Considerations for the Physical Preparation of Freestyle Snowboarding Athletes

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ABSTRACT

The rapid growth in trick progression for competitive snowboarding over the past 20 years has resulted in increased physical demands required from snowboarding athletes. Despite a wealth of knowledge surrounding strength and conditioning principles for other sports, researchers are yet to address the novel strength and conditioning challenges faced by the freestyle nature of competitive snowboarding. This article, therefore, offers practitioners strategies to address the unique considerations surrounding cultural qualities, injury prevention, unstable surface training, skill acquisition, and recovery strategies for the effective implementation of strength and conditioning interventions for snowboarding athletes.

INTRODUCTION

Competitive snowboarding has grown considerably since its introduction to the 1998 Olympics. Since this time, snowboarding has branched into multiple disciplines including slopestyle, half pipe, big air, snowboard cross, and alpine. Freestyle snowboarding consists of the slopestyle, half pipe, and big air disciplines, all of which promote high amounts of creativity, innovation, and style. These events require athletes to complete aerials on large jumps and half pipes while also performing maneuvers over purpose built features including rails, boxes, and tubes (18). The rise in popularity of freestyle snowboarding has resulted in a rapid progression of trick difficulty and physical demands of snowboard athletes. Despite the need for evidence-based physical preparation interventions for freestyle snowboarders, very few are currently available. Some researchers have discussed the physiological (3,44,73,75) and biomechanical (73) demands of freestyle snowboarding; however, only recently has this been translated into a comprehensive training plan (18). This article outlined the physical demands for freestyle snowboarding and integrated these qualities into a detailed, evidence-based training plan for strength and conditioning practitioners.

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Unlike other sports, there are unique considerations that must be addressed to optimize the effectiveness of physical preparation interventions with snowboarders. Snowboarding athletes face unique cultural and structural challenges that can often affect the application of traditional strength and conditioning practices. The considerations discussed in this article include cultural considerations, injury management, skill acquisition, and recovery strategies. Addressing these factors will inform coaches on how to foster positive training environments, develop athlete-coach relationships, increase athlete buy-in, and support the delivery of effective training interventions. This article will discuss the practical applications of the programming considerations and provide recommendations for coaching staff to assist in the physical preparation of snowboarding athletes.

CULTURAL CONSIDERATIONS

A common belief among snowboarders is that the only way to become a better snowboarder is to "snowboard more" (73). The current snowboarding culture tends to highly value athletes' riding style, trick innovation, rebellious lifestyles, and training autonomy. Common practice for freestyle snowboarders usually consists of large volumes of self-directed on-slopes training with few semistructured dryland skills and physical training sessions. Athletes' attitudes toward these training modalities often favor slopes training sessions, competition practice runs, and off-piste sessions over dryland training.

KEY WORDS:
snowboarding; physical preparation; freestyle; adventure sport

Freestyle snowboarders typically have a limited physical training history and knowledge of the performance benefits that come with physical training (73). This may be a result of various sociocultural and environmental constraints (57), such as lack of junior development camps, available educational programs, talent squads, and exposure to structured physical training. The coaching staff should identify and take into consideration each of Newell's constraints (task, environment, and organism) when educating snowboarding athletes on the importance of physical fitness training (57). Newell's model of constraints explains the dynamic relationships between task, environment, and organismic constraints that affect freestyle snowboarders' training and performance (57). Specific environmental constraints include availability and accessibility to training facilities, weather conditions, peer support, and training culture. Task constraints such as jump amplitude, degrees of rotation, number of flips, and innovative nature of maneuvers may be seen to affect performance. Furthermore, organismic constraints such as anthropometric measures, movement capacity, physical fitness, mindset, and cognitive ability may also affect training and performance. The coaching staff should identify and take into consideration each of Newell's constraints when educating snowboarding athletes on the importance of physical fitness training (57).

Although skill-based training may be the optimal way to train for snowboarding competition, disregarding the incorporation of physical fitness training may hinder the physical development of athletes and ultimately their ability to handle the intense physical demands of the sport (18). Consideration for the athlete's preconceived attitude toward structured dryland training should be given to increase the likelihood of engagement and adherence to the training plan.

