# TRAINING GEAR

# Contents

## ➢ Lecture [optional]

Training gear

# Weightlifting belts

Weightlifting belts are probably the most popular form of exercise gear. The common belief is that a belt helps prevent injury by stabilizing the spine. Safety is why many bros wear the belt during their entire training session. After all, those biceps-curl-turned-power-clean are heavy on the spine…

*If your biceps curls look like this, you may indeed want to wear a belt… but better yet, just fix your technique.*

## Safety

There is no long-term research on injury rates of lifting with vs. without a belt in strength trainees. Some studies have reported lower spinal compressive force when wearing a belt during weightlifting, but these calculations are contested and generally don't take into account people lift greater loads with a belt. In one of the studies most representative of an actual squat workout in trained lifters, Lander et al. (1990) reported higher average and peak compressive spinal forces with a belt than without one throughout the entire lift. Spinal shearing forces were comparable with and without a belt.

We do have a large literature on injury rates of similar belt usage during heavy manual labor. The research on occupational belt use generally finds no significant difference in injury rates for lifting with vs. without a belt [2]. If anything, there's a small trend for reduced injury rates but more severe injuries with a belt. Both may be largely psychological effects. The research shows wearing a belt creates a sense of security and it may serve as a reminder of the possibility of injury, resulting in lower injury rates due to being more careful. On the other hand, wearing a belt generally also increases how much weight you can lift by around 5%, thus if something goes wrong with maximal weights, it's likely to go extra wrong.

That last point is particularly relevant for strength trainees. If a weightlifting belt provides no inherent safety but does allow for greater loading, then it's likely using a belt in the gym will increase injury rates and severity.

A second safety consideration is that a belt increases blood pressure during training. For lean, physically active and healthy-eating individuals, this is likely not a serious concern, but it's a risk for people that are overweight or have cardiovascular problems.

## Effect of performance

Wearing a weightlifting belt can anecdotally increase how much weight you can lift by at least 5%. Some people gain as much as 15% or 50 pounds on their squat from optimal use of a powerlifting belt. The belt's primary mechanism of action is to provide stability in 2 ways.

First and most obvious, the belt acts as a brace, preventing spinal motion. To achieve this, the belt needs to be as tight as possible without interfering with the 'core' musculature's own ability to brace (core here refers mostly to the erector spinae, rectus abdominis and external obliques). The bracing effect becomes more powerful with greater levels of spinal flexion. The more your back rounds, the more pressure you apply to the belt and the greater the elastic recoil from the belt to help you lift the weight. However, spinal flexion under heavy loading majorly increases spinal shearing forces and is thus strongly inadvisable for spinal health.

With proper lifting technique, meaning a relatively neutrally positioned lumbopelvic complex, a weightlifting belt's primary benefit is a significant increase in average and peak intra-abdominal pressure: increases of 45% have been reported during squats. This effect of a belt is similar to that of the Valsalva maneuver you naturally perform when you're exercising: you stop breathing out air but maintain the force of exhalation against closed airways. This creates a source of internal stability. Increased intra-abdominal pressure can increase hip extension torque.

For Powerlifters, any increase in how much weight you can lift during a is beneficial. For muscle growth and strength development, however, increased stability does not necessarily translate into greater gains. You may be able to lift more weight in more stable conditions, but as you learned in the module on exercise selection, only major instability detracts from strength training adaptations. Making an inherently stable exercise more stable does not typically increase how much work your muscles perform during the movement. It may just increase how much force from your muscles is converted to upward movement. Think of hitting a ball with a hockey stick. Now imagine the hockey stick is made out of rubber. Even though you may produce the same force, you won't be able to put that force into the ball effectively. Most studies indicate wearing a weightlifting belt does not improve muscle stimulation.

- Escamilla et al. (2002) found that wearing a weightlifting belt did not affect muscle activity of the lower body or traps during conventional or sumo deadlifts in strength-trained football players. The measured muscles included the quads, glutes, hamstrings, calves and hip adductors. The belt did change the activity pattern of the core muscles: the belt resulted in higher rectus abdominis but lower external oblique muscle activity. The altered core activity may be due to higher benefits of intra-abdominal pressure and a lower need for stabilization against lateral and rotary forces. A limitation of this study is that the subjects performed only 4 reps at 12RM. That's enough to feel heavy but not nearly maximal performance.
- Zink et al. (2001) found that wearing a belt did not affect muscle activity at 90% of 1RM during back squats in the quads, hams, adductors, glutes or erector spinae. The belt did result in greater forward lean, greater ROM and faster movement. The subjects probably felt more confident 'dive bombing' while wearing the belt. The subjects were well-trained with an average 1RM of 156 kg (344 lb).
- Lander et al. (1990) found that wearing a belt did not alter ground reaction forces during squats at 70%, 80% or 90% of 1RM in well-trained lifters (1.5-2.4x bodyweight squat). This suggests total lower body force production and muscular work is unaffected by the use of a belt. However, the movement pattern during the lift did change. A belt resulted in greater forward lean with a trend for higher spinal and hip joint moments and lower knee joint moments, indicating greater reliance on the back to lift the weight. This technique takes advantage of the greater spinal stability. Muscle activity of the core muscles divided by spinal joint moment tended to be lower with a belt than without one,

indicating weightlifting belt result in a worse tissue stress distribution with comparatively less muscle stimulation per unit of joint stress for the core.

- Lander et al. (1992) again found no change in ground reaction force during squats with or without a belt. The subjects completed 8 reps at 8RM equaling 1.6x bodyweight. Interestingly, this time there was also no difference in forward lean or core muscle activity. In contrast to the other studies, quad and hamstring muscle activity tended to be higher with the belt, although for the quads the difference was only significant during half the reps and for the hamstrings it was only significant during the last reps of the set. Increased leg muscle activity is hard to reconcile with the lack of increase in ground reaction force and previously observed lower knee joint moments. With only 5 subjects in the study and the inconsistency of the data, this may have been a type I error.
- Jeffrey et al. (1999) found that wearing a belt significantly increased erector spinae muscle activity, but the test was extremely submaximal: 3 reps at 60% of 1RM. Velocity and technique were not controlled and several studies, including Zink et al. and Lander et al. (1990, 1992) above, report that people intuitively squat with more velocity and greater forward lean with a belt, possibly because of greater confidence, so it's plausible the increased muscle activity was merely the result of a difference in technique rather than an inherent effect of the belt.

A big limitation of the literature we have is that all studies used the same weight with and without a belt. Since you can lift more with a belt, it's plausible muscle activity levels would be higher with a belt at a similar percentage of 1RM and this would also explain the greater movement speed we see with a belt. However, the fact ground reaction forces do not increase with a belt even at higher velocities indicates the legs are not putting more force into the ground and are therefore likely not experiencing more tension.

In sum, the weight of the evidence indicates wearing a belt during squats or deadlifts does not increase muscle stimulation and therefore most likely does not increase your gains from training.

