Recovery and Regeneration for Long-Term Athlete Development

Angela Calder

"Recovery is what you do between training sessions and races so that you can train hard and perform well at the next session"

Cross country skier

Recovery is an Important Training Principle

The main role of recovery is to help athletes adapt faster to training. This is done by reducing fatigue so athletes can "bounce back" and be ready for the next session or event. This process is a critical step in the "overcompensation" model (Figure 1).

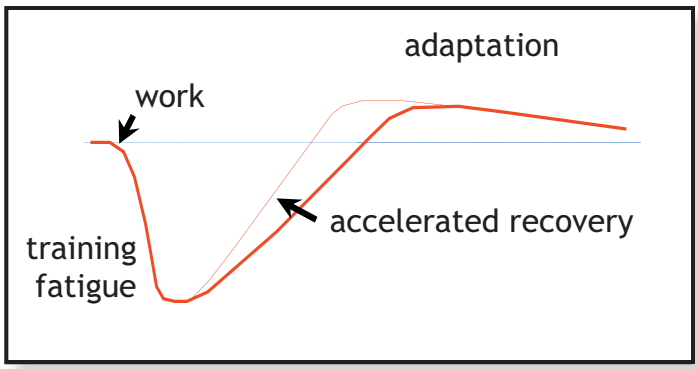


Figure 1: Overcompensation Model: The Principle of Recovery

Both work and recovery are very important stages of the adaptive process. Without the appropriate training stimuli there would be no improvement in performance and no resulting fatigue. To maximize the receptivity for athletes to learn, adapt, and improve, it is important for them to aim to begin any training session or event in a non-fatigued state.

Recognizing Fatigue

Prescribing training loads is a complex matter and coaches and athletes spend considerable time developing appropriate programs to suit both the developmental stage and performance level of an athlete. However, identifying fatigue from different types of training and stress tends to get much less attention and may even be overlooked by both the coach and athlete. A good coach understands not only what is being stimulated but also what is being fatigued.

There are several categories of training and competition fatigue for coaches and athletes to consider (Table 1). If the coach can recognize the main causes of fatigue and the corresponding expressions of these in the athlete, then specific recovery and regeneration strategies can be selected to deal with this fatigue.

Recovery and Long-Term Athlete Development

Human growth, maturation and training experience underpin Balyi's Long Term Athlete Development model. These factors have a critical bearing on the developmental stages of athletic adaptation and trainability. Chronological age is a poor indicator of individual development especially for adolescents as there is great individual variability in the rate of growth and maturation during puberty. The rapid changes that occur physically, cognitively, socially and psychologically during adolescence are a golden opportunity for the coach to provide

Canadian Sport for Life

Active Start
Males & Females
0 - 6 yrs.
Fun and varied activity everyday.

FUNdamentals
Males 6-9, Females 6-8 yrs.
Learn all fundamental movement skills, play many sports, focus on agility, balance, coordination and speed.

Learning to Train
Males 9-12, Females 8-11 yrs.
Learn overall sport skills as cornerstone of many sports. Play a variety of sports and develop specific skills in three.

Training to Train
Males 12-16, Females 11-15 yrs.
Build endurance, develop speed and strength towards the end of the stage. Improve sport specific skills. Focus on two sports.

Training to Compete
Males 16-23 +/-, Females 15-21 +/- yrs. Optimize fitness preparation and sport, individual and position specific skills. Learn to compete internationally. Focus on one sport.

Training to Win
Males 19+/-, Females 18+/- yrs. Ages are sport specific. Podium Performances. One sport.

Active for Life
Any age.
A smooth transition from a competitive career to lifelong physical activity and participation in sport.

athletes with an optimal training base for their sporting future. However, if these developmental stages are handled poorly through inappropriate training and planning, this opportunity can be lost and result in a restricted training base that limits the long-term potential of the athlete. In worse case scenarios poor training during these years may result in gifted athletes experiencing problems like overtraining, overuse, and burnout.