A key consideration while working with snowboarding athletes is to ensure the training plan is mutually agreed on, enjoyed, and adhered to. Gaining athletes' trust and respect before implementing any strength and conditioning program or sport science support is imperative. Athlete participation and adherence to dryland physical training should be derived from positive coach-athlete relationships and effective coaching strategies. To achieve this, it is recommended that the coaching staff develop an athlete-centered approach to physical training.

ATHLETE-CENTERED APPROACH

An athlete-centered approach allows athletes to take ownership of their learning and has been shown to improve decision-making ability and promote leadership qualities within individuals (42,43). Turnbull et al. (73) highlight the importance of understanding the sport's culture, athlete motivation, sporting history, and previous training behaviors. Gaining a deep understanding of the athletes' values and motives should be of primary interest. Coaches are encouraged to recognize the athlete's previous training behaviors and empathize with their views and ideologies. Engaging in these conversations may also maximize the likelihood of athlete buy-in, program engagement, and intrinsic motivation (36).

Although traditional approaches (23) focus specifically on deliberate practice for skill development, snowboarding athletes and coaches may benefit by shifting toward an ecological dynamics perspective (57,68). The strong culture seen within snowboarding and the potential implications it may have on athlete perceptions and behaviors support the relationship between organism, environment, and task constraints. Newell's constraint model highlights the relationships between the task, environment, and individual while demonstrating the effects each can have on one another. The dynamic relationships between these variables can often determine the overall effectiveness of learning and subsequent performance (57) in snowboarders. It is recommended that coaches identify these constraints and incorporate this sociocultural approach to assist in promoting an effective learning environment for freestyle snowboarding athletes.

Flexibility in scheduling is an important programming consideration while working with snowboarding athletes. Weather patterns and snow conditions can often significantly affect the quality and safety of on-slopes training sessions. For example, high winds and poor visibility can often compromise the safety of aerial practice and park feature practice sessions, whereas overnight snowfall and good snow quality can often produce excellent conditions for free riding of off-piste practice. Quality on-snow conditions such as overnight snowfall, light winds, high visibility, and groomed jumps provide trick innovation-rich environments with excellent opportunities for trick progression, hence it is recommended that these sessions are always prioritized (59,60). This can be achieved by regularly collaborating with skills coaches and scheduling upcoming sessions following weather predictions, allowing skills sessions and free riding to occur during favorable weather conditions. It should be noted that extra recovery sessions should be added if a significant amount of additional slopes training has been completed. Promoting athlete input into the scheduling of sessions within the strength and conditioning plan may also promote greater adherence, motivation, and well-being (20). Noonan (60) suggests that promoting athlete contribution can result in feelings of empowerment and connectedness with training solutions, which in turn may increase willingness to train and provide a flow-on effect into the broader snowboard culture. This is especially important because of the commonly rebellious and free nature of the snowboarding culture. It is therefore recommended that coaching staff should (a) strive to understand the athlete's needs, (b) create flexibility in training schedules, and (3) promote input toward training solutions to increase the likelihood of athletes conforming to a more structured and controlled training environment.

Effective communication and cueing strategies are also important when working with snowboarding athletes. The snowboarding culture often communicates through unique, sport-specific language and phrases to describe tricks, stances, body positions, feelings, and emotions. As a result, some coaches suggest their communication with freestyle athletes is similar to speaking a foreign language. A lack of training history may also result in a further lack of understanding of basic movement instruction and cueing. Although communication strategies have not yet been investigated within the snowboarding population, it is reasonable to suggest that unnecessary anatomical, physiological, and technical language should be avoided. Where possible, emphasis should be placed on external cues, metaphorical examples (79), and the use of relatable "snowboarding" terms commonly used by athletes. Common examples of these can be found in Table 1. It is also common for different countries to have specific sayings and terms that are unique to their culture. It is recommended that physical preparation coaches become familiar with commonly used terms to improve communication with athletes and coaching staff.