The type of belt does not seem to matter. Lander et al. (1990) found no difference in the effects of a regular weightlifting belt that tapered down in the center and a thicker one with a constant width.

## Conclusion

If your primary goal with training is muscle growth or recreational strength training, there's little physiological reason to wear a weightlifting belt. A belt does not seem to increase muscle stimulation and may come with increased injury risk due to the false sense of security it provides and the tendency to increase forward lean and movement velocity during squatting with heavier loads than without a belt.

The only trainees that gain a major advantage from a belt are Powerlifters, Strongmen and Olympic weightlifters, if they're allowed to wear the belt during their competition at least. Even if the belt doesn't improve training progression over time, being able to lift ~5-15% weight in competition is a major advantage. Since the belt alters exercise biomechanics, they should wear a belt during training as well, not just during the competition. They should wear the belt during all sets, including warm-up sets, to perfect the use of the belt. A squat with a belt is a different skill than a beltless squat.

To make optimal use of a belt, strap it on tight around the lumbar spine and your abdomen. Some people prefer it up higher on the belly. Most people prefer it lower with the bottom of the belt touching the hips. A good starting point of tightness is as tight as you can strap it when your belly is completely filled with air. During exercise, most trainees gain the most out of a belt when they forcefully push against the belt with their abdomen by using a Valsalva maneuver: inhale a big belly full of air before the lift and don’t exhale until you’re past the sticking point of the lift. However, for competitive strength athletes, whatever method allows for the greatest performance is preferred.

Make sure your belt’s width is allowed during your competition. Many Powerlifting competitions allow a maximum belt width of 10 cm.

For recreational trainees wearing a belt purely for personal preference, whatever’s most comfortable  or feels the most secure is fine.

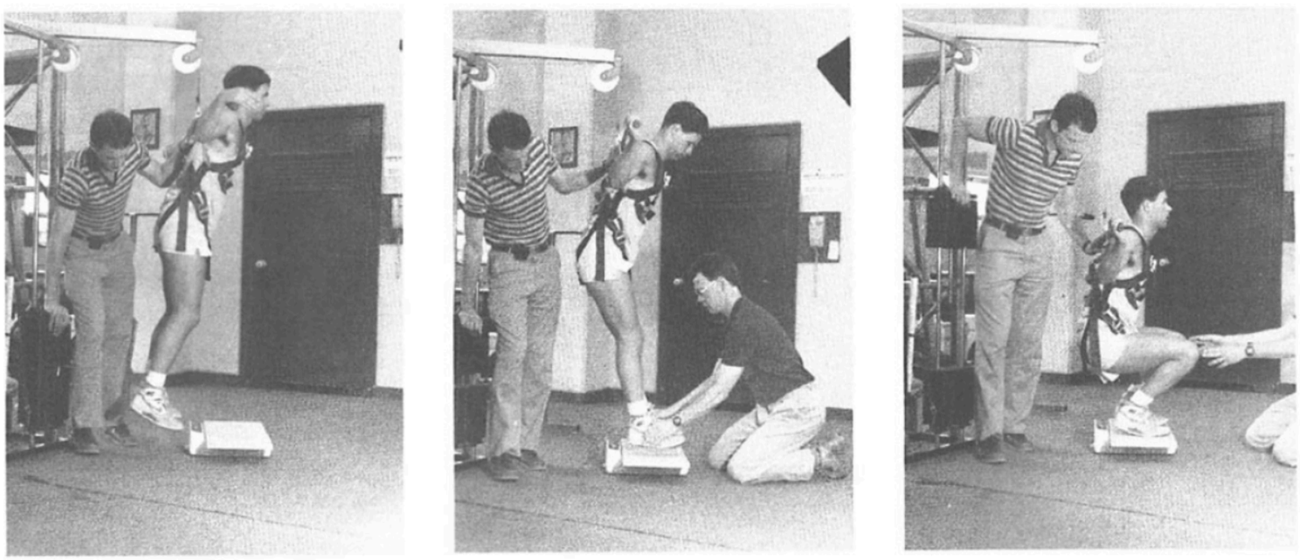
Most Powerlifting belt brands are fine and research finds no difference in the effects of different types, but most strength athletes prefer a belt that has the same width around its entire length. And for the love of iron, don’t get a Velcro belt with a hook-and-loop fastener. It’s not a toy. Get a sturdy leather belt with a metal clasp. You obviously don’t want to risk the belt falling off halfway through a 1RM.


*Left: good. Right: bad~~boy~~.*

## Knee & elbow wraps

Knee wraps consist of thick canvas, often lined with rubber. With few exceptions, only powerlifters, Olympic weightlifters and a few bodybuilders wrap their knees. If you've never worn knee wraps, you probably can't imagine how tight they are compared to knee *sleeves*. To give you an idea, some powerlifters in the lower weight classes have to be carried up the stairs to the podium because they can't flex their knees enough to walk up the stairs themselves while wearing the wraps. Knee wraps are typically tight enough to significantly occlude blood flow [2], so the use of knee wraps inherently comes with a KAATSU training effect (see the course module on advanced training techniques). Unsurprisingly, most lifters find knee wraps are uncomfortably tight.

The primary reason to wear such uncomfortable wraps is to help you lift more weight. Using knee wraps increased peak power and vertical impulse by 10% in one study. Other studies have found much higher values. Knee wraps increase isometric belt squat peak force at parallel depth by over 21%. In another study where trainees were lowered on a scale with a parachute to the squat position (see image below), vertical force was 25% higher with knee wraps. Finally, Brazilian powerlifter and professor Marilia Coutinho has done unpublished research that suggests knee wraps increase squat force production by 20%. All in all, you can likely gain 10-25% on your squat with knee wraps.



**Photos 1 through 3. Sequential photographs of the experimental procedure. The relaxed subject, suspended from a parachute harness, was lowered onto the scale until his thighs were parallel to the ground. A scale reading was then taken.**

How do wraps provide such a major performance advantage? Sinclair et al. (2019) performed a comprehensive kinetic and kinematic assessment of the effects of knee wraps and sleeves in well-trained male lifters performing 5 parallel squat reps at 70% of raw 1RM with and without knee wraps. They also studied competition vs. training wrapping, but the tightness of the wrapping did not considerably affect the results, so we won't discuss those results separately.

The key finding was that all muscle forces were considerably lower with the knee wraps: the quads, glutes, hams and even the calves produced less overall force when squatting with the wraps. Since the weight was the same, this indicates lower active muscle forces are required to lift a given weight with knee wraps than without it, because the knee wraps provide passive elastic force. The knee wraps likely also improve force transfer by acting as a brace around the knee, thus increasing how much of your force production is translated into upward movement and allowing you to lift more weight for a given amount of work done by your muscles.

