GUIDELINES FOR RESISTANCE EXERCISE
IN YOUNG PEOPLE

Research into Exercise Activity and Children’s Health (REACH) Group.
Liverpool John Moores University
**Contributors**

**Panel Chair**
Dr. Gareth Stratton. Research in Exercise and Children’s Health (REACH) Group. School of Physical Education, Sport and Dance. Liverpool John Moores University

**Coordinator**

**Editorial Assistance**
Professor Ken Fox. Department of Exercise and Health Sciences, Bristol University

**Panel Members**
Professor Simon P Frostick - Consultant in Orthopaedics. Royal Liverpool NHS Trust. Liverpool University.

Dr. Jo Harris. Department of Sport and Exercise Sciences. Loughborough University.

Professor Nicola Maffulli, Head of the Department of Trauma and Orthopaedics, School of Medicine. Keele University.

Dr. Martin Lee. Principal Research Fellow, Chelsea School of Physical Education, Sport Science, Dance and Leisure, University of Brighton.

Dr. Keith Tolfrey. Department of Exercise and Sport Science. Manchester Metropolitan University.

**Acknowledgements**
Mr. Phillip Vickerman for comments and suggestion on principles of inclusion for special needs and disabled groups.

Governing bodies for their response to issues about policy and practice for resistance exercise in their sport.

BASES for their support in completing these guidelines.
Guidelines for Resistance Exercise in Young People

CONTENTS

1.0 Setting
1.1 Background 1
1.2 Rationale, aims and terms of reference 2
1.3 Aims 3
1.4 Organisation 4
1.5 Glossary 5

2.0 Executive summary
2.1 Resistance exercise recommendations for young people
2.1.1 Recommendation 1 6
2.1.2 Recommendation 2 7

3.0 Evidence base for resistance exercise.
3.1 Evidence base for benefits of resistance exercise.
3.1.1 Muscle function 8
3.1.2 Flexibility 9
3.1.3 Sport performance
3.1.4 Blood Pressure
3.1.5 Lipids
3.1.6 Adiposity
3.1.7 Peak oxygen uptake 10
3.1.8 Skeletal health 11
3.1.9 Injury prevention 12
3.1.10 Psycho-social benefits

3.2 Evidence base for the risks of resistance exercise 13
3.2.1 Injury risk 14
3.2.2 Psychosocial risk 15

4.0 A practitioners guide to quality resistance exercise programmes
4.1 Principles of good practice 16
4.2 Guidelines for professional practice
4.2.1 Young people centred approach
4.2.2 Instructor/coach/teacher 17
4.2.3 Safety
4.2.4 Exercise prescription 18
4.3 Aims of resistance exercise programmes according to developmental stage and outcome

5.0 Research Needs
5.1 Effectiveness of resistance exercise
5.2 Interaction between resistance exercise and health
5.3 Pedagogy

6.0 References 23

7.0 Contributors Specialist Topics 30

1.1 BACKGROUND

REACH Group. Liverpool John Moores University 2
Early in 1998, the Health Related Exercise (HEI) working group of the British Association of Exercise and Sport Sciences (BASES) identified the need for a series of evidence based guidelines for resistance exercise for the range of professionals and volunteers working with British children and youth. There have been previous consensus documents on the topic of resistance exercise and young people (American Academy of Pediatrics, 1990; 2000; Blimkie, 1993). However, these have taken a narrow focus that has been largely aimed at informing medical practice for audiences in the United States or Canada. From a British perspective this group agreed that guidelines should encapsulate educational, psycho-sociological, and developmental as well as physiological and medical perspectives. These guidelines also aim to provide sound practical advice based on research evidence where possible and expert consensus where evidence was not available.

It was decided that the guidelines should be developed as a formal BASES document and at the 1998 conference in Worcester, a group of experts representing a range of sub-disciplines of sport and exercise and science were invited to contribute to a resistance exercise guidelines scientific panel. A proposal was developed and presented to the BASES executive for consideration. Funding for the initial meeting was provided by BASES. Panel members were asked to prepare short review papers covering evidence in their sub-discipline on resistance exercise with young people. In November 1999, a consensus meeting, chaired by Dr Gareth Stratton was held at Liverpool John Moores University. Papers were presented by panel members, terms of reference for the working group were determined, and a strategy developed for producing the guidelines. Between May 2000 and November 2001, a draft of the document was drawn up and circulated to a wide range of practitioners and organisations who work with exercise in young people for consultation. Funding for the printing of the guidelines was secured at the BASES 2001 conference in Newport. Following several modifications, the final version was delivered to BASES for comment in Summer 2002.

1.2 RATIONALE, AIMS AND TERMS OF REFERENCE

The evidence for benefits of physical activity and exercise on the health of British children has been reviewed (Biddle et al., 1998). This review produced two main physical activity recommendations. The first stated that children should optimally engage in 60 minutes of daily moderate to vigorous physical activity. The second and key focus for this consensus statement was that children should engage twice weekly in exercise that promotes strength, flexibility and bone health. Furthermore, there has been an increase in diversity of agencies interested in promoting children’s activity that include the commercial, educ...
and voluntary sectors. With this has come an increase in the range of organisations interested in producing resistance-training programmes for young people. Many individuals (some with minimal training in exercise), organisations and institutions are therefore seeking expert guidance. Although consensus documents on resistance exercise with youth or children exist in the USA and Canada, there are currently no formally recognised resistance exercise guidelines published in the UK. Subsequently, in addition to the need for recommendations about resistance exercise, the review panel felt that there was a need for the production of resistance exercise guidelines for those working with young people in the UK that is based on research evidence and expert opinion. Such guidelines need to encapsulate educational, developmental, psychosocial, physiological and medical considerations with the purpose of producing practical guidance for maximising safety, effectiveness and the quality of the experience for young people.