Consequently the coach is challenged to maximize adaptation by balancing training loads with appropriate recovery strategies to suit the individual needs of athletes. This can be achieved by teaching athletes about two concepts:

1. **Monitoring Recovery:** ***"How to listen to your body"***
(Identifying specific fatigue and the type of recovery needed)

2. **Recovery Management:** ***"How to look after yourself"***
(Planning and using recovery strategies)

These two concepts apply to every athlete at all stages of development and sporting experience as both are linked closely with the long-term training adaptations identified in Balyi's model. Monitoring athletic performance and fatigue provides a measure of the effectiveness of training and can forewarn of potential adaptation problems. Consistent and systematic monitoring enables the coach to identify specific recovery strategies relevant to the maturation level, training stress, and lifestyle of the athlete.

1. Monitoring Recovery
"How to listen to your Body"

Three monitoring perspectives are used to monitor athlete adaptation to stress. The player, the coach, and the sport science and medical staff, all contribute to this process through their observations and recording of select variables and markers. The focus of which specific variables to monitor varies in relation to the developmental stage and training experience of the athlete. (Table 2).

Active Start

Simple monitoring concepts can be introduced to very young children. Smiley Faces (Figure 1) have been used by a number of sports at all developmental stages. The number of faces is usually 3 as this provides a choice of options for the athlete. One of the most important variables to monitor at this early development stage is happiness. At each training session the child is asked to tick a box, or point to the face that best fits how they feel.

	☹	☺	😐
Happiness			

Figure 1. Smiley Faces

FUNdamentals

The Smiley Faces are also a very useful monitoring tool during the FUNdamental stage. With increased maturity the range of questions (variables) can be increased to include the child's perception of fatigue, life at school, life at home, etc.

The other critical variable to teach young children to monitor is their hydration. Pre-pubescent children are inefficient at loosing excess heat and can dehydrate and overheat very quickly. Children at this stage are less inhibited than they are at puberty, so if they are taught to check their urine output and then reminded about it, they quickly become quite proficient hydrators.

Learning to Train

The range of variables monitored increases as the child's cognitive skills improve and as growth patterns start to accelerate with the onset of puberty. Ratings either in the form of the Smiley Faces, or as a set of numbers instead of faces (1 to 3, or 1 to 5, with lowest to highest rating), can be used at training as a quick gauge of adaptation and wellness. The main variables should include ratings for fatigue, self-esteem, quality of sleep, and illness or injuries.

Reminders about toilet checks will be easy to reinforce if the child has developed a habit of checking during the FUNdamental stage.

This stage may also include limited sports specific field tests as a measure of performances changes. Some coaches monitor height and weight if this is relevant to the sport, e.g. basketball, rowing, etc.

Training to Train

This is a really critical developmental stage that can have a lasting effect on the sporting potential and health of the individual. During this stage adolescents are exposed to increased training loads at the same time that they are experiencing rapid physical changes. Increased growth, especially of muscle, bone, and connective tissue and hormonal changes coupled with an increase in mechanical loading, requires careful management. This is also a very stressful time emotionally and socially as most adolescents are studying hard to take career determining exams whilst experiencing increased social and psychological challenges from peers and family.

More than any other developmental stage this is the one that can expose the gifted athlete to overtraining, overuse, and burnout problems! For these reasons it is important for the coach and athlete to monitor individual adaptation by keeping a record of training loads, performances and the athlete's responses to these and other stresses.

Each athlete should also have a personalized training diary in which to keep this data. Unfortunately athlete compliance rates for recording information consistently and reliably are often poor. This situation is compounded further in those sports that do not promote or require the use of diaries despite the minimal financial costs and time involved. It takes 2 minutes a day to record

Top photo is courtesy of the Aboriginal Sports and Recreation Association of BC

Resting Heart Rate (RHR), body weight, quality of sleep, and fatigue levels. Whilst the reliability and usefulness of RHR can be debated, the regular recording of these variables trains theathlete to be more perceptive about their adaptation and wellbeing: to *"listen to their bodies"*.

In addition to the four variables noted above, the daily checklist should also include ratings for self-esteem, muscle soreness, appetite, external stresses (home and school), illness or injury, and for females, a record of the onset of each menstrual cycle and any ensuing symptoms. If a female has not started menstruation by the time she is 16 years of age there are increased future health risks for her so it is important that she consults a suitably qualified medical specialist for advice.