A different study by Gomes et al. (2015) supports that knee wraps provide a purely passive aid. Strength trained men performed 3 reps of parallel squats at 60% and 90% of raw 1RM with and without knee wraps. The wraps did not majorly affect muscle activity as measured by electromyography (EMG). At 90% of 1RM, the wraps reduced quad muscle activity without affecting glute activity, whereas at 60% of 1RM they increased it, as well as glute activity. These differences may have been caused by different ROMs, rather than an effect of the wraps per se, as vertical bar displacement tended to be higher at 60% with wraps and higher at 90% without wraps. We could argue that the knee wraps should have allowed the men to lift more weight, thereby achieving more muscle activity, but the wraps didn't decrease ratings of perceived exertion (RPE) in this study, so that's questionable.

In terms of the movement, both studies found the knee wraps did not change anterior bar displacement, a measure of forward lean. The wraps also didn't affect hip flexion range of motion (ROM). However, knee flexion ROM decreased slightly in both studies. Sinclair et al. went into more detail and found that below the trunk, things changed significantly. The wraps considerably increased internal hip rotation, knee adduction and knee internal rotation. The wraps slightly decreased knee flexion and ankle dorsiflexion. In other words, the knee wraps encouraged greater caving in of the knees (knee valgus) while slightly reducing the target ROM for the quads and calves, both generally undesirable effects.

In terms of the lifting performance, Sinclair et al. found the knee wraps increased concentric velocity. Despite the higher average velocity during the ascent, peak bar velocity, peak vertical force, rate of force development, peak power and ground reaction forces did not change, indicating the faster tempo was probably more a matter of confidence than greater explosiveness. Just like a weightlifting belt does, the feeling of stability provided by the wraps may encourage ‘dive bombing’.

The knee wraps significantly restricted internal knee joint movement: both anterior and lateral knee translation were reduced by the wraps. The knee cap normally moves in several directions when squatting, so preventing this may compromise joint integrity. However, there was no increase in the forces or stress acting on the knee joint or patellar tendon, so the reduced knee movement may not influence knee injury risk, but a given force can have different effects on tissue in different positions.

The effect of knee wraps on squatting biomechanics seem to be highly variable. In a similar study, Lake et al. (2012) observed even greater biomechanical differences when squatting with knee wraps in well-trained men used to squatting with wraps. When wearing the wraps, they dive bombed down much faster while staying more upright. Yet in contrast to Lake et al., Gomes et al. and Sinclair et al., Eitner et al. (2011) found no significant biomechanical differences in powerlifters squatting to parallel for 6 reps at 12RM with and without knee wraps. ROMs, movement velocity and total work in each joint were similar with and without wraps. It’s possible the powerlifters were so used to squatting with or without knee wraps that their motor patterns were fully engrained and no longer changed acutely when taking the wraps on or off.

Elbow wraps have not been studied much, but they likely function similarly to knee wraps. What knee wraps do for your squat, elbow wraps do for your bench press.


## Conclusion

Knee wraps majorly increase how much you can lift, but they don't increase the active work done by your muscles, so unless you're a competitive strength athlete, wearing them in training may needlessly increase injury risk by exposing your body to greater loads with higher velocities and altered biomechanics. Lake et al. concluded: "The elastic properties of knee wraps increased mechanical output but altered back squat technique in a way that is likely to alter the musculature targeted by the exercise and possibly compromise the integrity of the knee joint. Knee wraps should not be worn during the strength and condition process." Elbow wraps likely function the same way.

Thus, only Powerlifters and Olympic weightlifters should wear knee and elbow wraps during training if, and only if, they may wear them when they compete. Even then, given that knee wraps do not seem to majorly alter squatting biomechanics, for knee and elbow health their use may be best restricted to work with training intensities above 85% of 1RM.

If you're going to use knee wraps, experiment with the wrapping technique that allows you to lift the most weight. The figure-8 method depicted below is a good starting point, as scientific research has validated it. Based on the research, the x-wrapping technique is no more effective than the simple spiral wrapping technique though [2], it doesn't appear to matter if you do many looser wraps or fewer tighter wraps and the tightness of the wraps also doesn't seem to matter. All that seems to matter is getting wraps tightly around your knees, regardless of how.

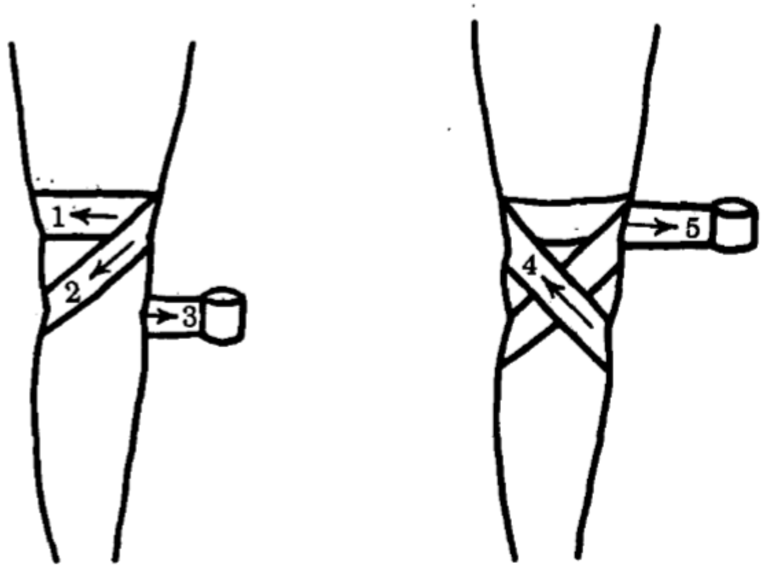



**Figure 1. Front Views of the Leg Showing the Wrapping Pattern**

During the first wrap cycle the wrap was stretched (1) horizontally around the leg once, (2) diagonally downward across the knee cap, (3) horizontally behind the leg, (4) diagonally upward across the knee cap, and (5) horizontally behind the leg again. Steps 2 through 5 were used for succeeding cycles until all the wrap was used.

## Knee & elbow sleeves

Knee and elbow sleeves are the light version of wraps. They're more like elbow and knee socks than performance enhancing gear. And in fact, a cut-up elastic sock can make for a fine budget elbow or knee sleeve. Cloth sleeves are normally not compressive or tight enough to enhance performance, occlude blood flow, impair knee joint movement or affect any squatting kinetics, kinematics or ROMs, other than increasing concentric bar velocity. Most lifters find knee sleeves comfortable and prefer them over wraps or nothing [3].

Other than providing subjective comfort and stability, cloth sleeves only achieve 2 things.

1. Joint sleeves enhance joint proprioception, our ability to tell in which position our joint is without seeing it. This may facilitate optimal lifting biomechanics and exercise technique.
2. Joint sleeves keep a joint warm. A proper warm-up should make this redundant, but injured joints and lifters training in cold environments may benefit from the warmth to reduce injury risk. The warmth may increase blood flow and some research shows a trend for faster acute recovery when wearing compression garments.