1.3 AIMS

The aim of the scientific panel was therefore to produce recommendations and guidelines that promote best practice in the use of resistance exercise in young people. The specific objectives were to:

- Establish the current evidence base regarding the benefits and risks associated with the participation of young people in resistance exercise programmes.
- Establish expert consensus on guidelines for the design and delivery of resistance exercise programmes for young people.
- Identify future research and practice priorities.

Resistence exercise was defined as exercise specifically designed to enhance muscular strength and endurance. It may involve a variety of activities that create work demands on the muscles such as weight/load bearing exercise (e.g. climbing), specific body weight exercises (e.g. curl-ups, press-ups, jumping, hopping), and the use of resistance materials (e.g. stretch bands, fixed weights, free weights).

While the potential for children to engage in resistance exercise during free play was recognised, these guidelines were to be written for those designing and leading formal programmes of resistance exercise for young people.

It was also recognised at an early stage that guidelines would require special consideration for youngsters of different developmental stage. It was decided to consider three different age groups.
• Children - up to 10 years old
• Early adolescents – 10 to 13 year olds
• Late adolescents - 14 to 18 year olds.

These age groups best reflect key developmental stages that take account of physical, emotional and cognitive maturation.

[Further definitions are set out in the glossary]

1.4 ORGANISATION

These guidelines are split into 3 main sections:

Executive Summary.
This section outlines the 2 key resistance exercise recommendations and has distilled the key points supporting each statement.

Literature Review
This section covers key scientific issues and expert opinions related to resistance exercise in young people.

Principles of Practice
The final section sets out basic guidelines and principles for good practice and is intended to support and inform practitioners.
1.4 GLOSSARY

**Physical activity**  Any bodily movement produced by skeletal muscles that results in energy expenditure (Caspersen et al., 1985).

**Exercise**  Planned, structured and repetitive bodily movement done to improve or maintain one or more components of fitness (Caspersen et al., 1985).

**Resistance exercise**  Resistance exercise is exercise specifically designed to enhance muscular strength and endurance. It may involve a variety of activities such as weight/load bearing exercise (e.g. climbing), specific body weight exercises (e.g. curl-ups, press-ups, jumping, hopping), and the use of resistance materials (e.g. stretch bands, fixed weights, free weights).

**Training**  Any programme of exercise designed to improve the skills and increase the energy capacity of an individual for a particular activity (Anshel et al., 1991).

**Weight lifting**  An Olympic competitive sport that involves lifting maximal weights using the snatch and clean and jerk techniques.

**Powerlifting**  A competitive sport that involves lifting maximal weights in the squat, bench press and dead lift.

**Maturation**  A state of optimal functional integration of an individual’s body systems and the ability to reproduce (Haywood, 1993).

**Development**  Complements growth and implies a continuous process of change leading to increasingly organised and specialised functional capacity (Timiras, 1972).

**Chronological age**  Age stated in years and months.

**Biological age**  Usually rated in five key stages, Tanner stages I through V (Tanner, 1962). Stages I and II are categorised as pre-pubertal whereas stages III to V are circum-pubertal. Girls usually develop through Tanner stage II between the ages of 11 and 13 compared to boys who pass through these stages between 13 and 15. Tanner stage V is typified by full
development of secondary sexual characteristics. **Children** are categorised as Tanner stage I and II, whereas **adolescents** III -IV, and **late adolescents** V. Children and adolescents are grouped together as “young people.”

**Health**

A state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity’ (World Health Organisation, 1990).

### 2.0 EXECUTIVE SUMMARY:-

### 2.1 RESISTANCE EXERCISE GUIDELINES FOR YOUNG PEOPLE.

All young people (5-18 years) need to regularly participate in physical activity that enhances their health. The second of two main physical activity guidelines for young people in the UK recommends that children engage in exercise twice weekly that promotes strength, flexibility and bone health (Biddle et al., 1998). While there is good information to support young people’s engagement in aerobic activities such as games, swimming and cycling, less information is available on higher intensity muscle specific required in resistance exercise. Furthermore, there has been increasing demand for guidance on this issue by parents, teachers and coaches. These guidelines will clarify the current **BASES** position on the use of resistance exercise in young people.

First, it is necessary to clearly define the term resistance exercise. Resistance exercise portrays images of lifting weights in gyms and while gym work using weight is one type of resistance exercise, the range of activities in this category are much larger, particularly for young people. Resistance exercise for the purposes of these guidelines involves weight-bearing exercise (e.g. climbing), body weight exercises (pressups, situps etc.) and resistance exercise equipment (Stretch, bands, fixed weights, free weights). Resistance exercise should be seen as another activity that can exist in its own right (resistance exercise machines, circuit training) or as part of other activities (climbing, swimming, athletic jumps).
Guidelines for Resistance Exercise in Young People

The key recommendations have been informed by reviews of the research literature in the fields of physiology, psychology, sports medicine and sociology and by expert opinion exercise science. The final recommendations have been presented with a view to improving practice and are intentionally educational in perspective.

1. All young people should be encouraged to participate in safe and effective resistance exercise at least twice a week.
2. Resistance exercise should be part of a balanced exercise and physical education programme.

