2)" Comment: Allocation was not concealed as participants followed the 3 phases of the study in the same order.
Incomplete outcome data (attrition bias) All outcomes	High risk	Comment: Insufficient reporting of the reasons why 49 flight attendants were initially enrolled but only 19 completed Phase 1.
Selective reporting (reporting bias)	High risk	Comment: Authors stated that they would measure changes in leg symptoms including discomfort, swelling, fatigue, aching and tightness after each study phase but did not present results on aching after Phase 2. Also, improvements in symptoms, reflected by the score on the visual analogue scale, are shown for swelling and discomfort but not for aching, tightness and fatigue.
Other bias	High risk	Only 10 of the 19 study participants completed Phase 2 as the opaque stocking did not meet the requirements for flight uniforms. This should have been addressed in the design of the study.

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Derman 1989	Not all participants were standing workers.
Flore 2007	Not a controlled clinical trial.
Kraemer 2000	Participants were not standing workers.

Study	Reason for exclusion
Mosti 2011	Participants were not standing workers.

ADDITIONAL TABLES

Table 1. Number of participants with reported symptoms following compression according to Weiss 1999 (Continued)

Symptom of CVI	Number of participants reporting symptom after no compression (Phase 0)	Number of participants reporting improvement after 8 to 15 mmHg compression (Phase 1)	Number of participants reporting improvement after 15 to 20 mmHg compression (Phase 2)
Aching	17/19	14/17	*
Discomfort	17/19	15/17	6/9
Tightness	16/19	13/16	7/8
Swelling	13/19	12/13	6/7
Fatigue	19/19	15/19	6/10

*Data not reported

Number of participants completed Phase 0 and Phase 1: 19

Number of participants completed Phase 2: 10

Table 2. Improvement in severity score of symptoms following compression according to Weiss 1999 (Continued)

Study phase	Mean score for swelling*	Mean score for discomfort*
Phase 0: No compression	2.47	3.05
Phase 1: 8 to 15 mmHg compression	1.42	1.68
Phase 2: 15 to 20 mmHg compression	1.50	1.70

*Mean score of symptoms on visual analogue scale, 0 = none to 5 = severe

APPENDICES

Appendix 1. CENTRAL search

(Continued)

#1	MeSH descriptor: [Venous Insufficiency] explode all trees	355
#2	(insufficiency or insuficiency or CVI):ti,ab,kw	5088
#3	MeSH descriptor: [Edema] this term only	999

(Continued)

#4	((edema or oedema or swell*) near (leg or low*)):ti,ab,kw	476
#5	MeSH descriptor: [Fatigue] explode all trees	1495
#6	MeSH descriptor: [Pain] this term only	8932
#7	MeSH descriptor: [Leg] explode all trees and with qualifiers: [Blood supply - BS]	1090
#8	((pain or fatigue or tired*) near (leg or low*)):ti,ab,kw	7621
#9	#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8	23981
#10	MeSH descriptor: [Occupational Diseases] explode all trees	922
#11	standing:ti,ab,kw	3796
#12	work*:ti,ab,kw	23753
#13	profession*:ti,ab,kw	5928
#14	occupation*:ti,ab,kw	4266
#15	MeSH descriptor: [Prone Position] explode all trees	201
#16	prone or upright:ti,ab,kw	2311
#17	#10 or #11 or #12 or #13 or #14 or #15 or #16	36222
#18	#9 and #17 in Trials	1671

WHAT'S NEW

Date	Event	Description
19 September 2013	New search has been performed	Searches re-run. No new included studies and one additional excluded study were identified.
19 September 2013	New citation required but conclusions have not changed	Searches re-run. No new included studies and one additional excluded study were identified. Conclusions of the review have not changed.

HISTORY

Protocol first published: Issue 1, 2007

Review first published: Issue 1, 2012

Date	Event	Description
3 November 2008	Amended	Converted to new review format.

CONTRIBUTIONS OF AUTHORS

LR selected relevant trials, assessed trial quality, extracted data and wrote the review.

SEY confirmed selection of relevant trials, assessed trial quality, extracted data and contributed to the review.

DK contributed to the review.

DECLARATIONS OF INTEREST

None known

SOURCES OF SUPPORT

Internal sources

- No sources of support supplied

External sources

- Chief Scientist Office, The Scottish Government Health Directorates, The Scottish Government, UK.

The PVD Group editorial base is supported by the Chief Scientist Office.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

The title of the review has been revised from 'Prevention of venous insufficiency in a standing workers population' to 'Non-pharmacological interventions for preventing venous insufficiency in a standing worker population' to reflect the objective of the review more accurately.

INDEX TERMS

Medical Subject Headings (MeSH)

*Air Travel; *Posture; *Stockings, Compression; Chronic Disease; Cross-Over Studies; Occupational Diseases [*prevention & control]; Prospective Studies; Venous Insufficiency [*prevention & control]

MeSH check words

Female; Humans