



**UNIVERSITY OF  
STIRLING**

**THE BENEFITS OF MOUNTAINEERING AND  
MOUNTAINEERING RELATED ACTIVITIES:  
A REVIEW OF LITERATURE**

**A Report to the Mountaineering Council of Scotland**

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# 1 INTRODUCTION

## 1.1 The Context

This report presents the findings of a review of literature aimed at identifying robust evidence on the benefits of mountaineering and mountaineering related activities. It presents a review of the evidence available under the following headings:

- Economic impact
- Physical fitness and health
- Psychological health and well-being
- Social and other benefits

## 1.2 The Research Approach

### Identifying relevant literature

A wide-ranging search was undertaken to identify relevant literature on mountaineering and mountaineering-related activities. A broad definition of 'mountaineering activities' was adopted, with the search for literature including the following activities: mountaineering, ski mountaineering, hill-walking, rock climbing, indoor climbing, sport climbing, ice climbing, bouldering, trekking, hiking, alpine/alpinism.

The approach included a search of the University of Stirling's extensive on-line library catalogue, which provides access to an extensive range of databases and hundreds of academic journals. In addition, a search of relevant websites was made. The bibliographies of reports and articles were also reviewed as a means of identifying relevant literature.

Also contact was made with representatives from a number of relevant UK-based organisations in order to identify literature which may not be identified in the various databases. Full technical details of the search are included in Appendix 1.

### Literature Identified: Limitations

The research identified a substantial amount of literature, although much of it was not directly relevant to the concerns of the study. Much of the literature containing 'mountaineering' in the title was concerned with undertaking activities (e.g. mountaineering/walking/climbing manuals or guides; route guides and maps; biographies of mountaineers/climbers; accounts of mountaineering/climbing expeditions) rather than evidence on the *benefits* of mountaineering activities.

Further, although a range of search terms was used, not all the evidence associated with outdoor mountain activities was directly related to mountaineering activities. For example, much of the literature on economic impact included the benefits of 'countryside activities' and 'tourism activities', which would have encompassed some of the mountaineering activities listed above. Where considered appropriate, the

findings of these findings have been included with appropriate caveats included. However, much of the data, are historical.

The report also considers the impact of mountaineering activities on the physical and psychological health/well-being of participants. Again, because of the limitations of existing data, we have drawn on wider literature about *physical activity* and mental and physical health. Although the literature highlights some positive health benefits to participants, the strenuous nature of the activities and the associated risks can lead to some negative health outcomes of engaging in mountaineering activities. These negative impacts are referred to where considered appropriate.

### **1.3 The Popularity of Mountaineering and Mountaineering Activities**

Although Sharp (2007) described mountaineering as a “highly popular” activity, obtaining robust measures of participation is difficult due to the nature of the activities and the absence of any formal registration. Despite this, it is evident that it is a popular activity and a substantial numbers of people in the United Kingdom take part in mountaineering activities.

#### **Scotland**

- Annual sports participation data show that between 1994-2006, around five per cent of the Scottish adult population took part in hill-walking/climbing/mountaineering during the busiest month of the year, although participation dropped to four per cent in 2007 (**sportscotland**, 2008a). For children, participation has fluctuated between 2-5% since 1998 (although such fluctuations may reflect the small numbers involved).
- Davidson (1994, cited in Sharp, 2007) estimated that there were between one million and five million mountaineering participation days in Scotland each year.

#### **England**

- According to the *Active People Survey* (England), mountaineering has become the tenth fastest growing sport. The *Active People Survey 2* found that participation in mountaineering has grown from 67,300 adults (0.17%) in 2005/06 to 86,200 adults (0.21%) in 2007/08. In this survey participation is defined as the percentage of the adult population in England who have taken part in the sport at least once in the last week. The increase in participation is 0.04%, which is a statistically significant increase (<http://www.thebmc.co.uk>). In the *Active People Survey*, ‘mountaineering’ includes the following: rock climbing, indoor climbing, solo climbing, sport climbing, mountaineering, mountaineering high altitude and hill trekking.

## United Kingdom

- Membership of the British Mountaineering Council (BMC) in 2008 was 64,000 and had increased steadily for the previous ten years, although this is beginning to plateau (BMC, 2008).
- There are approximately 300 climbing and mountaineering clubs (including student clubs) affiliated to the British Mountaineering Council (<http://www.thebmc.co.uk>).
- There are over 300 public access indoor climbing walls in the UK with approximately 5 million users annually (<http://www.thebmc.co.uk>).
- There has also been a growth in the number of females taking part in activities recognised by the BMC - “the proportion of women has increased from 16% to 25% from 2002 to 2006”, with a number of clubs and courses specifically supporting women in the sport (<http://www.thebmc.co.uk>).

Although hill-walking/climbing/mountaineering are minority activities (only the eighth most popular sport among adults in Scotland, and the twenty-fifth most popular among children) it reaches a substantial number of the UK population. This makes mountaineering worthy of an investigation into its impact on economic, health and social matters.

## 2 ECONOMIC IMPACT

### 2.1 Economic Impact and Expenditure Estimates

The national economic impact of sport is assessed every three years or so by **sportscotland** (2007), but there are no data on mountaineering's contribution to that total. Although there are a number of estimates of the economic contribution made by recreational activities undertaken in the natural environment, it is often difficult to identify the specific contribution of *mountaineering and hill-walking*. A further limitation is the difficulty of distinguishing between the impact of visitors to the area and residents within that area (a vital distinction in terms of economic impact). Further, the various estimates often relate to different mixtures of activities and use different definitions and approaches to measurement.