The first recommendation to promote appropriate resistance exercise supports the secondary recommendation made by the Health Education Authority (Biddle et al., 1998) that young people should engage twice weekly in exercise that promotes strength, flexibility and bone health. The second recommendation places resistance exercise in the context of health-promoting activity and young people’s physical education. They key summaries supporting recommendations 1 and 2 are outlined below.

2.1.1 Recommendation 1
All young people should be encouraged to participate in safe and effective resistance exercise at least twice a week

There is sound physiological evidence that young people of all ages can significantly increase their strength through the use of resistance exercise programmes. These gains are greater after puberty than before although these differences disappear when gains are stated relative to body mass. The mechanisms for increase in strength are not clearly understood. There is little increase in muscle size pre-puberty and improvements in strength are probably a result of better co-ordination in terms of technique and muscle efficiency. As young people move through adolescence to adulthood, increases in muscle size may also occur because of an increase in circulating androgens. Changes in muscle size and strength during adolescence are likely to be greater in boys compared to girls. Before puberty the potential for gains in strength outweigh those for the cardiorespiratory system. Furthermore, limited data suggests that flexibility, bone health and coronary risk factors such as adiposity, cardiorespiratory fitness, blood pressure and blood lipids (such as cholesterol) can be positively influenced by resistance exercise.
programmes. Although the evidence base is not extensive, psychological benefits of resistance exercise may also be possible for young people. As with many sporting activities, this might be experienced through improved self-perceptions, sense of achievement. Resistance exercise is particularly useful for experiencing measurable improvement in both strength and endurance performance and the learning of techniques. In addition, there may be social benefits as young people are given the opportunity to work together in a group in a positive and encouraging environment.

2.1.2 Recommendation 2
Resistance exercise should be part of a balanced exercise and physical education programme.

Ignorance and lack of understanding about the effectiveness, and relative risks and safety of resistance exercise in young people have meant that it is often discouraged in young people. There are particular concerns that participation in resistance exercise can place excessive loads on a growing skeleton. Although there have been no long-term prospective studies on the effect of resistance exercise on long-term injury, the incidence of acute injury are reported to be lower than many other sports in the UK. However, there have been few well-conducted studies to fully establish the effects of high intensity resistance exercise, particularly with younger children. The context of the resistance exercise programme is probably more critical than the exercise itself in determining the risks and benefits. The risks of resistance exercise are acceptable when supervised by knowledgeable leaders. The benefits are likely to be greater when programmes involve young people developing independent expertise, good practice habits and techniques, experiencing steady progression and understanding of the place of resistance exercise in a balanced programme of health-enhancing activity. Therefore any resistance exercise programme should be based on a set of operational guidelines that can reduce risk and promote physical education and sense of well-being in youngsters and also take into account the developmental stage of the young person. For example young children may not respond positively to structured resistance programmes but may enjoy activities such as climbing, dancing, skipping and jumping that are intrinsically gratifying. Adolescents on the other hand are able to grasp more abstract concepts and therefore participate in activities that have long-term goals.

3.0 EVIDENCE BASE FOR RESISTANCE EXERCISE
Guidelines for Resistance Exercise in Young People

Electronic searches provided limited literature on the risks and benefits of resistance exercise in young people. Where the literature was particularly sparse the group were left to consider; a) generalisations from sport and physical activity literature and b) expert evidence. Many studies presented are limited due to poor control, confounding influences and low subject numbers. Gender comparisons are difficult to identify and evidence is often tenuous. The following sections aim to highlight the available evidence of the risks and benefits of resistance exercise in young people.

3.1 Evidence base for benefits of resistance exercise.

3.1.1 Muscle function

There is now a large body of evidence identifying positive increases in muscle function following short-term resistance exercise programmes using fixed weights machines. Muscular strength gains have been evident across all maturity stages including pre-pubescents (Rians et al., 1987; Blimkie et al., 1989; Ramsay et al., 1990; Faigenbaum et al., 1993), pubescents and post-pubescents (Pfeiffer and Francis, 1986). The effects of implementing resistance exercise using other forms of resistance (e.g. body weight) is less clear, although benefits have been reported in pre-pubertal children (Falk and Mor, 1996) and children aged 10-13 years (Siegal et al., 1989). The use of weight lifting use free weights has not been widely researched due to safety and ethical considerations. However, Servedio et al. (1985) reported significant strength enhancement in prepubertal children. Two recent meta-analyses on the effects of resistance exercise on young people revealed positive effect sizes. Falk and Tenenbaum (1996) calculated an effect size of 0.57 on prepubertal boys and girls (boys<12 yrs; girls<13 yrs), and Payne et al. (1997) revealed effect sizes between 0.65 and 0.83 for children between 6 and 18 years of age. Based on the available evidence it appears that children of all maturity stages can enhance strength through resistance exercise. Prepubertal children demonstrate smaller absolute but similar relative strength gain to more mature children. When comparing training details the majority of effective programmes are of 8 weeks or longer, involve two or three sets of exercise, lifting 6 to 15 repetitions at between 50 to 100% of maximal effort. Little evidence exists of the sustainability of the strength gains. Faigenbaum et al. (1996) suggested that strength gains in prepubertal children regress towards untrained control values after an eight-week detraining period. The mechanism of strength enhancement is yet to be determined although much of the benefit seen has been attributed to neuromuscular rather than physiological adaptation such as muscle hypertrophy (Weltman et al., 1986; Ramsay et al., 1990; Ozmun et al., 1994).
3.1.2 Flexibility
There are some reservations that resistance exercise may produce muscle bound individuals with subsequent decreases in flexibility. However, findings from short term resistance exercise programmes are equivocal. Studies have revealed both significant (Weltman et al., 1986; Rians, et al., 1987; Siegel et al., 1989) and non significant improvements in flexibility across the various maturity stages (Servedio et al., 1985; Sewall and Micheli, 1986; Faigenbaum et al., 1993, Falk and Mor, 1996). Small (<5%; Sewall and Micheli, 1986), and moderate to large (8-12%; Rians, et al., 1987; Siegel et al., 1989) changes are also evident. Studies revealing improvement in flexibility included specific stretching exercises and warm-up routines involving stretching during the programme duration.

