SLED TRAINING

Weighted sleds are becoming a common feature of modern gyms and training facilities. They are a versatile piece of equipment that can be used for a surprisingly large range of purposes.

Resisted pushing and pulling are highly functional movements that directly match to requirements in many sports. Physical testing for tactical athletes such as military, law enforcement and fire fighters will usually incorporate some form of weighted drag.

In this paper, we will look at the scientific evidence for the effectiveness of sled training for goals ranging from improving sprint speed to rehabilitation after injury. We will also consider the main things you will need to know to use this kind of training effectively with your clients.

After reading this paper, you should understand how you could use a sled with your clients and how to implement sled training into their programmes.

SLED TRAINING

WHAT IS SLED TRAINING?

Pushing or pulling heavy objects has been part of sports training since ancient times but the modern use of sleds dates back to the early 2000s.

Training sleds are designed to be either pushed or pulled using handles or dragged using a harness and strap.

There are two main types of sled training – lighter work, where a sled is used to add moderate resistance to an activity such as sprinting, and heavier work, where moving the sled is a challenge in itself. Both of these approaches have their place in training depending on the needs of the client.

BENEFITS OF SLED TRAINING

Sled training, usually referred to in the scientific literature as resisted sled training, has been fairly well studied to investigate how it can benefit athletes across a range of sports.

SPORT-SPECIFIC TRAINING

There are some sports that involve movements that obviously translate to a sled. The ability to push horizontally is important in rugby, American football and other contact sports. Indeed, it was in college football in the USA that modern sled training first became popular.

Horizontal force production is also important in a range of other sports and there is evidence that heavy sled training can help (Morin et al., 2017; Spinks et al, 2007). Any time that players need the ability to change direction quickly, they will benefit from improving in this area.

TACTICAL ATHLETES

The selection and ongoing physical tests for military, law enforcement and fire fighters usually include some kind of weighted drag. Sled training is the most accessible way to train for these kinds of assessments.

SPRINT PERFORMANCE

There is evidence that resisted sled training can help to improve sprint performance (Alcaraz et al., 2018; Petrakos et al., 2016), especially in the initially stages of a sprint where the athlete is starting from standstill. Studies are more mixed on whether there are benefits for longer distance sprinting.

Some studies have found that performing resisted sprints with a sled can lead to better performance in sprints performed soon after; so called potentiation (Seitz et al., 2017) but other studies have disputed this (Whelan et al., 2014).

REDUCED SORENESS

Most strength exercises include a concentric phase where the key muscles shorten to create movement and an eccentric phase where they get longer but continue to work against the load. For example in the squat, the decent is eccentric while the ascent is concentric. It is widely understood that the eccentric portion is responsible for more muscle soreness than the concentric (Douglas et al., 2017; Hotfiel et al., 2018).

In a sled push or drag, the client does not need to support the weight so the vast majority of the work that they do is concentric. This may give benefits in terms of reducing delayed onset muscle soreness (DOMS) and enabling faster recovery between sessions.

In a sled push or drag, the client does not need to support the weight so the vast majority of the work that they do is concentric.

REHABILITATION

The backwards sled drag exercise (see later) is a good way to use a loaded movement that closely matches the terminal knee extension (TKE) exercise that is widely used in rehabilitation, especially after things like anterior cruciate ligament reconstruction. Even in less extreme cases, it is a useful way to exercise the legs without overloading joints, potentially making a problem worse. As we saw earlier, sled exercises have the feature of almost entirely avoiding eccentric loading, which can help to reduce strain on joints. This kind of pull also avoids the heavy loading on the spine that things like squats or deadlifts involve, so may be useful for those with back injuries who still want to train their legs.

ANAEROBIC INTERVAL TRAINING – CONDITIONING AND FAT LOSS

A popular use for sled exercises is in interval training. In this context, the big advantage of the sled over many other exercises is safety – the client is does not have to lift anything so the risk of dropped equipment is eliminated and injury risk from overreaching is reduced. A client trying to pull a sled that is too heavy for them is not nearly as risky as if they fail with a weight on their back or overhead.