While minor, these benefits are reasons to wear joint sleeves for injured or easy-to-injure knees and elbows and when training in cold environments. Anecdotally, joint sleeves can also help to get rid of psychosomatic pain, probably due to the sense of security they provide.

Since cloth sleeves have no significant downsides and most people like wearing them, so feel free to wear them all the time.

In contrast to cloth or nylon sleeves, neoprene (rubbery) sleeves can be sturdy enough to passively increase maximal squat strength, much like knee wraps, although they don't seem to improve performance for jumping or leg extensions. They still generally don't affect exercise performance that doesn't involve high knee bending, but they're effectively one step closer to being knee wraps than most cloth sleeves.

## Wrist wraps

Many people struggle with keeping their wrists straight during pressing exercises, letting their elbows slack back and thereby reducing force transfer. Wrist wraps are a potential solution for this. In the only direct study testing this, the researchers had a group of well-trained men and women find their bench press 1RM with stiff wrist wraps, soft wrist wraps and no wrist wraps. To reduce placebo effects, the lifters benched with bags over the weights so they couldn't see how much they were pressing.

*Wrist wraps (and elbow sleeves) during bench pressing.*

The wrist wraps increased perceived stability but had no effect on their 1RMs. The wrist wraps also had no effect on power output, handgrip strength or how many reps the lifters could do with 75% of their 1RM. The lifters found the wraps uncomfortable, so the wraps were likely tight enough.

Anecdotally, some powerlifters do bench more with wrist wraps, but this study suggests this could in large part be a placebo effect due to the greater stability and increased confidence.

Many less experienced lifters also 'benefit' from wraps because they slack their wrists back too much and hold the bar too high up in their fingers instead of on the thumb directly above the wrist. Better technique, as illustrated below, and some wrist curls can solve this problem without wraps.


All in all, powerlifters should probably use wrist wraps, because they can't hurt and might help, but for anyone else, wrist wraps are arguably not worth the bother.

## Lifting straps

Most lifters can't max out on deadlifts with a double overhand grip without the use of lifting straps [2, 3, 4]. Untrained individuals often don't have any problems with grip strength yet, but as the lower body gets stronger, the grip becomes a limiting factor. Grip strength is strongly genetically determined, more strongly genetically determined than other isometric strength tests and dynamic or isokinetic strength tests with a 7% higher heritability factor. Part of the reason is that grip strength has a significant anatomical component: the size and shape of your hands and forearms strongly influence how much weight you can hold on to with a given amount of force production. Only jumping ability seems to be as genetically determined as grip strength. Some people naturally have an extremely strong grip, while others never get that strong, even after years of training. In fact, grip strength is a surprisingly good measure of overall body strength and masculinity. Anecdotally, high grip strength also seems to be a good proxy for genetic muscular potential.

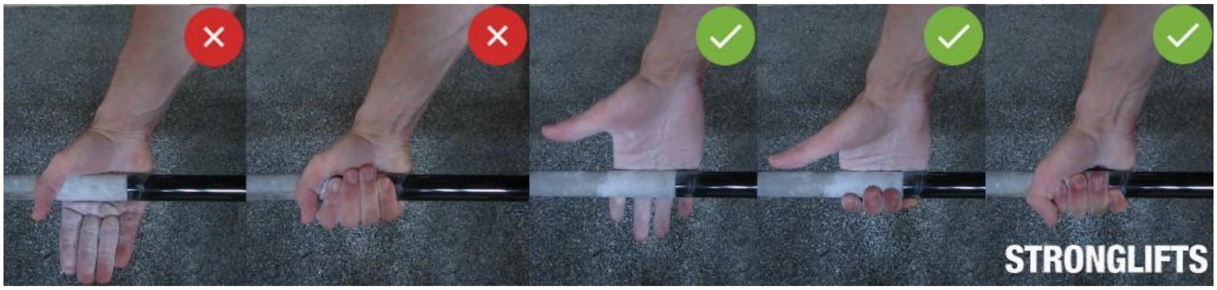
The genetic influence of grip strength also explains why men have such a stronger grip than women. Since you learned in the course module on gender differences that women have the same relative muscular potential as men and only a slightly lower potential for strength, their lower grip strength may come as a surprise, especially considering how extreme the difference in grip strength is between the sexes. 90% of women have a weaker grip than the weakest 5% of men. Even elite female athletes, including national level judokas, don't score better than the weakest 25% of men. The very strongest women in that group of athletes only reached the 58th percentile of untrained men. In other words, even most untrained men are significantly stronger than some of the strongest women, even after controlling for the difference in muscle and hand size.

Grip strength is also highly specific: there is only a moderate relationship between pinch grip and hand grip strength and almost zero relation between pinch grip and revolving thick bar grip strength. General grip strength training does relatively little to improve overall grip strength. To improve your grip during a certain exercise, you have to very specifically train grip strength in that exercise. That requires significant effort and time for limited returns, as forearm size does not develop that much from isometric grip training.

In short, you can make your grip much stronger with training, but it's a hassle and the rest of your body will often still outpace your grip gains. As a result, your grip becomes *relatively* weak. Men have trouble deadlifting without the bar slipping out of their hands and women often experience grip issues during several more exercises, such as pull-throughs, hip extensions and unilateral calf raises with a dumbbell.

Lacking grip strength is problematic, because as you learned in the course topic on exercise selection, this makes your grip the limit factor during the exercise. When your grip limits your performance, the target musculature of the exercise remains understimulated [2].

If your gym allows chalk (magnesium carbonate powder) and that's enough to maintain your grip, that's ideal. Chalk is particularly effective if your grip problem is caused by sweaty hands. The less training gear you need and the more you can develop your grip strength, the better.




*Gripping the bar with chalk before deadlifts.*

However, many gyms and lifters don't like the mess chalk gives. Liquid chalk is less messy than powdered chalk, but it's still messy. If chalk is not an option for you or not enough to keep hold off your weights, lifting straps are the best way to improve your grip. Strength athletes should check if they're allowed to wear straps in their competition though. With lifting straps, your grip should practically never be a problem.

[Here's an instructional video on how to use weightlifting straps](). There are many ways to use straps though and it doesn't really matter which method you use as long as it's safe and it allows you to keep hold of the weight. That last part is important: if you still have grip issues with straps, you are certainly not using them correctly. Powerlifting straps should allow you to hold onto more weight than you'll ever lift.

Some people don't like the solution of using straps because it's a crutch. Based on the above, however, you can see that it's more of a legitimate aid than a crutch for many people.

Moreover, it's not like your grip muscles completely stop working when you're using straps. Grip strength still fatigues after sets of deadlifts with straps [2]. It's about a third of the fatigue as without straps in the research we have, but there's still significant fatigue. You can easily verify this yourself by seeing how much weight you can hold on to before and after your deadlift sets.