3.1.3 Sport performance
Many sports in which children participate have a substantial strength or power component and training to enhance these attributes could serve to improve performance. The link between sports performance and resistance exercise has not been fully established since few investigators have used robust scientific procedures to address this question. Furthermore evidence of muscular development resulting from training in specialist sports such as gymnastics, swimming and athletics is only observational and the effects of this type of resistance exercise on performance are intuitive. Ainsworth (1970) found that 6 weeks of supplemental resistance exercise failed to increase swim speed in male and female swimmers between the ages of 7 and 17. On the other hand, longer-term resistance exercise programmes (Blanksby and Gregor, 1981) revealed significant improvements in 100yd swim times. Resistance exercise programmes also stimulate improvements in motor fitness scores (Nielsen et al., 1980; Weltman et al., 1986; Falk and Mor, 1996). However, further detailed research is required before the effects of resistance exercise on sports performance can be fully established.

3.1.4 Blood pressure
Acute responses to resistance exercise would appear to mirror adult responses (Nau et al., 1990) with a risk of syncope and elevated blood pressure. Chronic blood pressure responses to resistance exercise programmes are equivocal. Short-term resistance exercise programmes would appear to lead to no change (Rians et al., 1987; Faigenbaum et al., 1993) or a reduction in systolic (Servedio et al., 1985) and diastolic blood pressure in normotensive, prepubertal children. In hypertensive adolescents, resistance exercise was found to maintain systolic blood pressure at a reduced level following an aerobic exercise programme (Hagberg et al., 1984). When training ceased, blood pressure returned to levels non-significantly different from initial
levels. Resistance exercise may provide helpful in controlling hypertension, and would not seem to adversely affect blood pressure in young people. Further evidence is needed to fully qualify these statements.

3.1.5 Lipids
Lipid levels would appear to remain unchanged or reduced in response to short term resistance exercise programmes in young people. Weltman et al. (1987) identified reduced total cholesterol in prepubertal children in response to 14 weeks training. However, these children exhibited initially elevated levels that were more easily reduced by exercise. Additionally there was no dietary control and a simultaneous increase in VO$_{2peak}$, so the change cannot be attributed to resistance exercise alone. Fripp and Hodgson (1987) found improved cholesterol profiles following a nine-week resistance exercise programme in adolescents (14 to 17 years). Dietary intake was not controlled, although results were adjusted for body mass index. There is little evidence to highlight the effects of resistance exercise on lipid profile, it appears that either no change or an improvement is the likely outcome although further evidence is required.

3.1.6 Adiposity
In adults it has been suggested that high volume endurance based resistance exercise programmes can lead to reduced fat percentage and skin-fold thickness and increases or at least maintenance of muscle mass during weight loss. In children there is little evidence to substantiate this. Short-term resistance exercise programmes have led to either no change (Rians et al., 1990; Fukunaga et al., 1992; Ozmun et al., 1994) or a reduction (Faigenbaum et al., 1993; Lillegard et al. 1997; Southern et al., 1999) in body fat or skin fold measurements of non-obese children and adolescents. The equivocal nature of the results may be due to the difficulty in distinguishing the simultaneous effects of growth and development during the exercise period on body composition. In a well controlled resistance exercise intervention study involving obese children, Trueth et al., (1998) found no significant change in body fat in response to a short term resistance exercise programme in obese pre-pubertal girls. This would suggest resistance exercise programmes are ineffective in reducing body fat, leading to no change or changes that are not biologically significant.

3.1.7 Peak oxygen uptake (VO$_{2peak}$)
Resistance exercise programmes have led to no change (Fripp and Hodgson, 1987; Blimkie et al., 1993) or an increase (Docherty et al., 1987; Weltman et al., 1986) in peak oxygen uptake. The increases observed in VO$_{2peak}$ have been attributed to the reciprocal and concentric nature
of exercises and high volume programme. However continuation of other sports activities was allowed during these programmes. Further evidence is needed to establish a link between exercise volume and the potential for VO$_{2\text{peak}}$ improvement.