INJURY PREVENTION

TRICK RISK MANAGEMENT

Despite no current snowboarding-specific injury prevention plans presented in the literature (6,32), it has been suggested that a well-designed strength and conditioning plan will assist with injury prevention. Unlike other sports, the high neuromuscular demands and dangerous nature of competitive snowboarding require additional measures such as force generation and absorption assessments, a multidisciplinary approach to trick selection, neuromuscular load tracking, and trick progression frameworks to mitigate injury risk. Aerial tricks in particular are the primary contributors to neuromuscular load (73) and cause of injury (5,22,32) for snowboarding athletes. As an athlete gains experience, they will perform more sophisticated tricks with a higher degree of difficulty. This increase in trick difficulty is often met with a higher jump amplitude that can often result in higher landing ground reaction forces (GRFs) (73), neuromuscular loads, and an increased risk of injury after a fall (32,37). Landing mechanics and technical execution can also have a direct effect on the GRFs experienced during the landing phase. Snowboarding athletes and coaches commonly refer to successful landings as "soft" and unsuccessful landings as "hard." A miscalculated (hard) landing from a moderately difficult trick is likely to produce larger GRFs than a well-timed (soft) landing from a more sophisticated trick. Therefore, to reduce the likelihood of injury, priority should be given to fostering effective landing strategies and techniques, rather than reducing difficulty or amplitude. In addition, it is recommended that aerial practice is performed in safe environments (dryland, trampoline, landing bag, etc.) and correct landing technique is prioritized.

Specifically, the use of dryland skills training for the development of new aerial maneuvers is becoming increasingly popular as a "safe training" tool because it provides numerous trick attempts in a low-risk training environment (60). Training modalities may include trampoline, mini-trampoline, skateboarding, gymnastics, airbag, and foam pit practice. It is reasonable to suggest that trick selection and athlete competence will influence the likelihood of blunt force injury from a fall. Careful consideration should therefore be made when attempting to transition tricks from these dryland environments to competition jumps on the slopes. An example of how an athlete may use different training modalities to progress through the learning stages of a new maneuver is outlined in Figure 1. Decisions on trick selection and trick progress should be a multidisciplinary discussion involving athlete support personnel. The athlete should lead this discussion and ultimately decide on the speed of progression and the types of tricks selected for competitions. Allowing the athlete to take responsibility for these decisions will develop greater, intrinsic motivation, situational awareness, and confidence within the individual while also reenforcing the athlete-centered approach discussed earlier.

Most aerial injuries occur because of incorrect jumping and landing strategies and the consequent impact forces on the body (37). This may be a result of too much or too little takeoff speed, poor landing visibility, or undercommitment to a rotation or flip. Hyperextension of the knee during landing may result in excessive compression forces, whereas overextending the knee may increase the chances of anterior cruciate ligament (ACL) injury (80). Investigations in surfing have demonstrated the importance of time to stabilization, relative peak force, impulse, and frontal-plane video analysis during a drop-and-stick landing for ACL injury risk (50,51). It is reasonable to assume that the same would apply to snowboarding, and it is therefore recommended that effective dryland landing mechanics are developed before attempting more sophisticated aerial maneuvers or increasing jump amplitude. In light of this, caution should be taken when prescribing additional jumping and landing tasks off-snow. Exercises such as box step-offs, single-leg landings, depth jumps, drop jumps, single-leg lateral bounds/jumps, and mini-trampoline to floor exercises can be useful when practicing dryland landing mechanics. Technical considerations for successful landing mechanics should focus on (a) landing as softly as possible, (b) lowering the center of mass, (c) hips moving back (flexion), and (d) even distribution of weight across feet. It is also recommended that coaches implement load monitoring strategies to track training loads during skills and physical preparation sessions to avoid excessively fatiguing the neuromuscular system. This could involve total volume (sets × reps) of on-snow aerials and dryland jumps, countermovement jump velocity monitoring, or session rate of perceived exertion.