Still, you should only wear straps when you need them for maximum performance. Otherwise, you may further exacerbate the grip weakness. Miras-Moreno et al. (2024) found that lifting straps did not improve maximal strength or lifting velocity of prone barbell rows (also called seal rows) in strength-trained men. Similarly, Valério et al. (2021) concluded that "the use of lifting straps in the lat pull-down exercise by resistance-trained individuals does not promote beneficial effect in the 1RM value, the number of repetitions performed with 70% of 1RM, and muscle activation." Needing straps for pulling exercises beyond shrugs or deadlifts is often due to bad gripping technique or ego lifting with excessively heavy weights. Most natural male trainees should only have to use straps during deadlifts and possibly shrugs. However, there are exceptions of individuals that either have genetically very weak grip strength or individuals that got very strong without caring about grip strength. Strong women may also need straps for other lower body exercises, such as dumbbell split squats and calf raises. If you need straps for other exercises, you can and arguably should use them, but you should probably consider adding grip work to your program to have your forearms catch up with your upper body.

You may be wondering: why not just use an alternate grip?


A mixed grip is beneficial for strength athletes that can't use straps during competition, because it's easier to hold onto heavy weights, but the asymmetry may increase the risk of injury and asymmetrical muscle development. A mixed grip results in asymmetric muscle activation, even affecting the lats. A mixed grip also puts an asymmetrical stress on the upper body, from the wrists and elbows all the way to the shoulder and quite possibly affecting the spine. Supination of the wrist extends the elbow and flexes the biceps. This puts the biceps and its proximal tendon in a much more injurious position. Biceps tears almost never occur with a double overhand grip, but with a mixed grip, it's relatively common at the elite level. The extension of the elbow of the supinated arm can also cause uneven positioning of the shoulders, which can in turn affect the spine and the hip. Considering the huge weights used during deadlifts, there is little reason to exacerbate the risks just because you're too cool for straps.

So a mixed grip is not advisable unless it's needed for a competition. In that case, you'll want to alternate your grip as much as possible to avoid creating strength asymmetries and asymmetric overuse injuries. And before you try a mixed grip, experiment with a hook grip. Most people don't like it because it's painful for the thumb, but then again, most people never really try it and it improves grip strength without requiring an asymmetrical or underhand grip.


## Conclusion

Powerlifting straps are generally a legitimate training aid. Use them if, and only if, needed to prevent your double overhand grip from limiting your performance. Powerlifters should check if they're allowed to use straps in competition. If not, they should generally use a mixed or perhaps hook grip.

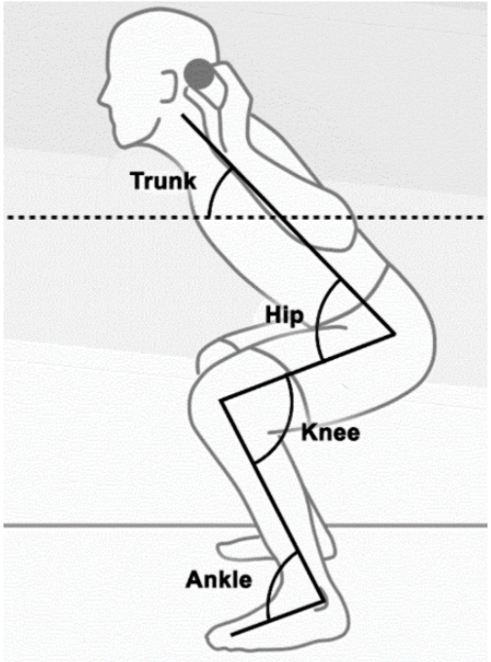
# Footwear

## The heel

Almost everyone in our time wears heels. Not necessarily 5” stiletto heels or Spice Girls tower type heels, but almost all shoes for both sexes have a heel lift. That heel lift slightly but significantly changes your posture. Yes, also if you’re a man. A heel lift puts your ankles in plantarflexion. This shifts the knee forwards. As a result, knee stress increases significantly when standing and walking in heels [2, 3]. Moreover, when standing in heels you sometimes see flattening of the spine, which can increase stress on the spine. In other individuals you see anterior pelvic tilt to keep the spine aligned above the center of gravity. Both the height of the heel as well as its width affect how much your posture changes.

The effects of a heel lift are arguably functionally undesirably in daily life, but in the gym, the main benefit of a heel lift is that it helps you squat deeper. That’s why Olympic Weightlifting shoes have a large heel: it allows lifters to catch the Snatch and Clean & Jerk in a deep squat position, which most people cannot do without a heel lift without a flexed spine and posterior pelvic tilt (‘buttwink’).

Counterintuitively, squatting further down doesn’t necessarily mean you increase overall range of motion. Remember that range of motion is measured in joint angles, not bar displacement: see the image below.




*How joint ranges of motion (ROMs) are measured during the squat. Source*

A heel lift generally sacrifices range of motion at the ankle for the potential for more range of motion at the knee. Theoretically, the greater the heel lift, the less dorsiflexion occurs at the ankle, the more knee flexion may occur and the more the trunk stays upright. Indeed, this is exactly what Monteiro et al. (2022) found in trained lifters: the greater the heel lift, the further you can flex your knees and the more upright you can keep your trunk when squatting as deep down as possible, which is further down when your heels are elevated. There was also a non-significant but consistent trend for hip range of motion to decrease with greater heel lifts ($p$ = 0.11). Sato et al. (2013) had similar results and Sato et al. (2012) and Charlton et al. (2017) both supported a heel lift reduces forward trunk lean but did not measure other joint angles. However, multiple other studies found that the increased squat depth from squatting in Olympic lifting shoes is purely because of the heel lift and actual range of motion at the knee and hip is practically unaffected [2, 3, 4]. A limitation of those studies is that they did not explicitly motivate the participants to squat down as far as possible, except for Sayers et al. (2020), but there's also a good theoretical reason for why not everyone can squat with more ROM with a heel lift. Many people likely don't benefit from a heel lift because they don't reach maximum dorsiflexion range of motion during their squats and structural ankle flexibility is not associated with maximum squat depth (*active* flexibility is), so they shouldn't need a heel lift to allow the ankle to travel further forward. In this case total ROM is actually slightly *less* when squatting in Olympic lifting shoes because you reduce ROM at the ankle without improving the ROM in other joints. Research by Legg et al. (2017) found that the effect of Olympic weightlifting shoes on squatting kinematics during 'ass to grass' deep squats differs per sex and training experience. Novice lifters experienced a small but significant increase in knee flexion ROM with the weightlifting shoes, but in experienced lifters, only men experienced a minor 3.6° increase. Ankle ROM decreased in all groups and hip and trunk ROM were unaffected in all groups. Sayers et al. (2020) also found that a heel lift allows novice level trainees to squat more like experienced trainees, but the heel lift did not significantly improve overall range of motion. Thus, it's important not to use a heel lift as a crutch to attain the arbitrary depth of parallel. If you can't squat to parallel without a heel lift, your technique probably needs work, as almost everyone should be able to. Very few people can squat ass to grass without posterior pelvic tilt ('buttwink') though. With a heel lift, almost everyone should be able to go below parallel during high bar back squats.