### 3.1.8 Skeletal health

The skeletal system provides more than just a structural framework for the body. Bone is a multifunctional tissue dependent on, and sensitive to, a wide variety of biological, biochemical and biomechanical stimuli (Bailey and McCulloch, 1990). Most researchers agree that efforts to increase bone density during the early years of bone formation are important if people are to maintain skeletal integrity and mobility throughout life (Bailey and Martin, 1994; Groothausen et al., 1997; Zylstra et al., 1989). To increase bone mineral density, individual bones must be stressed selectively. The two primary forms of mechanical loading for humans come from gravitational forces and muscular action. The pre-eminent ingredient in the development and preservation of a healthy skeletal system is the mechanical stress imposed by physical activity. Several studies have suggested positive links between physical activity and bone mineral density (Slemenda et al., 1991, Grimston et al., 1993; Groothausen et al., 1997). The type of physical activity is not clear although evidence suggests that weight bearing or impact loading activities promote bone health whereas non weight bearing or low impact activities do not (Grimston et al., 1993). Unfortunately, the available literature is not without limitations, the majority of the study designs have been cross-sectional, implying that factors other than physical activity may have intervened with the findings such as genetic makeup and nutrition. This approach means that a cause-effect relationship has not been determined, and cannot be assumed from the current literature. Additionally, specific-site bone mineral density alone does not provide a detailed insight into whole body bone integrity. Macro-architectural features also need to be considered. Despite the limits of the present scientific evidence, the general consensus is that physical activity is beneficial to bone health. This has led to the inclusion of weight bearing activity as part of recommended guidelines for physical activity in young people (Sallis & Patrick, 1994; HEA, 1998). As yet, there is no clear evidence for prescribing a particular dose or type of physical activity. The role of resistance exercise in promoting bone mineral density would seem clear, since it provides an obvious mechanical stress to the skeletal system. Fukunga et al. (1992) suggested that resistance exercise led to increased bone tissue in some children as assessed by ultrasound. Poor control over outcome measures limits this finding. However, well-designed studies have not been conducted to address this specific issue. The role of resistance exercise in promoting skeletal health is therefore as yet undetermined, although it is likely to be beneficial.
3.1.9 Injury Prevention

Properly structured resistance exercise programmes have the potential to provide an injury prevention mechanism. In adults, prescription of resistance exercise is common to help reduce the risk of joint and soft-tissue injuries, and recover following injury. This is based on the rationale that resistance exercise has the potential to strengthen specific muscle groups and muscles, increase joint stability and balance reciprocal muscle groups acting around a given joint. The efficacy of such advice in children is unsubstantiated, as only limited evidence is available. A structured resistance exercise programme was found to reduce the number and severity of knee injuries in adolescent male soccer players over a season (Cahill and Griffith, 1978). Similarly lower injury rates and recovery times from injury were reported in adolescent male and female athletes (Hejna et al., 1982). However, the scientific rigour of these studies is questionable, other factors influencing injury occurrence and rehabilitation were poorly controlled. Another potential benefit of resistance exercise is in the prevention and alleviation of low back pain which is increasingly common in children and particularly adolescents (Lebeouf-Yde and Kyvik, 1998; Kujala et al., 1996). Recently Jones (2002) has demonstrated that an 8-week resistance exercise programme can reduce the perception of pain and increase function in adolescent sufferers of recurrent low back pain. Again, evidence for this remains limited. It would seem that the effectiveness of resistance training in the prevention and rehabilitation from injury in young people remains largely unsubstantiated.

3.1.10 Psycho-social benefits

There has been limited empirical research on the specific effects of resistance exercise on the psychological well-being of children and adolescents. Biddle, Fox and Boutcher (2000) summarised the evidence for the impact of exercise in general on anxiety, depression, self-perceptions and self-esteem, cognitive function, and mood, affect and subjective well-being. Similarly, Calfas and Taylor (1994) reviewed the evidence for the effect of exercise on adolescent psychological well-being. There was general support for a positive effect and the strongest evidence was for the effect of fitness-related activities on children and adolescent physical self-perceptions and self-esteem (Fox, 2000). Conditioning and aerobics activities help young people feel better about themselves, particularly those who are initially low in self-esteem. In addition, motivational effects of aerobics programmes have been shown to be stronger when the focus is on self-improvement and mastery rather than competition. Some of these programmes have incorporated elements of resistance exercise.
The characteristics of resistance exercise have positive aspects that promote psychosocial benefits. These include:

1. **Incremental increases in strength lend themselves to short and long-term goal setting.**
2. **Resistance exercise can be performed in partnerships or groups that may provide social benefits.**
3. **Resistance exercise can be used to educate about the body and how it moves.**

With its capacity to overtly indicate personal improvement, given a child-centred approach to the setting, there is no reason not to expect psychological benefits from resistance exercise. There is also the potential to experience social interaction and support benefits from working alongside others, although this has not been researched. Such benefits are only likely if the experiences match the stage of psychosocial development of children. Young children are motivated by the here and now and are unlikely to work for the kind of delayed gratification that comes with resistance exercise. The activity needs to produce an immediate sense of fun and discovery. Young children are therefore not likely to respond positively to supervised resistance exercise or training, but may enjoy participating in resistance activities such as climbing, dancing, skipping and jumping. Adolescents are more likely to work hard along the lines of adults for longer-term changes in their appearance and performance.