National estimates in respect of Scotland include:

- Walking and cycling contribute £438m of tourism expenditure (Scottish Environment Link, 2001), approximately 10 per cent of total expenditure on tourism-related activities in Scotland (Scottish Parliament, 2002).
- More than £500m is generated by tourists whose main activity relates to the 'natural environment' (Grombach, 2002). This includes £200m by walkers.
- Outdoor recreation, such as hiking, watersports, field nature study and mountaineering, generates at least £600-£800m of Scotland's tourist income, much of which is in rural areas and extends beyond the traditional tourist seasons (Higgins, 2000).
- Scottish Natural Heritage (SNH) estimate that tourists participating in hiking and walking (*excluding* mountaineering and related activities) generated an expenditure of £257m in 1998 in Scotland (15% of total tourism turnover), supporting about 9,400 (fte) jobs and that hill-walking/mountaineering generates £104m and supports 3,950 (fte) jobs in the Highlands and Islands (Price et al, 2002; SNH, 1998)<sup>1</sup>.

At a local and/or trail level:

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<sup>1</sup> Extreme care needs to be taken with the interpretation of employment-effect figures included in economic impact studies. Ordinarily what is reported is the level of expenditure in a particular geographical area. This can be interpreted as the number of jobs and level of annual income to residents and businesses in that area supported by this level of expenditure. Marginal analysis can be carried out to estimate the opportunities for *new* employment, but this depends on issues specific to a particular area, e.g. existing levels of unemployment; spare capacity in local businesses such as hotels and their ability to absorb visitors without additional staff.

- A 1998 report on the economic impact of the use of West Highland Way [a long distance footpath and hence outwith the definition of mountaineering] found that approximately 50,000 people use the route annually, bringing £3.5m into the economy and supporting 120 FTE jobs. Twenty five percent of visitors were from overseas (SNH, 1998). A study of the Pembrokeshire Coastal Path in 1998 (Midmore, 2000) claimed that short distance walkers on that path generated a total expenditure of £11.02m in a twelve-month period.
- Taylor and McGregor (1999) found that, between September 1997 and August 1998, there were 123,000 visitor days in the Cairngorms, spending £2.2m.
- A Ross and Cromarty survey estimated that hill-walkers spent between £2.8m and £4.5m in 1995 (Higgins, 2000).

Highlands and Islands Enterprise (HIE) (1996) assessed the economic impact of mountaineering-related activity in its area and in the larger topographical highlands (TOP), where a significant proportion of hill-walking takes place:

- Approximately 767,000 mountaineers visited the TOP in the previous year, equivalent to 1.7 per cent of the GB population (HIE area: 506,000; 1.1% of GB population), with individuals spending an average of 11 days in the area.
- Mountaineering-related expenditure in the TOP was approximately £157.9m (HIE area: £104.1m); generating an income of £53m in the TOP area and £34m in the HIE area; supporting approximately 6,100 FTE jobs in the TOP area and 3,950 in the HIE area.

More recent figures can be inferred from work by George Street Research and Jones Economics (GSRJE) (2003/04) which assessed the economic impacts of walking and mountaineering activities across the HIE area:

- Expenditure attributable to walking and mountaineering in 2002/03 was £245.7m. This generated £49.6m of direct income, supporting 4,466 jobs.
- An omnibus survey of 4,000 UK households carried out by GSRJE estimated a participation rate for the UK population of 2.9 per cent for walking and mountaineering activities in the HIE area. Applied to 2003 population projections it estimated that 1.3m residents made trips to the HIE area during 2002 to walk and mountaineer.
- In 2002/03, 5.2m trips were made by UK residents to the HIE area to participate in walking and mountaineering activities- equivalent to 15.3m days spent in the area.
- According to the GSRJE omnibus survey, 3 per cent of the interviewees had been involved in some walking or mountaineering activity in the area in the last 12 months (December 2001-November 2002). This can be broken down as follows:
  - 2 per cent undertaking low level walks/rambles of 2-8 miles.

- 1 per cent undertaking low level walks of 8 or more miles.
  - 1 per cent participating in hill-walking involving ascents of hills higher than 2,500ft.
  - 0.2 per cent participating in mountaineering/rock climbing and only 0.02 per cent in ski mountaineering.
- GSRJE estimated that 6 per cent of walkers and mountaineers were Highlands and Islands' residents. Other areas of residence were: Other Scotland: 36%; other GB: 40%; outside GB: 17%.
  - The total annual spend by UK visitors in the HIE area during 2002/2003 on walking and mountaineering trips was £339m.
  - Expenditure wholly attributable to these activities (allowing for displacement and additionality) was £245.7m<sup>2</sup>.
  - Hill-walkers spent more per day (£44) than those taking low level walks (£38-£42).
  - The GSRJE report refers to a 'general consensus' that the mountaineering market is now stable. Further, several suppliers pointed to limits to growth such as: an ageing population; reductions in numbers progressing from low level walks to hill-walking and from there to rock and ice climbing.

In a review of the benefits and opportunities attributed to Scotland's landscapes of wild character, McMorran et al. (2006) estimated that hill-walking and mountaineering accounted for 600,000 visitors to the HIE area in 2003, equivalent to an 18.6 per cent increase on estimates in the HIE 1996 study. They also concluded that mountaineering-related expenditure was estimated at £198.8m in the HIE area.

### **Extending the Tourist Season**

SNH (1998) estimated that just over three-quarters of hill-walker / mountaineer visitor days in the Highlands and Islands take place in October to June, compared with just over half of all visitor days in the area. Therefore such activities help to maintain year-round tourism and reduce the seasonal nature of the more traditional forms of tourist employment.