A heel lift doesn't affect muscle activation levels in the quadriceps or erector spinae, in contrast to popular belief [2] and does not affect peak knee or hip joint moments, unless it changes how you lift. When the heel lift makes your knee travel further forward, knee torque will likely increase. The lack of meaningful changes in muscle activity when squatting with a heel lift is not surprising considering different squat variations (front, high bar, low bar) also all have very similar muscle activity profiles [2]. Your muscles tend to have a similar activity level during most types of squats, as it's the same functions they're performing during a very similar movement.

As such, the relevant factors to consider for squatting barefoot vs. in regular shoes vs. in Olympic weightlifting shoes are range of motion and joint stress and even those effects are often minor.

Deadlifts should arguably not be trained with a heel lift, because there's no benefit. While it's not a major difference, rate of force development during deadlifts is higher without shoes than with shoes, although lifting barefoot does not increase maximum force production. Shoes with a heel also require a greater excursion of the center of pressure, which is biomechanically inefficient. Anecdotally, deadlifting barefoot or in shoes without a heel lift makes it easier to stay on your heels and drive from the hips.

## Conclusion on heel lifts

Using a heel lift when squatting, such as by wearing Olympic weightlifting shoes, does not have major effects on how you squat. There is generally no effect on muscle activity patterns and there is only a slight change in ranges of motion and joint torques in some individuals. While vertical bar displacement may increase, total joint ROM is often not considerably greater with a heel lift. A heel lift generally sacrifices some ankle ROM for the potential for more knee ROM. Men, novice trainees and individuals with poor ankle ROM are most likely to experience an increase in knee ROM. Peak joint moments at the knee and hip are generally unaffected, but staying more upright should shift some stress away from your back and onto your knees. Theoretically, a more upright squat should thus increase knee injury risk while reducing back injury risk. In the ideal scenario greater knee flexion could promote quadriceps growth, but in most individuals, it's doubtful if the effects are large enough to meaningfully affect training outcomes. If they are, calf growth and potentially erector spinae and glute growth may be reduced.

The decision of whether to wear shoes with an elevated heel is thus largely one of personal preference, but beware of creating a crutch. Many people prefer Olympic weightlifting shoes because they make it easier to hit the arbitrary depth of parallel squats. If you can't squat to parallel without heels, you likely need to work on your technique, not just get Olympic weightlifting shoes to make it seem like you can squat to parallel. In Olympic weightlifting shoes, almost everyone should be able to break parallel. It's advisable to learn how to squat to at least parallel barefoot or in minimalist footwear before experimenting with any training gear. It will solidify your technique and many people experience an increased sense of proprioception when they first squat barefoot due to the direct contact of the feet with the ground.

Socks can be an acceptable way to squat 'barefoot' if your gym doesn't allow you to train truly barefoot, but if the floor does not have a lot of traction, socks can be unstable.

*If shoes with a heel allow you to squat with this much ROM, awesome. If not and you don't have a back or hip injury, beware of relying on a heel lift as a crutch to make squatting to the arbitrary depth of parallel artificially easier.*

It’s generally not advisable to put weight plates under your heels when you squat, because you may trip over them and they are unstable without any notable improvement in training efficiency. Anecdotally, there are virtually no strong squatters that squat on weight plates or with any heel elevation other than what’s in weightlifting shoes.

During deadlifts, a heel lift decreases rate of force development (related to power) and it makes the exercise less biomechanically efficient. Without any obvious upside to compensate for these potential downsides, you should arguably deadlift without a heel lift. The same applies to almost all exercises other than squats.

## Stability

Another feature of footwear is its stability. A shoe basically functions as a brace for your foot. The sturdier the shoe, the more stability it provides. However, by providing stability, shoes detrain your feet muscles. In contrast, wearing minimalist footwear strengthens your feet muscles [2, 3].

The net result appears to be neutral in terms of injury risk: shoes offer you protection that you only need because you’re used to wearing shoes. Shoes do not decrease injury risk during Military exercise or running [2].