ENJOYABLE TRAINING

While this is a difficult thing to measure, don't overlook the fact that pushing or pulling a sled can be a fun and motivating activity for many clients. Most gym exercises, especially strength movements, essentially involve moving a weight up and down in one place. The challenge of moving a heavy thing across a distance from A to B can be a good way to give clients a sense of achievement

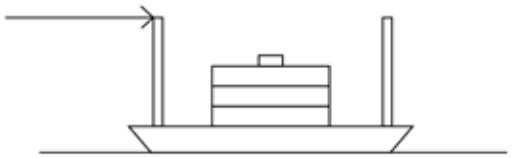
PHYSICS OF SLED TRAINING

While we don't need to calculate the exact forces involved in order to use sled exercises, it is useful to have some understanding of the physics that is involved and how that affects the difficulty of exercises.

The actual force required to move a sled and keep it moving at any velocity is not just determined by the weight on the sled – the material of the sled runners and the surface it is moving on will make a big difference.

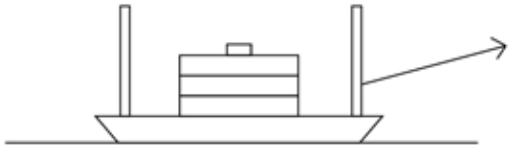
We can use a coefficients of friction for the materials involved multiplied by the load on the sled to work out what force is required to move the sled. There are two coefficients – we use the coefficient of static friction to work out the force needed to start it moving and the coefficient of kinetic friction to tell us what force we will need to keep it moving. Usually, the coefficient of static friction will be considerably higher. This makes sense – it takes more work to start a static sled moving than to continue to move one that is already moving.

For a simple situation where the sled is being pushed, the physics is very simple. The horizontal force applied by the client needs to overcome the friction force, which is produced by the gravity force of the load that is pushing straight downwards.



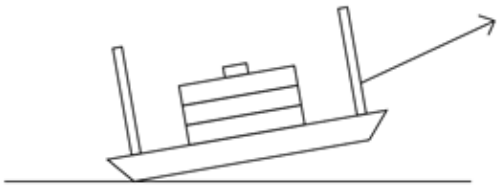
Unless you are having your client use a sled on a rubber floor, the coefficients of friction will almost certainly be less than 1, so the force required will be less than the weight of the sled and plates.

When a sled is being towed, things are a bit more complex. Now the force being applied may not be perfectly horizontal. If the tow line is angled either up or down, not all of the force that is being applied will be acting to overcome friction.



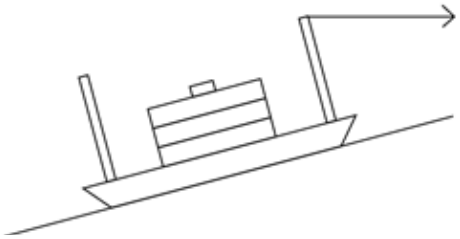
This means that the height of the attachment of the line to the sled, the kind of harness that is used and the height of the client can make a big difference to how challenging any particular loading will be.

Something to be aware of is that if the pulling force has enough of a vertical component to it that it actually lifts the front of the sled, the physics of the situation will change, reducing the friction (as part of the load is not going through the floor) and making the sled easier to pull.



For this reason, is it usual to use relatively long straps (two meters or more) to ensure the strap is close to horizontal during a pull.

If you are a tough enough coach to make your client push or pull a sled up an incline, things become really hard for them!



Now, as well as friction, they will have to directly overcome a proportion of the weight of the sled.

HOW TO COACH SLED TRAINING

We will now look at the practicalities of using a sled with your clients.

EQUIPMENT

Sleds are available in a variety of designs and weights. If you want to use a sled for resisted running, you will need to make sure not to get one that is too heavy – you will likely want to use loads as low as 20 kg. If you only intend to use a sled for heavier work then it may be more appropriate to choose a bigger sled that will be heavier and have more capacity for safely loading weight discs.

For pulling sleds, there are two main options for harnesses – those around the shoulders and those that are more like a belt around the waist. There is some evidence that a waist harness will enable sprinters to use a sled with fewer changes to their normal movement pattern compared to a shoulder harness (Bentley et al., 2016). Whatever kind of harness you use, you will want a strap that is at least two meters long between the sled and the harness.