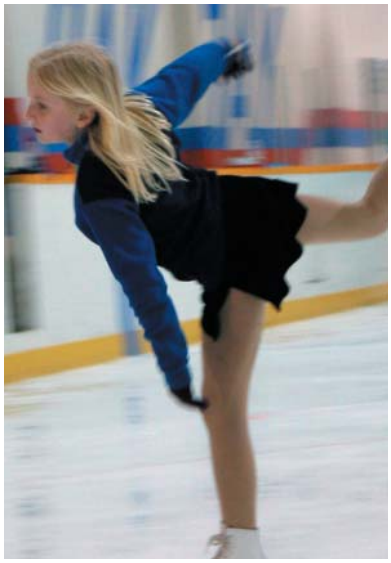
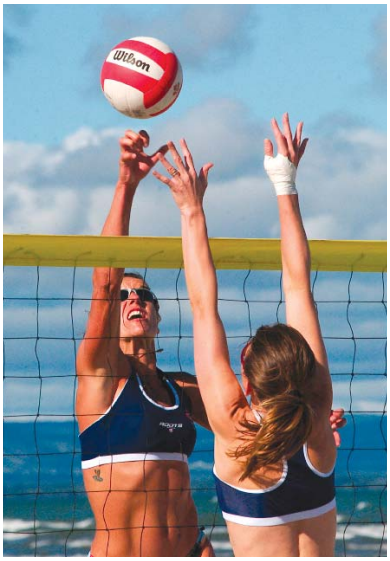
This is a critical stage to introduce medical and sports science screening and testing pre-season before the training year begins. In particular musculo-skeletal evaluations are critical to identify any of the common growth problems associated with the adolescent growth spurt (peak height velocity / PVH), especially those associated with the spine and lower limbs.

Training to Compete
By this training stage the athlete should have established a daily monitoring routine. The variables monitored are similar to those used in the previous developmental stage. The main differences are the number and frequency of performance tests and sport science and medical assessments. Many athletes will have finished their growth spurt but are continuing to increase in muscle size and strength. Musculo-skeletal assessments at this stage tend to focus more on muscle imbalances and corrections than problems associated with adolescent growth.

Training to Win
Daily monitoring for the high performance athlete is often undertaken through sophisticated computer based systems that graph the individual's responses and then compare these against a sport specific data set. Distance is no barrier for the coach with high speed IT and telecommunication systems transmiting data within a few seconds even if the athlete is overseas and the coach is at the home base. Athletes at this level require individualized testing and screening schedules to accommodate for the complexities of the sport and the requirements of the competition calendar.

Active for Life
Older athletes are as vulnerable to the same training problems as their younger counterparts in the Learning to Train and Training to Train stages. These athletes may vary greatly in their training experience (training age) with some having extensive experience in their chosen sports whilst others may be starting their competitive sporting activities in mid-life. Monitoring adaptation to training is especially important for a Masters Athlete as increased age is accompanied by longer recover times and slower adaptation rates. The basic monitoring strategies are similar to those recommended for the Training to Train stage. Sport science and medical screening focuses on cardiovascular fitness and health. Musculo-skeletal screening assesses any possible compromising conditions that may limit efficient joint mobility.

Summary: A pro-active approach to evaluating the training loads and adaptive responses of athletes can promote maximum development, enhance performance, and minimize the chances of under performance, illness and injury.


2. Recovery Management
"How to look after yourself"

Once the adaptive responses of an athlete have been identified through an appropriate monitoring program specific recovery management strategies can be identified. The type and amount of recovery an athlete needs depends on the type and amount of fatigue they experience. (Table 1) Once identified, the coach and athlete can plan to implement and manage the most appropriate recovery strategies for the athlete's situation. (Table 3)

Active Start
Drink breaks every 15-20 minutes, or more often in hot weather, allow for re-hydration and short rest intervals during activities. A light snack, with a piece of fruit, muffin, or sandwich post activity may be appropriate if the activity has lasted 40 minutes of more. Parents can be encouraged to make sure their children are showered or bathed before bedtime as this will promote both physical and psychological relaxation.