### 3.2 Evidence base for the risk of resistance exercise

#### 3.2.1 Injury risk

A major concern regarding the participation of young people in resistance exercise is the issue of injury. Retrospective and case studies are the major source of evidence regarding the incidence, severity and type of injury resulting from resistance exercise. It is important to distinguish injury occurrence between resistance exercise and weight lifting or power lifting. Injury through participation in resistance exercise and weight/power lifting in young people is partially determined by the characteristics of growth of the musculo-skeletal system. Tendons and ligaments are relatively stronger and more elastic than the epiphyseal plate, subsequently growth plate damage is more common than ligamentous injuries (Micheli 1983; Klenerman 1994; Kruger-Franke et al., 1992; Maffulli and Baxter-Jones, 1995; Stanish, 1995). In a research study designed to directly address the issue of injury risk of resistance exercise in pre-pubertal children, a short term supervised resistance exercise programme resulted in a low injury rate and did not adversely affect growth, development, flexibility or motor performance (Rians et al., 1987). Other resistance exercise studies have identified that no injury occurred as
a result of the training programme in pre-pubertal children (Weltman et al. 1986; Ramsay et al., 1990; Ozmun et al., 1994; Faigenbaum et al., 1995). Little is known about the long term effects of resistance exercise. The longest study involving resistance exercise was performed by Stahle et al. (1995) over a nine month period where no injuries were reported as a result of the resistance exercise. Retrospective surveys suggest lower injury rates compared to many other sports in the UK (Hamill, 1994) and US (Blimkie, 1993). It would appear that supervised, appropriately prescribed resistance exercise provides no greater chance of injury than other sports activities. Weight lifting and power lifting on the other hand where frequent maximum lifts are attempted can cause severe musculoskeletal injuries. The most common type of injury reported in power lifters were muscle strains (61.2%) with the lower back being the most common site of injury (50%) (Brown and Kimball, 1983; Risser et al., 1990). The increased risk of injury has been reported from competitive power and weight lifting (Brown and Kimball, 1983; Risser et al., 1990) respectively are deemed higher than that associated with American football. Several case studies from the US reveal serious injuries such as fatal cardiac rupture following a barbell slip (George et al, 1989), acute intervertebral disc prolapse, avulsion fractures of the anterior iliac spine (Brady et al, 1982), epiphyseal and metaphyseal fractures of the radius and ulna (Gumbs et al, 1982). Few data sets are available on the injury risk associated with weight lifting and power lifting in the UK.

The potential for injury during resistance exercise has been identified. Despite this concern little evidence exists regarding the direct issue of safety and whether or not injury can be avoided by safe practice. Appropriate supervision should be an integral part of any resistance exercise programme (Mazur et al., 1993). Rians et al. (1987) suggested that, during a short-term training period of resistance exercise programme a number of problems were identified, however these were all resolved with technique correction advised by the supervisor. When lifting heavy weights, the most common cause of injury appears to be loss of form or inadequate supervision (Mazur et al., 1993). Various methods to enhance safety and minimise injuries associated with weight and power lifting can be implemented.

3.2.2 Psychosocial Risks
The few studies that have been conducted with condition and fitness related exercise have largely shown positive or insignificant improvements in psychological well-being. There is therefore little evidence of negative impact. However, if leaders do not operate their programmes along sound educational and child-centred principles, then some young people could be at risk for lower confidence, lower self-esteem. Where volunteer programmes operate,
young people who are experiencing negative emotions are likely to drop out and this may have an impact on future engagement (perhaps even as an adult) in similar activities. In school programmes, where youngsters may have no option about attendance, then even more care needs to be taken to avoid negative psychological consequences.

4.0 A PRACTITIONERS GUIDE TO QUALITY RESISTANCE EXERCISE PROGRAMMES

The application of theory to practice is often the most difficult step for practitioners to make. The following section aims to inform practitioners about the overarching principles and general guidelines that form the basis for the delivery of high quality resistance exercise programmes to young people. These principles and guidelines are primarily aimed at teachers, coaches and fitness professionals. In the present climate, the aims of organised sport, health and fitness development and physical education for young people are similar and largely developmental and educational. A well-developed educational approach to health and fitness in the national curriculum has already provided a good source of reference for all professionals working in this area (refer to Harris, 2000 for further detail). Furthermore practical programmes by Kraemer and Fleck (1993) support practitioners who require examples of more specific programmes are also available. These principles and guidelines are therefore equally applicable to professionals working in physical education, health promotion, local authority or commercial sectors. This section is split into three areas. Each area contains information in short, bullet point form for ease of reference.

1. Principles of good practice
2. Guidelines for professional practice
3. Goals of resistance exercise programmes according to developmental stage and outcome.

4.1 Principles of good practice

4.1.1 The positive welfare and health of the young person is the primary outcome of any resistance exercise programme. Performance achievement is of secondary importance

4.1.2 The education of the young person is a fundamental element of any resistance exercise programme. Well-designed programmes that are led effectively produce young people with
greater knowledge and confidence about their bodies and safe and effective resistance exercise. They also encourage young people to have a responsibility and input into their own learning.

4.1.3 The physical development of the young person is a fundamental element of any resistance exercise programme. Quality resistance exercise programmes support natural growth and maturation.

4.1.4 The emotional and cognitive development of the young person is a fundamental element of any resistance exercise programme. Quality programmes are designed appropriately for the developmental stage to improve understanding and encourage enjoyment and fulfilment.

4.1.5 Principles of inclusion and integrity should be adhered to throughout all teaching programmes and activities should be made accessible to all.

4.2 Guidelines for professional practice

This section provides practical advice under 4 sub-headings:- Young people centred approach, instructor/teacher/coach, safety and exercise prescription.

4.2.1 Young people centred approach

• Place young people’s needs at the centre of the experience.
• Involve young people in the design of the resistance exercise area (e.g. playground) or programme and the setting of short and long-term goals.
• Educate young people about the risks and benefits of resistance exercise (The development of muscle and bone health, knowledge of exercise movements, breathing, back care and posture are areas that should be addressed).
• Help young people apply safe resistance exercise practice.
• Consider young people’s attitudes, behaviours and stage of development when designing programmes.