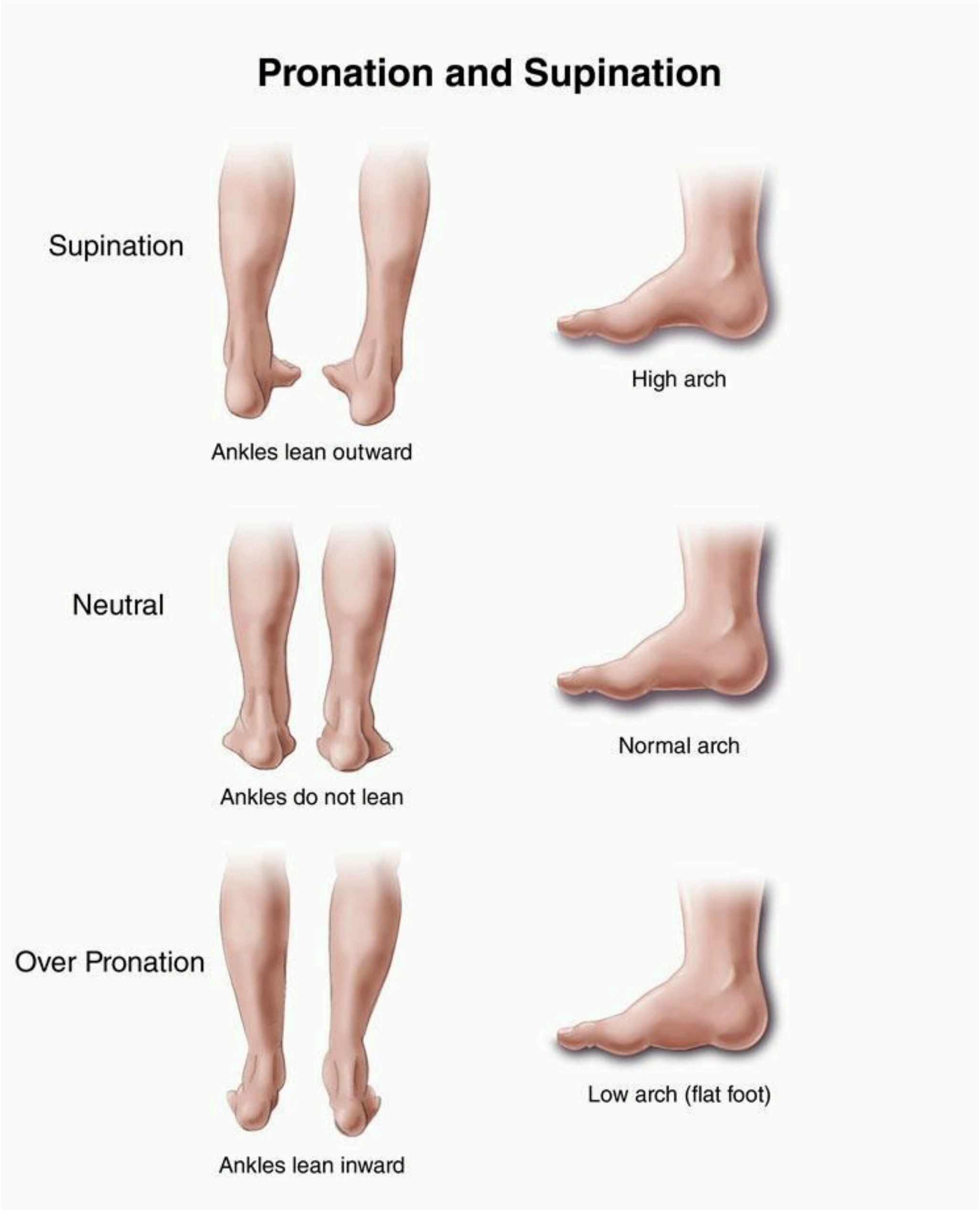
## Running economy

The external stability provided by shoes also changes our gait mechanics, how we walk and run. We tend to walk with more of a heel strike when wearing shoes. Optimal gait economy requires a gentle strike on the ground, generally more of a forefoot strike, to reduce the impact from the ground. As a result, minimalist shoes improve running economy compared to traditional and heavy shoes, according to the latest meta-analysis [2].

Runners and athletes should therefore consider minimalist footwear to improve their running performance.

## Pronation & shoe inserts

A common method of determining which kind of shoes you need is by looking at your walking posture (gait). The amount of pronation of the foot is then compared to the textbook standard that should occur and a type of shoe or shoe insert is prescribed to correct this.




While the idea of selecting footwear based on your level of foot pronation is superficially plausible, there is very little empirical scientific support for it. Most research finds no effects of choosing someone's footwear based on their foot type. In fact, research has found no relation between the degree of foot pronation and the risk of running injury in the first place. As you've learned in the course topic on posture, unlike what posture Nazis will tell you, there is no such thing as universally optimal human posture, so it's silly to force people into a standardized posture. There is significant interindividual variability in human anatomy and the motor cortex is adequately equipped to optimize movement based on your individual anthropometry.

Your brain's motor cortex is so awesome that you are often best off selecting your shoes simply based on how comfortable they are.

Wearing shoes may be the problem in the first place. While shoe inserts are often recommended for flat feet, the incidence of flat feet in children that wear shoes is severalfold higher than in children that walk barefoot and the studier the shoe type worn, the higher the incidence of flat foot was. Since children are unlikely to self-select different footwear based on their feet's anatomy, it's likely that wearing shoes caused the flat feet. Wearing shoes, especially shoes with a tight toe box and large heels, is also associated with the development of other foot abnormalities in women, including hallux valgus, hammer toe deformity, Haglund syndrome, metatarsal stress fracture, Freiberg infraction and Morton neuroma.

## Conclusion on footwear

Humans have evolved to walk barefoot very well. Unless you have a clinical foot or gait pathology, there is generally no advantage to wearing shoes, but there are potential drawbacks. Shoes reduce proprioception, decrease strength development of the feet and decrease our running economy. The only notable benefit of training in shoes is that a heel lift can help you squat deeper, but this is mostly a cosmetic change, since overall muscle activity, total joint ROM and joint torques are generally minimally affected. During deadlifts, shoes with heels may decrease hip drive. As such, training barefoot is perfectly fine and you may even argue that the best footwear is no footwear.

Since you probably do want to wear something protective on your feet, or your gym will want you to, a good option for many is minimalistic footwear with flat soles like VivoBarefoot shoes. A few other brands, including Nike and New Balance, also have a so-called minimalist shoe. If you're not just indifferent about fashion but you actively want to affront people with your presumably superior footwear, get some Vibram five-finger shoes. (*Hm, should we get an affiliate link for that recommendation*?)


It's probably best in general to select your shoes based on perceived comfort when wearing them, but err on the side of slightly more minimalist shoes than you're used to.

If you're going to switch to minimalist footwear or barefoot training, it's best to do it gradually, just like for any change in shoes. While the transition to barefoot training is generally intuitive and requires only a small learning curve, it's not a good idea to go run a full marathon to 'test drive' your new shoes. Wearing minimalist footwear significantly changes how your body moves (kinematics).

Competitive strength athletes are an exception. Powerlifters may benefit from the grip and stability provided by sturdier shoes, especially because you don't always know what kind of surface you'll be competing on. Still, many powerlifters favor the ballet dancer type slippers (and that says something) or the almost flat-heeled Chuck Taylors.


*If this guy competes in ballet dancer slippers, you know he has a damn good reason to.*

Olympic weightlifters often benefit from – you'll never guess – Olympic weightlifting shoes. They're simply the only way to catch a Clean or a Snatch in the ass-to-grass squat position without folding over like an accordion. Very few people can reach the deep catch position without a heel lift or completely losing the neutral position of their lumbopelvic complex, so shoes with a heel lift are practically mandatory for Olympic weightlifters.

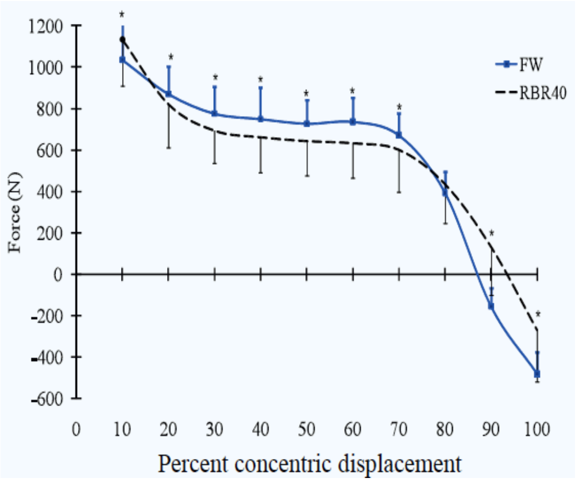
## Bands & chains

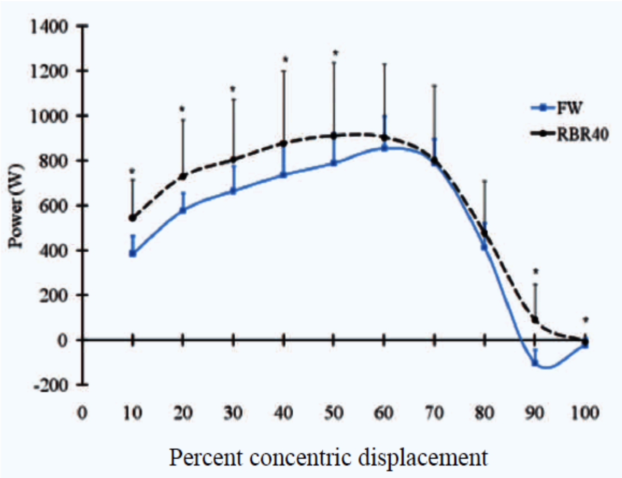
Bands provide accommodating resistance. The more the band stretches or the more chain comes off the floor, the more resistance it provides, so you get progressively more resistance towards the top of the movement. For example, during a bench press with chains, the further up you press the barbell, the more chain comes off the floor and the more weight you're pushing up. A reverse band set-up achieves the same but with heavier weights on the barbell (or whatever you use), as instead of fighting you more at the top, the bands now help you less. The reverse bands assist you progressively less nearer the top of the movement. For example, during a squat with a reverse band set-up you typically have the bands attached to the top of the squat cage. The bands are thus helping you lift the weight up. In the bottom, they're helping a lot. As you squat up, the bands slack and they help you less.