FUNdamentals
Each session should end with a fun activity followed by a few light active stretches of the major muscles used in training. The session is completed with re-hydrating and refuelling with some water, cordial or fruit juice and a light snack such as a muffin, sandwich, and piece of fruit or yoghurt. Children should be encouraged to have a shower or bath when they get home to help their muscles relax. This is a critical time to begin the education of parents about the importance of recovery strategies, as they are often the ones preparing post session drinks and food. Parents can help by observing their child's response post- session and assist the recovery process by reinforcing the use of the shower or bath and massaging tired legs and backs when tucking their child into bed at night.

Learning To Train
With increased workloads at this stage there is a corresponding need to increase the amount and type of recovery used by athletes. Hydration and refuelling strategies are maintained both during and after training and competition. Pre and post session weight checks may be helpful in hot weather as a means of assessing the effectiveness of individual fluid consumption. Individuals should aim to maintain their weight throughout the training session or game. The training recovery routine should involve some short active recovery exercise and some light active and static stretches (10 seconds per stretch). Athletes are encouraged to shower as soon as possible after training and to have a meal within 2 hours of the end of the session. Contrast showers, spas, and saunas, are NOT recommended for prepubescent children as their thermodynamic regulatory systems are not fully developed and they can easily dehydrate and overheat. Cold immersion pools are also NOT recommended as a smaller body mass is more susceptible to chilblains and frost bite than adults.

Children are mature enough at this stage to learn to use simple self-massage techniques. Parents and children can be taught self-massage techniques for the feet, legs, arms, and neck and these can be used in the evening whilst the athlete watches TV. Long-held static stretches (30 seconds to 1 minute) are best done in the evening and each child can have a specific stretching program to do before bed time. The role of hobbies and other sports can provide younger athletes with a number of different ways to relax emotionally. As the athlete moves to the next developmental stage the number of sports played should reduce in proportion with an increase in the training demands from the athlete's preferred sport.

Training To Train

Increased workloads and a growing body during the Training to Train stage require the use of more recovery than in the previous two stages. The amount and type of recovery used should correspond with the types of fatigue and stress identified by the monitoring strategies outlined in Part 1 above. During this stage the athlete learns how to use a range of recovery modalities and develop appropriate routines to complement training fatigue and lifestyle stresses.

In addition to the routines developed in previous stages, athletes at this developmental stage have greater nutritional requirements for pre, during, and post training and competition situations. The use of specific carbohydrates, protein, and electrolytes incorporated in both liquid and solid forms to suit individual requirements becomes increasingly important. Specialist nutritional advice is very important at this stage as the nutrition requirements necessary to meet the metabolic demands of an athlete's sport and maturational needs are very demanding. Individuals going through the PHV growth spurt, especially tall mesomorphic males, need to plan the timing of their food intake, food type, and amount with great care. Those athletes who do not consume appropriate food in sufficient amounts may experience excessive fatigue and this may pre-disposed them to a number of illnesses and injuries.

The range of physical recovery strategies expands during this stage to include daily contrast showers, and a developmental stretching program to be done in the evening before bed. On a weekly basis, a spa with a short (30-60 seconds) cold immersion plunge (10°C to 15°C), a sports massage, and a specific training session to improve flexibility will help reduce fatigue and help maintain mobility.

A selection of relaxation strategies and psychological skills are introduced to help the athlete cope with any emotional and psychological stresses that result from heavy training, school, and home situations. Visualization, progressive muscle relaxation, and mental toughness skills are some of the ones most often used to expand the athletes relaxation repertoire and stress-coping skills.

Training to Compete

By the time an athlete reaches the Training to Compete stage the main recovery routines have been established and are periodized into the athlete's annual training program. Recovery techniques are selected to suit training and competition demands in a variety of different environments. This enables the athlete to be more adaptable and prepare for major events away from the home environment. Travel fatigue is something athletes at this stage need to experience and learn to mange effectively. Recovery strategies for both short and long journeys are trialled and appropriate routines identified particularly in relation to adapting to different time zones and climates.

The number of massages may increase to two a week, and relaxation strategies may include flotation tanks, meditation and yoga. More active recovery activities are included in training programs and these may vary from swimming to golf. It is very important during this stage and the Training to Win stage that there is variety in the recovery program to offset the monotony of doing the same recovery routine week-in and week-out.