As we saw in the section on the physics of sled training above, the surface you use the sled on will make a big difference to how hard it will be to pull or push. Sleds are commonly used outside on grass or asphalt and inside on concrete, carpet or artificial grass. You also need to think about whether there is potential for damage to a surface. Sleds will metal skis will inevitably scratch asphalt or concrete and may wear other surfaces over time. Some sleds have plastic skis available as an option, which will be much kinder to the floor surface.

TRAINING PARAMETERS AND PROGRAMMING

As we saw earlier, a loaded sled is a versatile piece of equipment that you can use with clients in several ways:

- Heavy pushing for athletes who need to develop that ability for their sport
- Resisted running for improving sprint performance
- Exercising legs safely during rehabilitation
- Interval training for general conditioning

The right loading, distances and training frequency will be different depending on what kind of client you are working with and what the goal is.

Every client will be different but here are some recommendations

Heavy sled training is typically done at the end of a strength training session – it has a low technical requirement so can be performed safely when fatigued.

Lighter sled training for sprint performance will usually be done as a session of its own, with some unweighted sprints as a warmup. This is so that the athlete can focus on maintaining their optimal movement patterns while using the sled.

Sport-specific sled training will usually be done in a block of programming lasting six to eight weeks, most likely away from competition season.

When sled training is used for conditioning, it fits well in a circuit including other exercises, especially those that target the upper body.

Heavy sled training is typically done at the end of a strength training session – it has a low technical requirement so can be performed safely when fatigued.

Lighter sled training for sprint performance will usually be done as a session of its own, with some unweighted sprints as a warmup. This is so that the athlete can focus on maintaining their optimal movement patterns while using the sled.

Sport-specific sled training will usually be done in a block of programming lasting six to eight weeks, most likely away from competition season.

When sled training is used for conditioning, it fits well in a circuit including other exercises, especially those that target the upper body.

TECHNIQUE

While using a sled does not have very high skill requirements, there are some things that you can look for to ensure your clients are doing to get the most out of their training.

For harnessed sled drags, especially if the goal is to improve sprint performance, the most important thing is that the client maintains their usual running movement pattern. Watch them sprint without resistance and make sure they are not changing things significantly once they are dragging the sled. You may need to start them with a very low weight on the sled and increase the load gradually.

Goal	Sled Load (% body weight)	Distance per run	Runs per session	Session Frequency
Maximal pushing ability	100% – 200%	10m – 20m	3	2-3 per week
Horizontal Force	80% – 100%	100m – 30m	3-6	3 per week
Sprint Performance	20% – 80%	20m – 30m	5-10	3 per week
Rehabilitation	20% – 100%	10m – 20m	1-5	1-3 per week
Conditioning	50% – 100%	10m – 20m	3-5	1-3 per week

For sled pushing, the most important thing is that the client maintains a good posture with a tight back and core throughout the exercise. The bent over position of a sled push has potential to put the spine at risk if a good posture is not actively maintained. You want to get your client into a position where their back is as close to horizontal as they can manage without any rounding of their back.

Some people will be able to achieve a horizontal back by gripping the uprights low down. This will give them efficient pushing mechanics but don't let anyone sacrifice a neutral spine to get lower. Those with less mobility will need to grip the uprights high up and adopt a more vertical stance.
Make sure the client keeps their feet decently wide – narrow feet will often lead to them losing balance and being unable to push the sled straight.

VARIATIONS

There are many exercises that can be done with weighted sled beyond the usual pulls and pushes. We will look at a few here but with some creativity you will find many more ways to put a sled to work.

Lateral sled pulls, holding the strap in the hands and standing at ninety degrees to the direction of movement, can be fantastic for clients who need to develop more core strength for lateral stability. The load will need to be much lighter than for a normal sled pull and you should also reduce the distances used.

Lateral sled pulls, holding the strap in the hands and standing at ninety degrees to the direction of movement, can be fantastic for clients who need to develop more core strength for lateral stability.

Sled drags can become a back and upper body exercise by attaching a rope to the sled and having the client pull it from a static position using an arm-over-arm technique. Watch out for a rounded back here to maintain safety.

Earlier we mentioned that the backwards sled drag is useful for rehabilitation. This kind of drag is sometimes called the Petersen sled drag after the Petersen step up that it resembles. You should ensure your client places the ball of each foot down before the heel as they move. As well as being a good rehab exercise, this is also a great way to strengthen the vastus medialis oblique muscles that play a key role in stabilising the knees.