### **Costs of Mountaineering**

There is also a variety of economic *costs* associated with the recreational and/or educational use of the outdoors (e.g. footpath repair) and which should be considered alongside the benefits (Higgins, 2000).

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<sup>2</sup> These figures take account of *Additionality*: the extent to which such activities caused the expenditure in the HIE area to occur and *Displacement*: extent to which walking and mountaineering-related expenditure in the HIE area would have been spent in the HIE area if it had not been spent on these activities.



Increases in the number of mountaineers since 1945 (Hanley and Wright, 2003) resulted in opportunity, or non-economic, costs e.g. environmental damage to the hills, reduced utility for visitors arising from congestion. Studies have looked at intervention (e.g. car parking charges, 'long walk in' policy), designed to increase the time price of access to reduce demand.

## **2.2 Economic Impact Studies/Population Estimates for Other Countries**

### **United Kingdom**

The official UK Tourism Survey 2000 indicated that climbing and mountaineering 'activity holidays' generated £81.7m and walking 'activity holidays' generated £897.1m per annum (BMC, 2003).

### **England**

Christie and Matthews (2003) estimated that over 527m trips are made annually to the English countryside, generating expenditure of approximately £6.14bn. The income generated from this expenditure is estimated to be between £1.473bn and £2.763bn, equivalent to between 180,559 and 245,560 full-time jobs. They also estimate that overseas visitors undertake just over one million walking trips annually in the English countryside and spend a total of £255m. Based on this they estimate that income benefits from overseas tourist walking in the UK for 2003 was between £85m and £160m, equivalent to between 10,441 and 14,200 jobs.

### **Wales**

Using the same approach as SNH (1998), Midmore (2000) estimated that walking-related expenditure in Wales was £132m, equivalent to 4,800 jobs. Focusing on rural impacts alone, it was estimated that walking generated incomes of £55m, equivalent to 3,000 jobs. Including mountaineering generates a further £22m, equivalent to 1,250 jobs. According to Midmore this represents two per cent of rural GDP and about one per cent of rural jobs.

Newidiem (2004) estimated that the adventure tourism industry contributes over £140m per annum to the North West Wales economy, £60m of which is contributed to the economy within the Snowdonia National Park area. It is estimated that this directly supports 6,703 jobs in North West Wales, less than 40 per cent of which is full time employment. The report also noted that high and low level walking remain the most important activity attractions that influence businesses operating within adventure tourism.

### **Ireland**

Fáilte Ireland data indicate that overseas visitors who walked in Ireland in 2003 spent an average of €673 (Fitzpatrick Associates, 2005). A study on the economic value of trails and forest recreation found that overseas walking visitors were expected to

spend €878 during their visit in 2005. Fáilte Ireland estimated that about 260,000 overseas tourists took part in hiking/hill-walking in 2004; total expenditure by these visitors was just under €138m (Fitzpatrick Associates, 2005).

## Sweden

Heberlein et al (2002) found that 43 per cent of the Swedish adult population (2.66m) visited the mountains at least once during a five year period (1995-1999). Only 5 per cent of visitors to the Swedish mountains are from outside Scandinavia and 85 per cent of those who visited the Swedish mountain region did so primarily for recreation or vacation. Over 80 per cent of the winter visits involved downhill skiing and nearly 20 per cent of the summer visitors undertake overnight backpacking.

## United States

According to a report by the Outdoor Industry Foundation (2006), 56 million American citizens participated in trail-based activities (defined as trail running on an unpaved trail, day hiking on an unpaved trail, backpacking, rock climbing and ice climbing). Expenditure by these citizens is estimated to support 716,000 jobs and generated federal and state taxes of \$11.2 billion.

## Other

A number of studies estimate the economic value of different outdoor activities in different countries using approaches such as the travel cost method: for example, rock climbing in Scotland (Hanley and Wright, 2003), rock climbing in the North Eastern Alps (Scarpa and Thiene, 2005), ice climbing in Montana (Andersen, 2010); and mountain biking in Utah (Chakraborty and Keith, 2000; Fix and Loomis, 1998). The majority of these papers provide estimates of the value per trip for the particular activity: for example, per person trip values in respect of ice climbing in the Hyalite Canyon in Montana are estimated to be in the range \$76 to \$135 (Andersen, 2010).

## 2.3 Conclusions

- Specialist research evidence on the economic impact of mountaineering is limited.
- The evidence which does exist for Scotland and elsewhere on levels of participation in hill-walking and mountaineering, plus broader classifications such as outdoor activities, plus participant expenditure, points to pursuits which are economically important.
- This can be interpreted as *supporting* notable levels of employment in rural economies.

## **3 PHYSICAL ACTIVITY AND HEALTH**

### **3.1 Introduction**

There is extensive evidence that regular moderate-to-vigorous physical activity (MVPA) can improve physical health by reducing risk factors for disease (Coalter, 2009a). It can have a positive impact on cardiovascular (CHD), musculoskeletal, metabolic, endocrine and immune systems and has been shown to be effective in the prevention of several chronic diseases such as diabetes, cancers, hypertension and osteoporosis.

Both moderate and vigorous levels of activity can contribute to health, although *vigorous activity* is recommended for maximum cardiovascular protection and *moderate level activity* for general health benefits (Department of Health, 2004). Exercise at a vigorous level reduces the incidence of CHD, and 30 minutes of vigorous activity per day can provide the same level of risk protection from colon cancer as 60 minutes of vigorous activity (Cerin et al, 2005, cited in British Heart Foundation, nd).