4.2.2 Instructor/coach/teacher

• Hold an up to date and appropriate qualification commensurate with the resistance exercise that you instruct.
• Have appropriate personal and liability insurance.
• Adhere to sound ethical and moral principles.
Include young people and significant others (parents) in the design of resistance exercise programmes.

Promote the development of mastery and self-improvement.

Focus the activity on enjoyment and task completion.

Use competition appropriately. Focus on improvement.

Maintain access to good quality training and resources to support effective teaching and leading of resistance exercise to young people.

Act as a positive role model.

### 4.2.3 Safety

- Adhere to safe and effective exercise guidelines at all times (BAALPE, 1999).
- Facilities and equipment must be designed to suit the level of maturity of the participant.
- Start resistance exercise programmes by teaching safe and correct movements and proper technique. Progressively increase the volume of exercise but adhere to correct and safe principles of training.
- Supervise young people AT ALL TIMES during resistance exercise. The ratio of supervisor to participant will vary depending upon the type of resistance exercise and the level of understanding of the participants. Participation in weight training and weight lifting may require close supervision. The ratio of instructors to participants should adhere to professional guidelines (BAALPE, 1999).
- Include a suitable warm up and cool down in all structured exercise sessions.
- Allow young people to stop or withdraw from resistance exercise at any time without redress. Sharp or persistent pain should be heeded as a warning and medical attention sought.
- Do not include high intensity exercise during periods of rapid growth.
- Teach proper breathing technique during specific resistance exercise movements.
- Encourage resistance training in young people with special needs or medical conditions where appropriate. Seek medical clearance where necessary and closely supervise and monitor participants.

### 4.2.4 Exercise prescription

Exercise prescription follows a continuous cycle of planning, performing, evaluating and adjusting training programmes.
• Ensure that the aims of the resistance exercise programme are appropriate to the developmental stage of the participant.
• Do not impose adult programmes on young people. It is always better to undershoot a young person’s ability.
• The level of participation can increase with adaptation to the resistance exercise and maturity.
• Principles of training must be followed when designing resistance exercise programmes. (For more detail see Kraemer et al., 1989).
• Programmes must be individualised to the meet the needs of the participant. A range of activities should be included in the programmes. Eccentric exercise should generally be avoided.
• Resistance exercise must aim to develop all major muscle groups paying equal attention to flexors and extensors and encourage an appropriate reciprocal balance and joint stability.
• Resistance exercise should be participated in 2 to 3 times a week to accrue strength.
• Exercise programmes should be progressive. A guide is that light loads can be completed for 15-20 repetitions, moderate loads for 10-15 repetitions and heavy loads for 6-10 repetitions. When performing structured resistance exercise the sessions should begin with just single sets and then develop to include up to 3-4 sets.
• The rest time between bouts/sets of resistance exercise will depend upon the purpose. Shorter rest periods may be effective at enhancing cardiorespiratory benefits. A circuit approach should be encouraged to maximise on possible cardiorespiratory benefits.
• Rest and resistance exercise should be alternated where the training stimulus involved considerable overload. Recommend, a 48 hours recovery period after heavier resistance exercise programmes.

4.3 Goals of resistance exercise programmes according to developmental stage and outcome.

Exercise sessions will emphasise different aspects depending on the aims of the programme. Aims of the programme are defined in terms of health or performance and age and stage:- child, adolescent and young adult. Table 4.1 provides general guidance for resistance exercise that has health or sports performance goals. Health goals are inclusive and include all young people. Performance goals are for young elite performers who wish to use resistance exercise to enable them to meet the demands of their sport. Resistance exercise for performance cannot be
developed without a basic understanding of resistance exercise for health. Age considerations are based on the principles and guidelines for quality, resistance exercise programmes.
Table 4.1  
Goals of resistance exercise programmes according to developmental stage and outcome.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Stage</th>
<th>Health</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Child</td>
<td>• The focus is on self-improvement (mastery), not comparison with others.</td>
<td>• Use body weight exercises to develop a good basic level of muscle fitness.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Promote an understanding of the basic principles of safe and effective resistance exercise.</td>
<td>• Children (pre-pubertal) can begin weight training (resistance exercise using weights) BUT emphasise correct technique.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Develop and enhance fundamental movement skills.</td>
<td>• Include exercises of low intensity and high repetition.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Measure progress in terms of individual advances in knowledge, understanding and competence.</td>
<td>• Involve parents/guardians in the design of the exercise programme.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Promote participation in resistance exercise as part of a balanced exercise programme.</td>
<td>• Ensure that all major muscle groups are exercised.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Emphasise activities that exercise the upper and lower body such as use of climbing frames, jumping activities, body-weight.</td>
<td>• Recognise that participation in high intensity exercise during sports or dance training or performance may also be categorised as resistance exercise (such as dance, match play, athletic jumps and throws, gymnastics etc).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Promote understanding of the short-term effects of exercise.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Introduce basic resistance exercise vocabulary</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adolescent</td>
<td>• Develop knowledge of resistance exercise training principles, benefits and risks.</td>
<td>• Carefully balance resistance exercise demands against those required during performance and training.</td>
</tr>
<tr>
<td></td>
<td>Adolescent</td>
<td>• Progress from resistance exercise in sport or dance to specific weight/circuit training.</td>
<td>• Avoid high intensity exercise during phases of rapid growth.</td>
</tr>
<tr>
<td></td>
<td>Adolescent</td>
<td>• Where specific weight training is used, exercises should be of low intensity and high repetition.</td>
<td>• Recognise that high intensity exercise can bring significant improvements in strength and power during this stage.</td>
</tr>
<tr>
<td></td>
<td>Adolescent</td>
<td>• All of the large muscles groups should be exercised.</td>
<td>• Boys may increase in strength and size more so than girls.</td>
</tr>
<tr>
<td></td>
<td>Adolescent</td>
<td>• Recognise that activities such as gymnastics, swimming and other sports and activities also contribute towards sound muscular-skeletal development</td>
<td>• Adolescents involved in more advanced forms of resistance exercise should be involved in the design of their training programme and should be set realistic goals and targets.</td>
</tr>
<tr>
<td></td>
<td>Adolescent</td>
<td>• Promote sound understanding of short and medium term effects of resistance exercise programmes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adolescent</td>
<td>• Develop resistance exercise vocabulary.</td>
<td></td>
</tr>
</tbody>
</table>
### Guidelines for Resistance Exercise in Young People