Table 1
Commonly used snowboarding terms, technical words, and sayings

Snowboarding term	Description
Kicker	Jump used for performing aerials (on snow).
Feature	Rails, boxes, tabletops, and quarter/half pipes (on snow).
Off-piste/Backcountry	Slopes situated away from prepared runs and ski lifts.
Bluebird day	Favorable conditions (often fresh snow, blue sky, and light winds).
Competition run	One official attempt at all jumps and features in a competition.
Natural/Goofy	Describing which leg (left/right) is leading (dominant) in stance.
Switch/Fakie	Riding with nondominant foot forward.
Heel/toe edge	Referring to heel or toe side of snowboard.
Frontside/Backside	Direction of take-off phase in relation to rider's stance.
Speed check	Small adjustment to slow down speed (often before jump/feature).
Grind	Rider slides board on top of thin metal railing.
Butter	Leaning forward on the tip of snowboard.
Tail grab/press/slide	Maneuvers involving the rear tip of the snowboard.
Shifty	Upper-body rotates opposite to lower body.
Tweak	Pulling board forward or backward during a maneuver.
Boned out	Straightening of 1 or both legs during an aerial.
Stomping a landing	Successful landing of a maneuver.
Winding down the windows	Using arms to regain control during an aerial maneuver.

UNSTABLE SURFACE TRAINING

An important consideration for snowboarding athletes is the implementation of unstable surface training into physical development programs. This type of training is often prescribed to combine strength and power development, an increase in core recruitment and injury prevention into single exercises (21). Despite this well-intentioned approach, there is currently no evidence to suggest unstable surface training is an effective training modality for snowboarders for any of the expected training outcomes. Common examples used by snowboarders include squats, deadlifts, lunges and push-ups on balance boards, standing, squatting, upper-body pressing on Swiss balls, jumping and landing on unstable surfaces, and cognitively demanding tasks (e.g., juggling, decision making, throwing, and catching) while simultaneously balancing on wobble boards or narrow beams. It is recommended that the use of unstable surface training should be goal orientated and reflect the desired outcomes of the training session.

STRENGTH AND POWER

The available literature consistently demonstrates that unstable surface training is an inferior training method for strength (1,2,28,29,45,65,66,74) and power (16,28,72,81) development when compared with traditional (stable surface) training. Significant reductions in maximal force capacity have

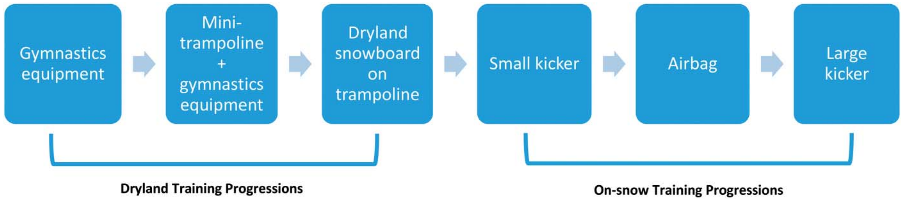

Figure 1. Example of training progression for new aerial maneuver. On-snow training progressions. Dryland training progressions.

been found in the squat (1,53,65), deadlift (15), chest press (2,66), shoulder press (45,74), and plyometric exercises (28) when performed on an unstable surface. A study involving adolescent surfers showed that unstable surface training over 7 weeks resulted in a 6.5% decrease in lower-body power, whereas traditional (stable) training resulted in a 5.7% increase (72). In addition, 10 weeks of unstable surface training has also been shown to attenuate performance in elite athletes (16). Because of these findings, it is recommended that snowboarding athletes avoid excessive amounts of unstable surface training if trying to develop strength or power qualities.

Plyometric exercises are also commonly performed on unstable surfaces by snowboarders (28). Jumping and landing on unstable surfaces have been shown to reduce force production and EMG activity in lower-limb muscles (6). Key findings from this study indicated that jumping and landing exercises should be performed on stable surfaces to optimize power development and force absorption. Similar reductions were also found in upper-body power production when performed on a Bosu ball and Swiss ball when compared with stable surface (bench) (81). Therefore, it is recommended that any plyometric exercises performed to develop strength or power should be completed on stable surfaces.

Collectively, the current literature suggests that unstable surface training may not be an effective training modality for freestyle snowboarders because this has the potential to attenuate strength adaptations and decrease lower-body power development. Because of this, unstable surface training would not be recommended if muscular strength and power development are the primary goals; however, it may serve a purpose for skills training, proprioception training, or returning from injury.