Despite the evidence of a positive correlation between physical activity and positive health, evidence about the benefits of *sports activity* to health is generally lacking. In particular there is little evidence about the direct impact on health of mountaineering and related activities. Research on walking has focussed mostly on daily walking as part of an active lifestyle, rather than the impact of hill and mountain walking.

People who participate frequently in sports activity report significantly higher levels of general health than non-participants (Farrell and Shields, undated), with the average daily duration of participation positively related to health. Although current research does not provide a precise understanding of *how much* activity is needed for *what* health benefits (Rankinen and Bouchard, 2002), the Department of Health (2004) recommends 30 minutes of moderate level activity most days of the week for adults and 60 minutes for children (moderate level activity being the equivalent of brisk walking).

This section will review evidence on the following:

- The benefits of walking to physical health;
- The impact of mountain walking on physical health;
- The impact of rock climbing activities on physical health.

### **3.2 Benefits of Walking to Physical Health**

The Department of Health (2004) advocates the inclusion of walking as part of a physically active lifestyle. It suggests that daily walking (to school and work) and longer walks can be incorporated into the lives of children and adults for the purposes of improving and maintaining good physical health.

In a review of 24 randomised control trials on the impact of daily walking where the average duration of walking was less than 40 minutes, Murphy et al (2007) conclude that walking can:

- Reduce risk factors for cardiovascular diseases;
- Increase VO<sub>2</sub> max;
- Decrease body weight;
- Reduce BMI and percentage body fat; and
- Lower resting blood pressure.

However, none of these trials included mountain-walking activities, which are often characterised by long walks in multi-terrains.

Hakim et al (1999) found that distance was related to the reduction of the risk of a coronary event, with an increase of 0.5 miles per day reducing the likelihood of a coronary event. For those walking less than 0.25 miles per day the incidence of a coronary event was 5.1 per cent, compared to 4.5 per cent for those walking 0.25-1.5 miles, and 2.5 per cent for those that walked more than 1.5 miles. However, the European Heart Network (1999: 22) suggests that *frequency* of participation in physical activity is more important than the intensity:

“In order to maintain these benefits the activity has to be repeated frequently, i.e. daily: one long walk during the weekend does not confer all the health benefits that are gained by shorter daily walks.”

Although long walks may not confer all the benefits of regular activity, they are likely to have some positive health benefits.

### **Walking and Energy Expenditure**

The above research relates to daily walking undertaken at ‘moderate’ levels of intensity. According to the American Heart Association ([www.heart.org](http://www.heart.org)), moderate activity for walking is associated with walking at a brisk pace of 3 - 4.5 miles per hour on a level surface, or the equivalent to 3.0 - 6.0 METs (3.5 to 7kcal/min). MET (or Metabolic Equivalent) refers to a measure a person’s metabolic rate, with one MET being the energy expenditure of a person at rest. If someone is exercising at a rate of 3 METs they are working at a level three times their resting level. Activity performed above 6.0 METs (more than 7 kcal/min) is classed as ‘vigorous’ activity.

### **Negative Impacts of Sports Participation**

While sports participation can lead to injury and have a negative impact on the musculoskeletal system, the evidence on daily walking and health is almost all positive. While there is the possibility of injury through daily walking, the incidence of injury is very low. A study in the USA found that only one per cent of those who walked regularly for exercise had reported a walking-related injury in the previous 30 days (Department of Health, 2004). Although there is an increased risk in extended participation in some types of sport/activity, the Department of Health reports that there moderate activity such as walking lowers the risk of osteoarthritis (Department of Health, 2004).

### **3.3 The Impact of Mountain Walking on Physical Health**

#### **Physical Demands of Mountain Walking**

The above evidence is associated with daily walking activity undertaken on level ground usually for short distances. However, mountaineering or other mountain walking activities are characterised by longer walks in multi-terrain environments. Based on walking activities in the Alps, Burtscher (2004) concluded that uphill walking demands a higher workload and greater aerobic performance than walking on level paths.

While moderate walking is the equivalent to 3.0 - 6.0 METs (3.5 to 7kcal/min), the American Heart Association indicates that activities such as walking and climbing briskly up a hill, backpacking, mountain climbing, rock climbing and cross-country skiing, are 'vigorous' activities that demand energy expenditure of more than 6 METs. The MET value of 'backpacking' is 7.0 ([www.brianmac.co.uk/mets.htm](http://www.brianmac.co.uk/mets.htm)), although this is lower than football (8 METS) or running (12.5 METS for 8 minute miles at or 8.5 METs for 12 minute miles).

This suggests that, while mountaineering is a walking activity, at certain levels it can be considered as a 'vigorous' form of activity. Consequently, the findings of positive relations between moderate and vigorous activity and health can be attributed to mountain walking.

A number of factors influence the energy demands of mountain walking. Burtscher (2004) found that age, altitude, additional weight and the quality of the path affect the physical demands of walking. Climbing 300 metres per hour at an altitude of 1,500m on a gradient to 15 per cent is equal to an oxygen uptake of 18ml/min/kg – this increases as the altitude increases. Even at 1,500 metres (and at lower levels), uphill walking demands a high endurance capacity. Burtscher (2004) suggests that those intending to mountain walk need to evaluate their physical abilities and that prior training may be necessary. Although age is a factor in determining physical capacity, "endurance can be trained, even in old age" (Burtscher, 2004: 49).