Training to Win

By the time athletes reach this stage they should have all the appropriate skills and experience to have a major input into their recovery requirements and programming. Strategies are periodized and tailored to suit the competition calendar with minor adjustments made for different performance

environments. Any new recovery strategies or changes to recovery routines should not be trialled at major competitions. Experimentation with new ideas, techniques or protocols is best done in the training environment or at minor competitions and events.

Active for Life

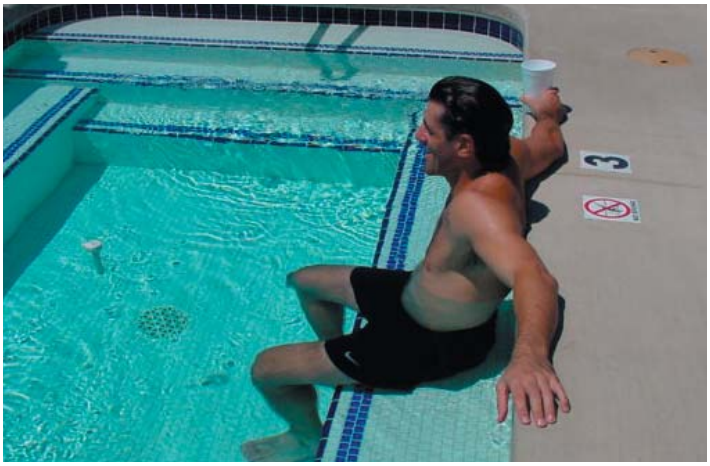
Active for Life athletes and their coaches often underestimate the amount of recovery needed for older individuals as recovery rates are very variable and much slower than they are for younger people. Rest periods need to be longer as an older body takes longer to adapt to increased workloads than does a younger and developing body. This can be very frustrating for those highly motivated Active for Life athletes who subscribe to the erroneous belief that "more is better!" Such subcultures in some sports, such as triathlon, tends to encourage this belief by emphasizing "how far" or "how long" an athlete performed rather than focusing on the quality of the performance or "how well" the athlete recovered before the next training session.The recovery strategies that best suit Active for Life athletes are almost identical to those recommended for the Training To Train stage. Athletes at both stages undertake relatively large workloads and have a variety of challenges that impact on the speed with which they can adapt to training and lifestyle stresses.

In sports that require a great deal of time commitment many Masters Athletes struggle to undertake sufficient recovery for their needs. Time management becomes a major issue for those ageing athletes with family and work obligations, as recovery practices are often minimized or excluded from training programs. This is counterproductive and can lead to poor training quality and poor performances. Coaches of Active for Life athletes should consider their athlete's lifestyle commiments and integrate these into the training program to help the athletes identify and prioritize their recovery needs.

Summary

Recovery strategies can be introduced to athletes from an early age. Initially these involve the use of simple recovery techniques that are expanded in the later stages of development to suit the specific recovery needs of athletes throughout their sporting lives.

Ironically it is not only the athlete who needs recovery but also the coach. Coaches are often overworked, underpaid, or not paid at all, are time poor, and have many other commitments besides training their athletes. What does the coach do for recovery?



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Biography

Angela Calder was the Recovery Consultant for the Australian Institute of Sport from 1990 - 2002. From 2003-2005 Angela lectured in the Coaching Science degree at the University of Canberra, currently she is an adjunct senior lecturer at the University of the Sunshine Coast in Queensland, teaches in the postgraduate coaching program for the University of Queensland, and is studying for her PhD from the Australian National University in Canberra. Over the last 18 years Angela has provided consultancies and educational information on Recovery to over 50 Olympic and non-Olympic sports worldwide.