MUSCLE RECRUITMENT

Freestyle snowboarding demands high amounts of trunk and hip stability to withstand frequent unexpected perturbations placed on the rider (59). Coaches often prescribe unstable surface training based on the understanding that these exercises more closely reflect the trunk and limb stability demands present in snowboarding tasks. The current evidence however is mixed when determining the EMG activity between unstable surface training and stable training. Some (2,65,74) have found no changes in EMG activity, whereas others (1,53) have found increased recruitment of trunk and hip stabilizers.

The squat is a commonly performed exercise on both stable and unstable surfaces. Saeterbakken and Fimland (65) found that decreasing stability during the squat demonstrated the same EMG activity as regular squats despite a significant reduction in maximal force production. By contrast, McBride et al. (53) found a significant reduction in agonistic muscle activity (vastus lateralis and vastus lateralis) and no difference in antagonist muscles (biceps femoris and gastrocnemius) when performing isometric squats on a BOSU ball, when compared with a stable condition. This was also accompanied by significant reductions in peak force and rate of force development (53). They concluded that there is no clear benefit from performing isometric squats on an unstable surface. Anderson and Behm (1) suggest that stabilizing muscles such as soleus, abdominal, upper lumbar erector spinae, and lumbosacral erector spinae are more active when squatting on balance discs when compared with the free squat. This training modality may therefore be beneficial for injured snowboarders who are unable to tolerate high loads and require increased or the same stabilization muscle activity as regular exercises. Because of this, it would be reasonable to suggest that unstable surface training may be valuable for rehabilitation practices in snowboarders.

Based on the available literature, it is recommended that freestyle snowboarders should predominantly favor traditional (stable) surface training over unstable surface training. Specifically, strength and power adaptations should always be developed through traditional (stable surface) resistance training. If the primary goal is to increase trunk stabilization recruitment, snowboarders may implement small doses of unstable surface training alongside traditional stable training, ensuring it is not the primary modality of training. It is strongly encouraged to avoid any heavy loading during lifts performed on these unstable surfaces. Finally, to reduce the likelihood of injury, it is important to consider the level of the athlete and match the complexity and difficulty of the exercise to suit their ability.

SKILL ACQUISITION

Coaching staff typically agree that skills training (on and off snow) should always be the prioritized training modality (59,60). A retrospective study found that elite snowboarding athletes spend 60% of total training time on the slopes, whereas 40% is spent off-snow (78). In addition, it is also common for a large portion of the "off-snow" training to also be skills training such as modified tricks on trampolines, gymnastics equipment, and skateboards. Throughout the stages of learning and reinforcing maneuvers, athletes depend on observational learning, contextual interference, and effective feedback strategies to ensure continual skill progression (19,58).

Contextual interference throughout skill practice is consistently shown to improve performance and skill retention (4,8,71). One investigation suggests that contextual interference specifically applied to the skill acquisition of snowboarding may increase skill-learning retention (71). This investigation found that snowboarders who frequently changed between practicing 2 different maneuvers had improved performance and retained their skills better over time than those who practiced each skill in isolation. Therefore, it may be favorable for coaches to incorporate higher levels of contextual interference during on-slopes and dryland skills training sessions. It is recommended that each skills session should promote athletes to perform a high number of different maneuvers in no particular order, whereas bulk repetitions of a single maneuver should only be completed when necessary.

Despite the current wealth of knowledge regarding motor skill acquisition, there are currently limited evidence-based recommendations for optimizing learning in snowboarding-specific skills. Participation in sports such as skateboarding and surfing is common for snowboarding athletes. Skateboarding in particular has become a popular training modality implemented in snowboarding skills training sessions. Künzell and Lukas (47) examined the transfer effect of skateboard training on subsequent snowboarding skill development. Participants who received five 1-hour lessons in skateboarding scored significantly better in rhythm, speed, safety, and overall impression during various snowboarding tasks when compared with the control group. Despite the participants being young (mean age: 16.6 $\pm$ 1.0 years), novice snowboarders, this clearly shows that skills learned during skateboard practice have either transferred to or influenced the learning process in snowboarding. This supports the common belief that individuals who have previous experiences in sports such as skateboarding or surfing should learn basic snowboarding skills more quickly (52) and ultimately supports their integration into dryland skills training.