There is little evidence of the health benefits of mountaineering activities. A number of studies identified that weight loss was an outcome of prolonged walking (Ainslie, et al 2005; Baker, 1980), but most of the studies on mountaineering activities are concerned with the potential negative physiological impacts of mountain walking or the physiological impacts of mountaineering in extreme environments (e.g. cold, altitude).

### *Weight Loss*

Longer walks and mountain walking can contribute to the reduction and maintenance of body weight, which can make a positive contribution to physical health. A study by Ainslie et al (2005) of prolonged activity by recreational hill-walkers over one day and consecutive days assessed the physiological impacts on the walkers. Ainslie et al (2005: 41) suggested that “hill-walking represents a relatively unique form of activity in which the prolonged duration and varying intensities place exceptional demands on the recreational participants”. Consequently, taking part in prolonged hill-walking can lead to a large deficit in energy balance (energy expenditure for exceeds energy consumed during the activity). Furthermore, it has “the potential to impose severe stress simultaneously upon several regulatory systems” and that in certain circumstances cooling of the body after prolonged exercise can lead to such conditions as hypothermia. Despite these possible problems, Ainslie et al (2005) suggested that these can be avoided by appropriate energy consumption and hydration before and during exercise and that appropriate clothing can prevent hypothermia. Although Ainslie et al (2005: 642) highlight these risks, they conclude that at a recreational level hill-walking can be considered “as an ideal adjunct for weight loss and/or health related programme”.

Weight loss is also an inevitable outcome of mountaineering at more extreme levels. Baker (1980) found that mountaineering reduced absolute body fat and lean body mass in a cohort of generally fit outdoor education students on a four week expedition in the Alps.

### *Risk of Injury*

Research illustrates the risks of excessive uphill and downhill walking, as well as traversing a hill (Ainslie et al, 2005, Strauss, 2004). Such activity can cause stress on the Achilles tendon and ankle joint (Ainslie et al, 2005), particularly while descending, or lesions on the heel (Strauss, 2004). Stiff-soled walking boots/shoes were found to be a cause of stress on the tendons and skin, and the prolonged nature of mountaineering activities can exacerbate problems.

Some literature also highlights a range of injuries that can occur to mountaineers as a result of trips or falls. A review of injuries experienced by fell walkers over a three year period in Cumbria (Goel and Addison, 1992) included fractures, head injuries abdominal injuries.

However, steps can be taken to minimise these injuries. Tests on walking-poles suggest that they can increase the maintenance of static balance and lateral stability, relieving the strain on lower extremity joints and improve efficiency in walking (Jacobson et al, 2000), although not all studies have found these benefits (Duckham et al, 2009). Also, tape dressings can be used to stop or minimise blistering of skin (Strauss, 2004).

### *Risk of Cardiac Arrest*

As was highlighted earlier, mountaineering can make substantial physical demands on the body, particularly because activity is extended over a prolonged period of time.

These demands can place physical and emotional demands on individuals that can increase the risk of sudden death through cardiac arrest, although Noakes (1998, no page numbers) is clear to highlight that “persons who die suddenly during exercise have advanced heart disease of which they are frequently unaware”. An Austrian study found that the risk of cardiac death for male mountain walkers aged over 34 years is increased by a factor of 4.3, compared to the overall risk of sudden cardiac death (Burtscher et al, 1993). It was estimated that there was one cardiac death per five million hours of hiking. This compares to one fatality for every one million hours exercise among recreational runners (Sudden Death in Athletes, <http://www.rice.edu/~jenky/sports/sudden.death.html>).

For skiers the risk was slightly less, but increased by a factor of 2.1 compared to the overall risk of sudden cardiac death. The risk for women was found to be much lower than for men. The causes of sudden cardiac death on mountains were thought to be a result of the effects of altitude (most deaths occurred between 1,100m-2,100m), along with physical exertion. It should be noted however that only 49 mountains in Scotland exceed 1,100m (3,608ft) and none exceed 1,344m (4,409ft) ([www.munromagic.com](http://www.munromagic.com)), therefore the impact of altitude may not be as great a risk factor for sudden cardiac death on the mountains in Scotland, or the rest of the UK.

While exercise increases the risk of sudden death during exercise for those with heart disease, taking part in regular exercise reduces the incidence of coronary heart diseases and reduces the overall risk of sudden death (Noakes, 1998).

### **3.4 The Impact of Rock Climbing Activities on Physical Health**

The search for mountaineering-related activities resulted in the identification of literature focusing on the impact of ‘climbing’. This literature was associated with both indoor and outdoor climbing disciplines, although the academic literature was limited in terms of the benefits of climbing to physical health, with several authors indicating that more research on climbing is needed (Mermier et al, 1997; Morrison and Schoffl, 2007).

Much of the research on the physical impact of climbing is about elite level or committed rock climbers and much of this highlights the negative impact of climbing. Literature reporting on the impact on recreational climbers was less prevalent.

#### **Benefits of Rock Climbing**

Tiessen (2006) indicates that rock climbing impacts on four of the five components of physical fitness:

- Muscular strength
- Muscular endurance
- Body composition
- Flexibility



Mermier et al (1997) examined the energy expenditure of indoor rock climbers and concluded that climbing demands *moderate levels of activity*. Furthermore, in a study of elite sport rock climbers, Booth et al (1999: 18) concluded that “the current belief that aerobic fitness is not a requirement for climbing may be inaccurate”. Consequently, Mermier et al (1997) suggested that rock climbing is a good activity for increasing cardiorespiratory fitness and muscular endurance.