<table>
<thead>
<tr>
<th>Young Adult</th>
<th>Young adults should be taught body resistance exercises before they perform resistance exercise with external weight.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weight training can be used as a form of resistance exercise, and a variety of gymnasium type exercises may be developed in this context. Programmes should start with lower intensity exercise and a higher number of repetitions.</td>
</tr>
<tr>
<td></td>
<td>Young adults should link exercises to major muscle groups.</td>
</tr>
<tr>
<td></td>
<td>Progress programmes by increasing resistance where appropriate.</td>
</tr>
<tr>
<td></td>
<td>Promote advanced resistance exercise vocabulary.</td>
</tr>
<tr>
<td></td>
<td>Encourage young adults should to design, implement and evaluate their own resistance exercise programmes and recognise the long term benefits to health related outcomes such as bone health and osteoporosis.</td>
</tr>
<tr>
<td></td>
<td>Promote young adults resistance exercise in community settings.</td>
</tr>
</tbody>
</table>

| Young adults can engage in advanced resistance exercise programmes to enhance sport and dance performance. |
| High intensity exercise may be recommended for this group after a base level of resistance exercise competence and physical condition has been attained. |
| Elite young sport and dance performers should be encouraged to: compare and contrast different types of resistance exercise programmes: design, implement and monitor their own training programmes under the guidance of a suitably qualified person. |
| Young adults should recognise cycles and phases of training in relation to sports performance. |
5.0 RESEARCH NEEDS

One of the main problems in completing guidelines for resistance exercise in its broadest sense has been the agreement on a clear definition of resistance exercise. There is also limited data from UK studies in this area. More research is needed to try and quantify the effect of resistance exercise on physical activity, health, performance and well-being. Research questions may best be answered using multi or inter-disciplinary approaches. These questions can be prioritised into three key areas:-

5.1 Effectiveness of resistance exercise

- To evaluate the dose-response interaction of resistance exercise across the maturity stages and in both boys and girls.
- Establish the effects of long-term resistance exercise programmes across the maturity stages in both girls and boys.
- Investigate the sustainability of adaptation to resistance exercise.
- Conduct research into alternative resistance activities such as playground activities, sports and dance.
- The role of resistance exercise as a method of performance enhancement requires more detailed study.

5.2 Interaction between resistance exercise and health

- The effect of resistance exercise on several physiological measures such as blood pressure, lipid profile, body composition, bone health, flexibility, and peak oxygen uptake should be investigated.
- The effect of resistance exercise on psycho-social aspects such as self esteem, motivation and stress issues required quantifying.

5.3 Pedagogy

- How can resistance exercise be best presented to children to promote participation, learning and enjoyment of the activity?
- What pedagogical approaches promote long-term and independent adoption of regular resistance exercise behaviour.
7.0 REFERENCES


Guidelines for Resistance Exercise in Young People


## 8.0 CONTRIBUTOR’S SPECIAL TOPICS

<table>
<thead>
<tr>
<th>Contributor</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor Ken Fox</td>
<td>The effects of resistance exercise on the psychosocial development, mental well-being and exercise motivation in young people.</td>
</tr>
<tr>
<td>Professor Simon Frostick</td>
<td>The role of resistance exercise in relation to skeletal health and selected clinical issues.</td>
</tr>
<tr>
<td>Dr Jo Harris</td>
<td>Educational considerations on the teaching of resistance exercise in young people.</td>
</tr>
<tr>
<td>Dr Michelle Jones</td>
<td>Review of existing resistance exercise guidelines and the contribution to each sub-discipline.</td>
</tr>
<tr>
<td>Dr Martin Lee</td>
<td>Values, ethics and the young person at the centre of the resistance exercise experience.</td>
</tr>
<tr>
<td>Prof Nicola Maffulli</td>
<td>Young people participation in resistance exercise: injury risk, severity and prevention.</td>
</tr>
<tr>
<td>Mr Craig Simmons</td>
<td>A survey of governing body position statements in relation to resistance training in the developing child.</td>
</tr>
<tr>
<td>Dr Gareth Stratton</td>
<td>Physiological aspects of resistance exercise on muscle function and performance across the developmental stages.</td>
</tr>
<tr>
<td>Dr Keith Tolfrey</td>
<td>The association between resistance exercise and cardiovascular risk parameters in children and adolescents.</td>
</tr>
</tbody>
</table>