Optimal learning experiences are derived from movement patterns closely aligning with the target skill in an environment that replicates competition demands (35). This specificity of training plays a crucial role in the successful transfer of skills into performance during competition. To achieve this, it has been recommended that athletes focus on intrinsic feedback and become exposed to various training stimuli with minimal structure (24,27,62). Activities such as skateboarding, gymnastics, parkour, trampoline aerials, mini-trampoline jumps, and dryland rail riding are all valuable inclusions for dryland skills training sessions. Airbag practice, half pipe, board control drills, park run-throughs, and feature practice are all valuable training modalities for on-slope skills sessions. Including on-snow and off-snow skills training sessions will assist in fostering transferable motor skills, technical competency, mental confidence, and creativity needed for trick progression.

FLOW STATE PRACTICE

Flow is an optimal psychological state where an individual is completely absorbed in the task at hand while feeling and performing at their best (39). It is commonly referred to as the key to high performance and athletic success (17,39,64). There is a high incidence of self-reported flow state experiences reported by snowboarding athletes during competition, with the ability to enter and remain in this state being noted as crucial for peak performance (38). Alongside the competition benefits, flow state has been shown to focus athletes' attention on the present moment and significantly increase levels of creativity and innovation (17,34,38). These attributes are highly desirable in freestyle training environments, therefore incorporating flow practice at the beginning of skills training may improve session quality. For example, 10 minutes of autonomous flow state practice and awareness could be completed during the warm-up protocol for each skill session. Tasks that influence flow state differ between athletes and may include cognitive games, juggling, slacklining, skateboarding, listening to music, and unstable balance tasks (18). Coaches can use the previously published Flow State Measurement Scale (40) to assess the effectiveness of tasks completed by athletes.

RECOVERY STRATEGIES

Recovery is a vital consideration for the health and success of freestyle snowboarding athletes. Evidence-based, recovery strategies should be presented to athletes as a guide to account for their personal preferences. Recovery advice should be communicated using simple, easy to understand methods. For example, Figure 2 shows how this information could be presented to athletes while giving them the autonomy to complete the strategies they perceive as beneficial. The poster addresses each unique consideration for snowboarding athletes and prioritizes strategic importance based on the available literature. The athlete should aim to reach "100 points" of recovery after every training session and can achieve this total by completing any combination of the tasks presented on the poster. A simple reporting system can be used by the coaching staff where the athlete can communicate their recovery points and perceived recovery after each session.

RECOVERY AND SLEEP

As shown in Table 2, a snowboarding athlete's training regimen typically consists of high volumes of training and frequently includes consecutive daily sessions. It is also common for planned training loads to be exceeded because of good snow conditions on rest days or additional recreational riding. To ensure recovery is adequate it is important to understand the athlete's workload. Considering this, it is recommended that a reporting system is used, whereby the athlete reports all completed planned and unplanned sessions while also training intensity and load. To reduce the likelihood of overtraining, it is important to follow an appropriate sequencing strategy (9) while assigning recovery sessions and recovery days throughout the weekly program (7,25,30). Further investigations into optimal periodization strategies for snowboarding athletes are needed.