Balas et al (2009) assessed the impact of an eight-week climbing programme on body strength and body composition in a group of boys and girls. The findings showed that the higher the height climbed the more positively influenced were grip strength, upper body muscular endurance and relative body cellular mass. Lirgg et al (2006) also showed that grip strength in fourth grade boys and girls increased following involvement in a four month indoor climbing programme in which they participated two to three times per week. Other studies emphasise the need to take care to avoid injuries, particularly overuse injuries (Morrison and Schoffl, 2007).

### *Risk factors*

Although there is some evidence that taking part in climbing can make a positive contribution to physical fitness and health, climbers who participate regularly, or to a high level, are susceptible to overuse injuries. For example, climbers may experience tendonitis, carpal tunnel syndrome and stress fractures as a result of taking part in indoor climbing (Backe et al, 2009). Backe et al (2009) found that there were 4.2 injuries per 1,000 climbing hours, 93 per cent of which were related to overuse injuries, with individuals showing higher body mass index scores at greater risk of injury.

More specifically, climbing has been identified as a risk factor in the development of Dupuytren’s disease, also known as Dupuytren’s contracture. This condition causes thickening of tissues in the palm of the hand, which can lead to one or more fingers contracting (bending) and preventing the fingers from straightening. Although the cause of the disease is not known ([www.patient.co.uk](http://www.patient.co.uk)), a study of rock climbers supports the hypothesis that repetitive strain to the palmar fascia is a major factor in the cause of the disease (Logan et al, 2005).

In a survey of 1,100 UK climbers, Logan et al (2005: 643) conclude that “there is a higher prevalence of Dupuytren’s disease in committed male rock climbers than in the general population” and that “climbers develop the disease at an earlier age and the disease is more severe”.

Feet are also under considerable stress during climbing, which can be caused by wearing tight climbing shoes. Dengler and Gajdosik (2002: A-55) conclude that “rock climbers are at risk of pain and loss of ROM [range of motion] in the MPJ [metatarsalphalangeal joints] of the hallux [big toe]” and that the injuries could have life-long effects. Morrison and Schoffl’s (2007) review of studies identified that the majority of foot injuries are associated with wearing climbing shoes which are unnaturally shaped or too small. They conclude it is not recommended that young climbers whose feet are still growing wear excessively restricted climbing shoes, otherwise they are at risk of limiting the full growth potential of their feet and may experience localised bouts of acute or chronic pain, injury or permanent deformity.

Despite some concerns about the negative physical impact of climbing, adapted indoor rock climbing can be used as a complementary therapy programme for children with cerebral palsy, although further research is needed to better understand functional gains and quality of life (Cheng, et al, 2004).

### **3.5 Conclusions**

The specialist research evidence on the direct benefits of mountaineering and rock climbing to physical health is limited. However, based on the known benefits of physical activity and the type of activity involved in mountaineering and climbing, it is likely that mountaineering and climbing can make a positive contribution to physical health. Through the demands of the activity, mountain walking and climbing can have an impact on cardiovascular, musculoskeletal, metabolic, endocrine and immune systems.

Much of the research on mountaineering and rock climbing highlights the potential negative physiological impact of the activities. However, research also demonstrates that it is possible to minimise potential problems through adequate nutrition and hydration, and appropriate fitting and use of equipment. All physical activities have some degree of risk, but the European Heart Network (1999: 24) suggests that “the potential risks of physical activity are far outweighed by its benefits”, although it urges those considering taking up more intense types of activity to consider the risks. Those considering engaging in physically and emotionally demanding forms of activity (including mountaineering and climbing), should seek medical advice, particularly those with “symptoms or clinical signs of, or risk factors for coronary or other forms of heart disease” (Noakes, 1998).

## **4 MENTAL HEALTH AND PSYCHOLOGICAL WELL-BEING**

### **4.1 Introduction**

As with research on physical health, research in this area tends to concentrate on the impact of *physical activity* in general, rather than on specific activities such as mountaineering/hill-walking. In terms of general physical activity, the Chief Medical Officer (2004) emphasises the clear psychological benefit:

- It can improve mood and reduce short-term ‘state’ anxiety or long-term ‘trait’ anxiety (people regularly experience anxiety in anticipation of threatening situations, similar to neuroticism). It can also help people to feel better through improved physical self-perceptions and can improve self-esteem, particularly in those with initial low self-esteem.
- It is effective in the treatment of clinical depression and can be as successful as psychotherapy or medication, particularly in the longer term.
- It may also help people with generalised anxiety disorder, phobias, panic attacks and stress disorders, and can have a positive effect on psychological well-being in those with schizophrenia.

### **4.2 The Psychological Benefits of Hill-walking: An Overview**

Although no studies focus directly on this issue, a number of studies in related areas suggest that hill-walking could have a positive impact on mental health. Research indicates that the component elements of hill-walking – physical activity, outdoor activity, pursuing a sporting ‘challenge’ – can have a positive impact on psychological well-being.

As a *physical activity*, hill-walking might offer the range of psychological benefits. For example, in their review of relevant literature, Biddle and Mutrie (2001: 253) write: “the potential psychological benefits range from increasing a person’s sense of confidence, control and self-esteem, improving mood, increasing social opportunities, improving cognitive function and improving quality of life”.

As an *outdoor activity*, hill-walking is likely to offer some of the benefits identified in studies of people participating in outdoor exercise. On the basis of a review of literature and primary data collection, Barton et al (2009: 275) conclude that:

“access to the countryside and urban greenspaces for fresh air, leisure, exercise, getting away from everyday stresses and reconnecting with the natural world, all positively impact on physical and mental health... the primary reward is enhanced emotional well-being through exposure to nature and participation in exercise”.