Table 1: Training and Competition Fatigue

Type of Fatigue	Main Causes for Fatigue	Expression of this Fatigue	Recovery Strategies
Metabolic Fatigue (energy stores)	• Training lasting one hour or more, or • From several (even shorter) sessions a day, & • It can be cumulative when training or performing over a number of days	• Athlete fatigues sooner than is normal for that athlete • Athlete struggles to complete a session or event	• Rehydrate & refuel before, during & after training • Use contrast temperature showers or pool or spa and cold plunge, or active recovery activities • Meal within 1-2 hours of training & monitor hydration
Neurological Fatigue (nervous system) **Peripheral Nervous System Fatigue (muscles)**	• After short high intensity sessions, e.g. weights, plyometrics, complex skill execution, etc. • After long but low intensity sessions especially involving repetitive movements, e.g. steady state swimming, running, cycling, paddling, rowing, etc.	• Reduced localized force production e.g. slow feet. reduced acceleration, poor technique, etc.	• Rehydrate & refuel (including small amounts of protein as well as carbohydrates) before, during & after training • Within 5 – 15 minutes after training use a spa or shower with jets focused on the large & fatigued muscles • After training or later in the day – massage large muscle groups using jostling / light shaking technique
Neurological Fatigue (nervous system) **Central Nervous System Fatigue (brain)**	• Low blood pressure levels • High pressured training session - especially involving rapid decision making & reactions • Poor motivation e.g. monotony of training, emotional factors, injury etc.	• Lack of drive • Lack of motivation	• Steady & regular intake of carbohydrates during training & after training to maintain normal blood glucose levels • After training – unwind, listen to music, visualization • Sauna – contrast hot and cold • Rest
Psychological Fatigue (emotional, social, cultural)	• Lack of team or squad cohesion, personality conflicts etc. • Competition pressures, event venue, residential conditions, parents, coach, media, etc. • Other lifestyle stresses – home, school exams, personal relationships	• Athlete looses self-confidence or self esteem • Poor interaction & deteriorating communication with other athletes & staff • Athlete's body language, increased signs of anxiety, negative attitudes, etc. • Quality of sleep is poor	• Focus on process rather than outcome performance measures • Debrief by identifying 1-3 things that worked well and 1-3 that need more work • Take mind off training with escapist or funny movie, TV, book, or socialize with family & friends • 10-15 minutes before bed switch off from the day by using relaxation techniques
Environmental & Travel Fatigue	• Disruption of normal routines, especially biological clock • Disruption to sleep, waking and meal times • Sedentary & limited body positions on long journeys, i.e. 30 minutes or more • Adapting to different climates and time zones	• Athlete takes longer to warm-up, are slower to start • Unforced errors in the first 15 minutes are well above normal • Athletes fatigue sooner than normal	• Preparation planning will minimise fatigue • Stay hydrated and refuelled • Stay cool in the heat - use a pool, shade, iced towels, etc. • Keep moving as much as possible on long journeys • Minimise visual fatigue by wearing sunglasses outside & limiting time on computers & play stations

Table 2: Monitoring Strategies corresponding with athlete development and increased workloads and stress

Active Start & FUNdamental	Learning to Train	Training to Learn	Training to Compete	Training to Win	Masters Athletes & Coaches
Specific Training Age: 0 years	Specific Training Age: 1-2+/- years	Specific Training Age: 3-7+/- years	Specific Training Age: 8-10+/- years	Specific Training Age: 10-12+/- years	Specific Training Age: 1-100+/- years
At Training (C)* *Smiley Face.* • Energy / tired • Happiness **Reminder (C)** • Toilet (hydration) checks	**Start Recording (A)** • Energy / tired • Self-esteem • Quality of sleep • Illness or injury **Reminder (C)** • Toilet checks **6-9 months (C)** • Limited field and sports specific testing	**Daily Records (A)** • Resting HR • Energy / fatigue • Self-esteem • Quality of sleep • Muscle soreness • Appetite • Body weight • External stresses • Illness or injury • Menstrual cycle **Ongoing (A)** • Toilet checks **2-6 months (SS)** • Musculo-skeletal checks • Sports science & Medicine checks	**Daily Records (A)** • Resting HR • Energy / fatigue • Self esteem • Quality of sleep • Muscle soreness • Appetite • Body weight • External stresses • Illness or injury • Menstrual cycle **Ongoing (A)** • Toilet checks **2-6 months (SS)** • Sports science & Medicine checks **6-12 months (SS)** • Musculo-skeletal checks	**Daily Records (A)** *(as previous stage) Plus:* Individualized testing and screening varies for each sport and athlete (C & SS) Access to facilities and technology, plus the intensity of the competition schedule will influence when and how often testing and screening are done	**Daily Records (A)** • Resting HR • Energy / fatigue • Self esteem • Quality of sleep • Muscle soreness • External stresses • Illness or injury • Menstrual cycle (if relevant) **Ongoing (A)** • Toilet checks **6-12 month (SS)** • Sport Science & Medical checks **Annual (SS)** • Musculo-skeletal checks