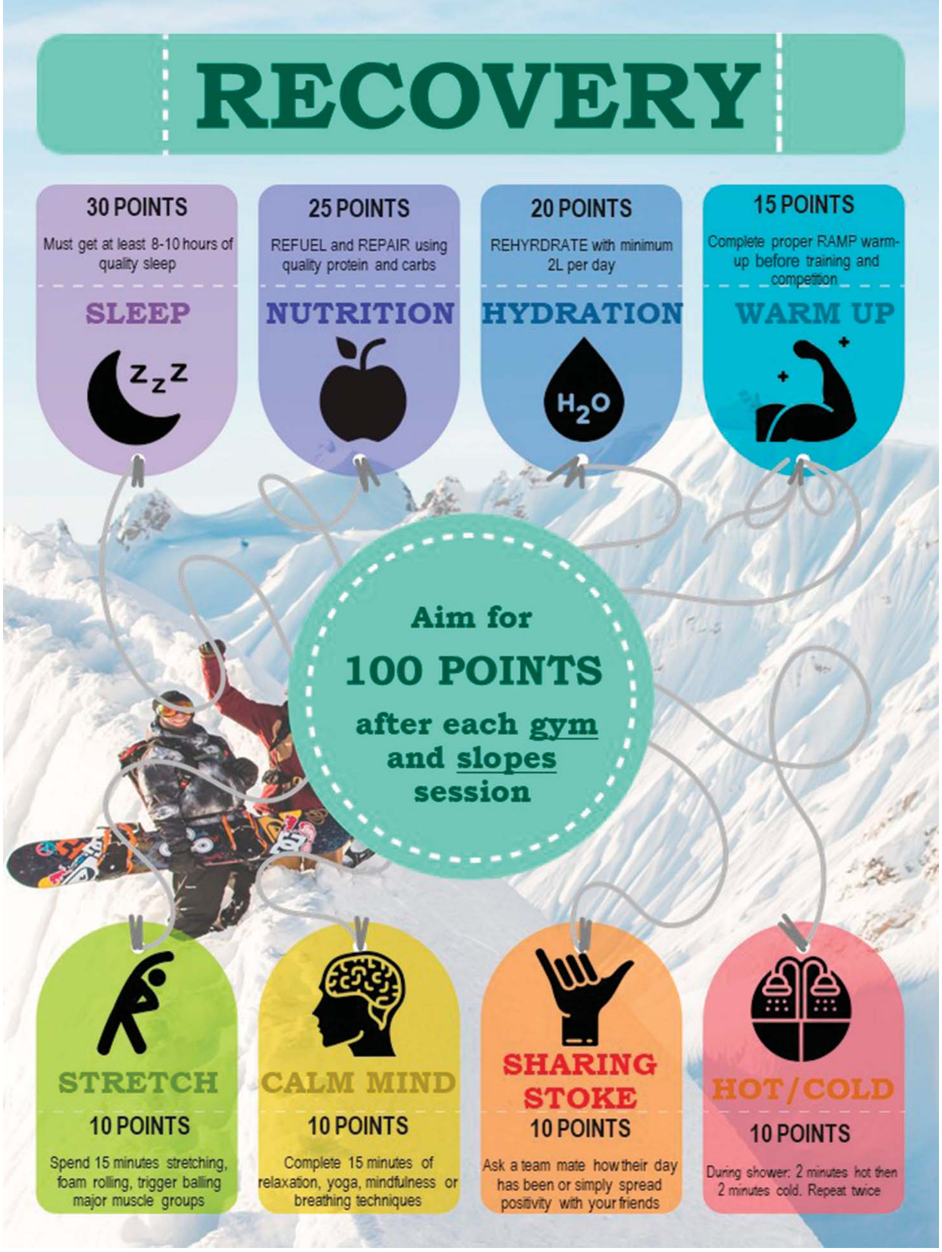

Figure 2. Recovery Strategy Poster for Snowboarding Athletes.

Sleep has been shown to have a significant effect on the physical and mental performance of athletes (26,31,70). Ensuring snowboarding athletes optimize sleep quality may increase mental clarity and decision making that are important for optimal performance and reducing injury risk (31). In addition, a reduction in reaction time and muscle activation patterns may compromise learning during training and could result in an undercommitted trick or an athlete performing a maneuver they are potentially not prepared for, which could increase the risk of injury. To mitigate this, the 5 behaviors listed in Table 3 should be encouraged for snowboarding athletes (10,70). Collectively, these strategies will promote adequate physiological and mental recovery.

NUTRITION AND HYDRATION

Ensuring athletes follow favorable nutrition and hydration strategies is essential for the recovery process (31). Snowboarding athletes are often predisposed to an increase in energy expenditure and fluid loss (54–56). Ensuring adequate food and water consumption during training and competition are also common challenges faced by snowboarding athletes (56).

Table 2
Example Weekly Training Schedule for a typical part-time, amateur or youth snowboarding athlete

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Morning (6–8 AM)	Strength (gymnasium)	Skills (dryland)	Strength (gymnasium)	Skills (dryland)	Rest	Free riding (off-piste)	Rest + recovery
Day (10–2 PM)	School/work	School/work	School/work	School/work	School/work		
Afternoon (4–6 PM)	Skills (slopes)	Skills (slopes)	Free riding	Skills (slopes)	Skills (slopes)		

This can often be due to a lack of food availability or the inability to store food during sessions (55). It is recommended that snowboarding athletes consume high-energy diets to meet their nutritional needs (55). Carbohydrate consumption during time spent on the slopes is crucial because the thermoregulatory response to cold environments can significantly increase an athlete's metabolic rate (13). It is recommended that athletes consume carbohydrates with a low-glycemic index (GI) and snack on protein-rich foods. Low-GI carbohydrates (multigrain bread, yogurt, nuts, seeds, strawberries, and peaches) may assist in sustained energy throughout the day (49).