Finally, a small number of studies suggest that confidence and self-esteem can be enhanced through the feelings of successfully completing a task or challenge, and stress can be reduced by the experience of escape, or immersing one's self in an activity (Fredrickson and Anderson, 1999).

### **4.3 Physical Activity and Mental Health**

The area of mental health includes a variety of conditions: depression and anxiety, stress, mood, self esteem, body image, and social integration.

- Scully et al (1998: 111) note that there is a common view among GPs, media and academics that “the psychosocial benefits of physical exercise may equal if not surpass the psychological benefits”.
- A number of reviews of the research-based literature point to the positive relationship of physical activity and mental health:
- Coalter's (2009b) review of the literature highlights that studies have shown that exercise can be effective in improving mental well being. For example, Fox (1999) claims that research shows that exercise can be effective in improving mental well-being via improved mood and physical self-perception and that exercise can help to treat clinical depression and anxiety. In a 12 month longitudinal study DiLorenzo et al (1999) found that increases in aerobic fitness have both short- and long-term beneficial effects on psychological outcomes.
- Biddle and Mutrie's (2001) extensive literature review focuses on studies which are based on the collection of primary data and the use of systematic methodologies. They found that participation in exercise and physical activity is consistently associated with positive affect and mood, improvements in self-esteem, reductions in anxiety, and reductions in depression.

Most likely beneficiaries of physical activity:

- Those most likely to benefit from exercise are those already receiving psychological care or have mental health problems (Scully et al 1998; Fox, 1999; North et al 1998). Fox (1999) concludes that general improvements in self-perception/self-esteem are most likely to occur in those who have most to gain physically from exercise and the greatest improvements are most likely in those with low self-esteem, physical self-worth and body image.

Non-clinical populations

- Coalter (2009b) emphasises that, while symptoms of depression can be reduced in the short term among non-clinical populations (Lawlor and Hopker 2001), the most likely beneficiaries are those with low self esteem, physical self worth and body image (Fox 2000). This is supported by Biddle and Mutrie (2001) whose findings on non-clinical groups are less marked than

those for those defined as clinically depressed or having other mental illnesses. Indeed they suggest that exercise ‘is associated with a moderate reduction in non-clinical depression’ (2001: 201).

- Pretty et al (2005) show that non-clinical populations in a range of outdoor activities can benefit from positive mental health changes.
- A large scale longitudinal study of people aged over 65 (Morgan and Bath, 1998) found evidence that physical activity contributes independently to the promotion and maintenance of psychological well-being in later life. However they also stated that the contribution is ‘extremely modest’.

### **Types of Exercise**

- Biddle and Mutrie (2001) show that research suggests moderate, rather than intense, activities are more likely to improve psychological well-being. For instance, Hardy and Rejeski (1989) report more negative moods after higher intensity exercise, and experimental trials “show that moderate, but not high intensity exercise, has mood enhancing effects” (Biddle and Mutrie, 2001: 175).
- Scully et al (1998) speculate that the activities most likely to help reduce depression are aerobic exercises such as walking, jogging, cycling, light circuit training, and weight training. They also note that exercise is more likely to be effective if it extends over several months.
- Nicoloff and Schwenk (1995) provide recommendations based on the American College of Sports Medicine guidelines: aerobic exercise conducted at 60-70% of maximal heart rate, for 30-40 minutes, 2-5 times a week.
- Most studies have focused on physical activities different from those associated with hill-walking and mountaineering. Nonetheless, some studies would suggest that as a sociable activity, chosen by the participant, done regularly and in combination with other exercise, hill-walking might contribute towards improved psychological health.

### **Outdoor Activities**

There are numerous descriptive accounts that promote the notion of hill-walking’s contribution to psychological well-being; the idea that escape from urban life into peaceful rural settings reduces stress and brings pleasure in communing with nature.

- Barton and Pretty (2010) show that as little as 5 minutes of outdoor exercise can improve self-esteem and mood. Their analysis of a number of studies concludes that the groups who benefited most were those with pre-existing mental health problems; younger people gained most in terms of improved self-esteem; and middle-aged people in terms of mood. The authors suggest that “a regime of doses of nature may be prescribed for anyone, but will have a greater effect for the inactive or stressed and mentally ill” (Barton and Pretty, 2010: 5).

- Pretty et al (2005) report that a range of ‘green exercise’ activities show a significant improvement in self-esteem. Of the ten types of exercise initiatives studied, four included walking, though none could be classified as hill-walking. They found positive changes in participants’ mood, including anger-hostility, confusion-bewilderment, depression-dejection, fatigue-inertia and tension-anxiety.
- Kuo and Taylor (2004: 9) found that outdoor activities benefited those between five and 18 years of age who suffered from Attention-Deficit/Hyperactivity Disorder (ADHD). The activities included guided 20 minutes walk for the first part and any form of non-intensive outdoor physical activity in the second part. They argue that “the green advantage... reflects a systematic phenomenon that is objectively measurable and not easily attributable to activity characteristics”.
- Fredrickson and Anderson (1999) examined 12 women’s experiences of exploring wilderness places in the USA. They point to the positive aspects of such experiences and “the potential for physical and emotional growth” and “the opportunity to grow spiritually” (1999: 38). However, it is not clear what mechanisms are involved e.g. are they related to the social aspects of a small group in a new, inspiring location, or to physical activity? It is also unclear what sorts of psychological benefits are being referred to. However, some of their findings reflect the theory of ‘peak’ or ‘flow’ experiences, in which participants lose a sense of self and become immersed in a particular moment. The respondents reported feeling “heightened sensory awareness” and “a momentary loss of the passage of time” (1999: 36). While such emotional responses have been reported by hill-walkers and may contribute to psychological health, more research is required to understand these processes, or their longer lasting effects.
- Barton et al (2009) cite a range of research studies supporting the notion that the experience of being outdoors, combined with moderate activities such as walking, have a positive impact on psychological health. However, they claim that few studies directly assess ‘green exercise activities’ using objective and standardised instruments. They evaluated changes in self-esteem and mood and walking in National Trust sites in the East of England, including forests, fens, lowland heaths and coastal areas among 132 people aged 31-70. They found that walking helped to improve the respondents’ moods, including reducing anger, confusion, depression, fatigue and tension.