***** Monitoring responsibilities: (A) = Athlete: (C) = Coach: (SS) = Sport Scientist or Sport Medical Specialist

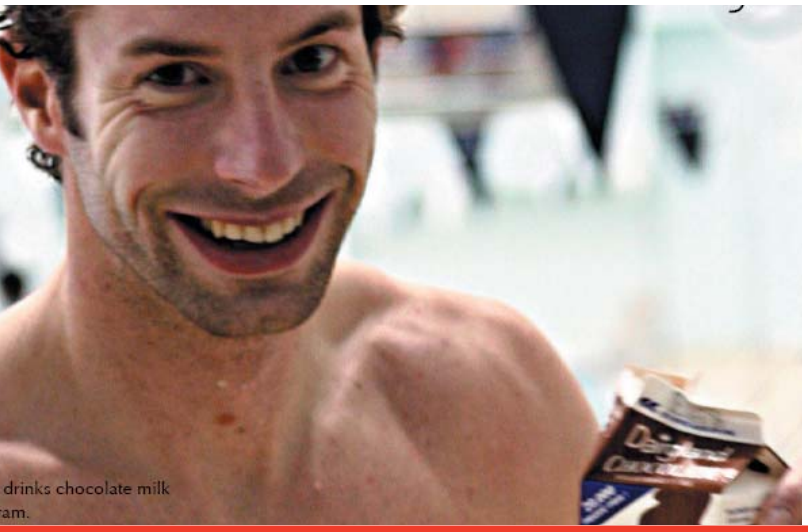

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Table 3: Recovery Strategies corresponding with athlete development and increased workloads and stress

Active Start & FUNdamental	Learning to Train	Training to Learn	Training to Compete	Training to Win	Masters Athletes & Coaches
Specific Training Age: 0 years	Specific Training Age: 1-2+/- years	Specific Training Age: 3-7+/- years	Specific Training Age: 8-10+/- years	Specific Training Age: 10-12+/- years	Specific Training Age: 1-100+/- years
During Training • Rehydrate every 20-30 minutes **After Training** • Drink (water, cordial, fruit juice) & light snack (e.g. fruit, muffin, or yoghurt, etc) • Light stretch • Shower at home	**During Training** • Rehydrate every 20-30 minutes **After Training** • Post game drink & snack • Active recovery • Light stretch • Shower • Meal within 2 hours **Before bed** • Self Massage • Stretching • Relaxation (TV, book, music)	**During Training** • Rehydrate every 20-30 minutes **After Training** • Post game sports drink & snack • Active recovery • Light stretch • Contrast shower • Meal ASAP **Before bed** • Self Massage • Stretching • Relaxation (as for previous stage) Plus: Progressive muscle relaxation, visualization, etc. **Weekly** • Sports massage • Active recovery (e.g. pool, golf, walk dog) • Spa & plunge pool • Stretching session (e.g. Yoga)	**Periodized recovery** *(as previous stage)* *Plus:* • Compressive skins post training • 2 massages a week • Strategies selected to suit specific fatigue (Table 1) • Recovery program individualized • Competition scenarios trialled • Especially recovery from travel fatigue and adjusting to different facilities • Increased range & use of psychological recovery (e.g. lotation, meditation) • Variety of active recovery and rest day activities	**Periodized recovery** *(as previous stage)* *Plus:* Detailed competition planning of recovery programs Fine-tuning recovery strategies for different competition environments Athlete has major input into the recovery program Variation in recovery strategies to prevent monotony	**During Training** • Rehydrate and refuel regularly **After Training** • Post game sports drink & snack • Active recovery • Light stretch • Contrast shower • Meal ASAP **Before bed** • Self Massage • Stretching • Relaxation movie, TV, book, music, visualization, meditation, etc. **Weekly** • Sports massage • Active recovery (e.g. pool, golf, walk dog) • Spa & plunge pool • Stretching session (eg. Yoga)

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