SUMMARY

In this paper, we have seen that there is evidence that sled training can benefit a variety of kind of client. We have also looked at how the physics of a weighted sled affects the decisions we need to make when using one.

The key points to remember are:

- Choose the right sled for your purposes
- Loading and other parameters depend on the goal
- For sprint training, ensure the client maintains their usual movement pattern
- For sled pushes, ensure tightness is maintained for spine safety
- Consider variations to get more value from a sled

You should now have some ideas about clients who could benefit from sled training and how to go about implementing it with them.

REFERENCES

Alcaraz, P. E., Carlos-Vivas, J., Oponjuru, B. O., & Martínez-Rodríguez, A. (2018). The Effectiveness of Resisted Sled Training (RST) for Sprint Performance: A Systematic Review and Meta-analysis. Sports Medicine, 48(9), 2143–2165. https://doi.org/10.1007/s40279-018-0947-8

Bentley, I., Atkins, S. J., Edmundson, C. J., Metcalfe, J., & Sinclair, J. K. (2016). Impact of Harness Attachment Point on Kinetics and Kinematics During Sled Towing: Journal of Strength and Conditioning Research, 30(3), 768–776. https://doi.org/10.1519/JSC.0000000000001155

Cross, M. R., Brughelli, M., Samozino, P., Brown, S. R., & Morin, J.-B. (2017). Optimal Loading for Maximizing Power During Sled-Resisted Sprinting. International Journal of Sports Physiology and Performance, 12(8), 1069–1077. https://doi.org/10.1123/ijspp.2016-0362

Douglas, J., Pearson, S., Ross, A., & McGuigan, M. (2017). Eccentric Exercise: Physiological Characteristics and Acute Responses. Sports Medicine, 47(4), 663–675. https://doi.org/10.1007/s40279-016-0624-8

Hotfiel, T., Freiwald, J., Hoppe, M., Lutter, C., Forst, R., Grim, C., … Heiss, R. (2018). Advances in Delayed-Onset Muscle Soreness (DOMS): Part I: Pathogenesis and Diagnostics. Sportverletzung · Sportschaden, 32(04), 243–250. https://doi.org/10.1055/a-0753-1884

Keogh, J. W., Newlands, C., Blewett, S., Payne, A., & Chun-Er, L. (2010). A Kinematic Analysis of a Strongman-Type Event: The Heavy Sprint-Style Sled Pull: Journal of Strength and Conditioning Research, 24(11), 3088–3097. https://doi.org/10.1519/JSC.0b013e3181b62c2f

Luteberget, L. S., Raastad, T., Seynnes, O., & Spencer, M. (2015). Effect of Traditional and Resisted Sprint Training in Highly Trained Female Team Handball Players. International Journal of Sports Physiology and Performance, 10(5), 642–647. https://doi.org/10.1123/ijspp.2014-0276

Morin, J.-B., Petrakos, G., Jiménez-Reyes, P., Brown, S. R., Samozino, P., & Cross, M. R. (2017). Very-Heavy Sled Training for Improving Horizontal-Force Output in Soccer Players. International Journal of Sports Physiology and Performance, 12(6), 840–844. https://doi.org/10.1123/ijspp.2016-0444

Petrakos, G., Morin, J.-B., & Egan, B. (2016). Resisted Sled Sprint Training to Improve Sprint Performance: A Systematic Review. Sports Medicine, 46(3), 381–400. https://doi.org/10.1007/s40279-015-0422-8

Seitz, L. B., Mina, M. A., & Haff, G. G. (2017). A sled push stimulus potentiates subsequent 20-m sprint performance. Journal of Science and Medicine in Sport, 20(8), 781–785. https://doi.org/10.1016/j.jsams.2016.12.074

Spinks, C., Murphy, A., Spinks, W., & Lockie, R. G. (2007). The effects of resisted sprint training on acceleration performance and kinematics in soccer, rugby union, and Australian football players. The Journal of Strength and Conditioning Research, 21(1), 77–85. https://doi.org/10.1519/R-18145.1

Whelan, N., O'Regan, C., & Harrison, A. J. (2014). Resisted Sprints Do Not Acutely Enhance Sprinting Performance: Journal of Strength and Conditioning Research, 28(7), 1858–1866. https://doi.org/10.1519/JSC.0000000000000357