Mechanistically, proper use of bands increases average force output in the deadlift at a given RM. The same should apply to the squat and the bench press, as well as the use of chains. By shifting up the sticking point, you increase the range of motion experiencing near-maximum force outputs. Consequently, the accommodating resistance makes you perform more work per set at a given RM and you should achieve a higher area under the curve of muscle tension. We can see the extra force production comes from the top part of the movement, and that's also when we see a trend for greater muscle activation. However, research does not find consistent increases in muscle activation from the use of bands or chains, although there is a trend for the deadlift and the squat in well-controlled research in trained lifters. Unfortunately, many studies having a poor research design that does not normalize the resistance across conditions to a given RM. Plus, EMG is likely too noisy to detect the marginal differences in already near-maximal muscle activation that would be expected to accompany slight increases in average force output. For example, in Andersen et al. (2016), the use of bands did not significantly increase muscle activation in the squat for

3 out of 4 studied muscles; however, in absolute terms, both band conditions achieved higher average muscle activation levels than the free-weight condition for all 4 studied muscles at their respective 6RM loads.

Theoretically, we would expect bands or chains to improve rate of force development significantly, strength development slightly when appropriately used and muscle growth ever so slightly over the long term as a result of the greater internal work over time. Several studies [2, 3, 4, 5] did indeed find that using bands or chains improved strength or rate of force development, or found a considerable trend in this direction [2], especially in trained individuals. However, most studies [2, 3, 4] found no significant benefits, especially not in untrained individuals. Many studies do not properly use the bands or chains as accommodating resistance or have poor study designs that are not reflective of how athletes should use them. One common limitation is using far too much band tension, which creates the opposite problem: insufficient resistance at the bottom and thereby a lack of stretch-mediated hypertrophy.




*Bench pressing force (left) and power (right) output with a free weight barbell (FW; blue) vs. a barbell with a hefty 40% band tension. The band increases total power output and force output near lock-out, but it decreased force output during the start of the reps compared to the barbell.*

Another limited study design is the equation of total work between groups, which completely negates the expected benefits of the accommodating resistance.

## Effect on strength gains

When you group all studies or a certain selection of studies together, most analyses find no significant benefits in the literature on average from the use of bands or chains. A 2015 meta-analysis (corrected in 2018) found no significant benefits for strength development of using bands and chains compared to not using them. There was, however, a trend for greater strength gains when looking specifically at trained individuals ($p = 0.1$). Based on the kinetic and kinematic effects of accommodating resistance, more advanced trainees benefit more from the use of bands and chains than recreationally active trainees. Novice lifters may not have the coordination and rate of force development yet to be explosive enough to benefit from accommodating resistance. Moreover, if in the meta-analysis we exclude the odd study on machine squatting with a bungy apparatus by Cronin et al. (2003), the effect becomes significantly in favor of bands and chains. This was the only study with a decidedly negative mean difference score and it happened to be the largest in the whole analysis, despite the study itself finding that across all its measurements as a whole, the bungy and non-bungy groups achieved comparable strength gains. Statistical power was also a concern due to lack of standardization on what constitutes the ideal amount of band or chain resistance, lack of equating total work and/or exercise intensity and the fact the most studied exercises, namely squats, bench presses and leg presses, already achieve decent tension throughout their entire ROM.

Another meta-analysis by Andersen et al. (2022) also found that on average in the literature, variable resistance training – mostly but not exclusively via powerlifting bands – did not improve strength development or power compared to traditional resistance training without accommodating resistance. However, this analysis did not include multiple of the aforementioned studies that did find significant benefits and it included multiple studies not representative of serious strength training. All 3 studies with medium to large negative effect sizes of variable resistance training consisted of unconventional training practices.

1. Boyer (1990) was misclassified as training with elastic bands when in reality they used the Soloflex machine, which is comparable to a Smith machine, and compared it to free weight and Nautilus machine training.
2. Pipes (1978) compared free weights to unspecified machines with variable resistance.
3. Walker et al. (2013) compared 2 types of special machines with fixed vs. variable resistance.

Perhaps most importantly, they did not separate the analysis for untrained and trained individuals, which the previous meta-analysis found to be a crucial distinction.

## Effect on muscle growth

For muscle growth, we have far fewer data. However, the data we have unanimously show no effect of the use of bands or chains on muscle hypertrophy [2]. Theoretically, a small benefit could be expected due to the greater total force production and thereby muscle tension per set. However, an increase in total force production per set requires an optimized amount of accommodating resistance and it may not matter in the end, given that you reach the same fatigue endpoint in the set. Moreover, any such benefit is likely negated by reduced stretch-mediated hypertrophy.

## Effect on joint comfort

Gains aside, another potential benefit of using accommodating resistance is that it often reduces joint stress. In one study, bench pressing with chains reduced shoulder pain 3-fold compared to regular bench presses. Anecdotally, bands and chains help to reduce pain and prevent back injuries during squats and shoulder injuries during bench presses, because these joints are more vulnerable in the bottom position than the top position.

## Practical application

All in all, bands and chains offer significant potential benefits without any reported downsides for exercises that are otherwise very easy at the top. Exercises that already have their sticking point near the top do not benefit from bands or chains and may even become less effective due to reduced stretch-mediated hypertrophy. While most studies find no significant effects of band or chain use on our gains, several do find benefits and none have reported downsides. Accommodating resistance should slightly increase average force production and muscle activity per set, increasing the mechanical tension on your muscles. They also allow you to accelerate the weight more, which may benefit neurological strength development and power. Proper use of bands or chains will likely benefit long-term strength development slightly and plausibly thereby also very long-term muscle growth. If you have them, you should probably use them. If you don't though, it may not be worth purchasing them for the minor expected benefits, unless you're a competitive athlete, or you have a home gym and they help reduce joint pain.

Squats and bench presses are particularly good exercises to use bands or chains with. Only use bands or chains for exercises that feel very easy at the top of the movement and use only enough to make the top part harder without making the bottom part easy.

The bottom part of the lift is generally more important than the top, as it can induce stretch-mediated hypertrophy.

As for which is better, bands and chains are equally effective, so you can use what's available or most convenient. They achieve the same thing: accommodating resistance.

## ➢ Guide

How to use powerlifting bands