It may also be beneficial for athletes to consume foods containing quality proteins and carbohydrates to promote the repair and rebuilding of damaged muscle tissue and replenishment of energy stores. Some suggest the body is most effective at refueling and repairing up to 60 minutes after exercise; however, food consumed 12–24 hours after the session will also assist in the recovery process (46). Quality options to start the recovery process can include chicken, steak, fish, brown rice, potatoes, vegetables, flavored milk, yogurt, bananas, nuts, or a protein smoothie. Consumption of a protein drink before bed is also recommended because it has been shown to maximize overnight recovery (11).

Cold temperatures and altitude can both significantly increase the risk of dehydration in athletes (55). Suggested mechanisms behind this additional risk involve increased nonevaporative heat loss, increases in central blood volume, and decreases in circulatory strain (14). Dehydration has been shown to decrease performance by impairing cognitive function and weakening muscle contraction (12). The recovery process also relies on hydration because of the role of water in maintaining blood volume, regulating body temperature, and promoting muscle repair (69). Athletes should then aim to consume 2–4 L per day and 150% of the fluids lost after exercise sessions (77). If training or competing at altitude, recommendations are increased to a baseline of 4–5 L per day (55).

Table 3
Recommendations to increase sleep quality

Sleep Checklist
1) Get 8–10 h each night
2) Avoid screen time 2 h before bed
3) Limit distractions by muting all notifications
4) Create a dark, quiet and cool environment
5) Establish a consistent sleep schedule

COLD WATER IMMERSION

Because of the cold climates snowboarding athletes usually reside in, cold water immersion (CWI) is a common recovery practice. Research has shown that cold exposure can assist in reducing delayed onset of muscle soreness, slowing inflammation, and minimize muscle damage (48). By contrast, CWI has also been shown to reduce strength, power, and hypertrophy adaptions after regular use over prolonged periods (63). A review article has shown that the most effective CWI protocol for recovery purposes is immersion in 10–15°C for 5–15 minutes in duration (76). Despite the lack of studies examining the response from snow sport individuals, it is reasonable to suggest these findings would carry over to snowboarding athletes. It is recommended that snowboarding athletes partake in CWI for optimizing repeat (acute) performances; however, they should avoid frequent use to avoid impairing long-term (chronic) physiological adaptations.

SAUNA

A popular recovery method used by athletes in alpine regions is the sauna. Despite one investigation suggesting that sauna can lead to detriments in muscular endurance (33), most evidence indicates it can have a positive influence on the recovery process (41,61,67). Sauna has been shown to increase blood flow and the delivery of oxygen to muscles that can assist in long-term recovery (67). In addition, a traditional Finnish sauna technique consisting of 15 minutes at 35°C ± 2°C with relative humidity at 15 ± 3% showed a strong positive immune system response in athletes after exercise (61).

Despite the potential physiological benefits, there have been mixed reports on the perceived psychological advantages. Some athletes have reported stress responses, whereas some have described relaxation and meditative responses from sauna (41). This method may be a viable option if the athlete perceives it as mentally refreshing and not a burden to the recovery process. In summary, the evidence suggests that sauna should not be the primary recovery method; however, it may be used if the athlete perceives this as beneficial.

SUMMARY

An effective strength and conditioning plan is essential for the physical preparation and injury prevention of snowboarding athletes. Competitive snowboarding involves unique considerations that must be addressed to develop an effective training plan. These considerations include athlete motivation, injury management, trick innovation, skill acquisition, time constraints, and recovery strategies. Applying the practical applications suggested throughout this article may assist in the development of a positive training environment, respectful athlete-coach relationships, athlete buy-in, and ultimately the effective implementation of strength and conditioning interventions that compliment on-snow performance.

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