### **Hill-Walking: Specific Studies**

- There are no specific studies to assess the potential psychological benefits of hill-walking. As outlined above, the most relevant studies relate to the combination of physical and outdoor activity. However, there are some discussions of the nature of hill-walking that are of interest.

- A report commissioned by Scottish Natural Heritage, Scottish Enterprise, VisitScotland and Forestry Commission Scotland, identified four different types of walkers (Scottish Natural Heritage et al, 2005).
  - (i) *Committed Explorers*: experienced, prefer challenging, remote walks with a sense of adventure and challenge.
  - (ii) *Part-time Explorers*: experienced and like a challenge, but will be doing other activities, such as other outdoor activities and socialising.
  - (iii) *Committed Wanderers*: prefer light to moderate walks in their comfort zone.
  - (iv) *Part-time Wanderers*: prefer easy, well marked walks and like to do other things on their trip.

The psychological benefits would depend on the objectives of the walkers, their experiences and the sorts of outcomes that they seek. Much of the general research on walking and outdoor activity might be relevant for the Part-time Wanderers but less meaningful for understanding the Committed Explorers.

- Edensor (2000) also offers a categorisation of hill-walking, in which each type might have different psychological outcomes. For example, *rambling* is more likely to be a recreational and sociable experience, whereas *long distance walking* to achieve a recorded time is more competitive and may create stress.
- Much of the general literature on exercise and psychological refers to the satisfaction of skill acquisition, a notion which might be indirectly transferable to the hill-walkers' satisfaction of achieving a particular goal.

#### **4.4 Potential Limitations of the Research Findings**

A number of reviews indicate that the evidence base is sometimes weak and inconsistent. Biddle and Mutrie (2001: 182) suggest that other “factors may be operating as moderators of this relationship” and that “it could be that exercise studies attract people who are already psychologically healthy and thus have little room for improvement in any of the standard measures”. They also suggest that “the mechanisms of the psychologically beneficial effects of physical activity and exercise are not clear at this time but there are many plausible mechanisms” (Biddle and Mutrie, 2001: 235).

Coalter (2009b, no page number) shows that reviews of available research have found weaknesses and that some critics, “speculate that measured improvements may be due as much to psychosocial factors as the exercise itself”. However, since hill-walking generally involves social engagement as well as physical activity, this cautionary note should not undermine the argument that hill-walking can have positive impacts on mental and emotional well-being.

Impacts vary between clinical and non-clinical groups, according to age, gender and social class, and according to the types of activities studied, i.e. between moderate and intense activities. Some studies show that shorter bouts of outdoor activity have more

benefit, and that the improvements in mood might only last for 1-2 hours. Moderate activity is often cited as most beneficial, and subjects who are already healthy tend to gain more than those who are sedentary, unfit or overweight.

Few studies are longitudinal and we have little evidence about long-term effects.

Hill-walking has very specific characteristics that are not reflected in most studies: it is irregular but of a long duration; it requires travel to mountain locations and specific forms of social interaction; it is of various types and these may have different psychological impacts.

More research is required on the profile of hill-walkers in terms of age, gender and social class.

## **4.5 Conclusions**

The direct evidence of the benefits of mountaineering activities to mental health and psychological well-being is limited. However other evidence shows that taking part in regular physical activity (including walking) has the capacity to improve mental health and psychological well-being, particularly among those with existing mental health issues. Engaging in physical activity has been shown to:

- Improve mood;
- Reduce depression and anxiety;
- Increase confidence and self-esteem;
- Improve cognitive functioning; and
- Improve the overall quality of life.

The literature also demonstrates that improved mental well-being can be achieved by engaging in activities in outdoor/natural environments, and that fulfilling or achieving goals associated with activities can also have a positive impact on individuals.

From this broader literature it is reasonable to assume that mountaineering activities have the capacity to improve mental health and psychological well-being. They are activities that:

- Make demands of participants at moderate and vigorous physical activity levels;
- Take place in outdoor natural environments; and
- Present a broad range of challenges to participants (e.g. completing a journey, ascending a hill or peak, reaching the top of a climb).

Although mountaineering activities would appear to have qualities that can improve mental well-being, care needs to be taken to ensure that such activities do not have negative psychological outcomes. Mountaineering can also be physically and mentally very challenging resulting in high levels of stress and having potentially negative outcomes on mental well-being. Some of the literature suggests that less stressful activities may be more suited to promoting positive mental well-being, particularly for those with mental health issues or low confidence and self-esteem. In



this context, activities such as rambling or low-level hill-walking may be more suited than the more demanding activities of mountaineering and rock climbing.

## **5 SOCIAL AND OTHER IMPACTS OF MOUNTAINEERING ACTIVITIES**

The literature search identified a number of areas, other than economics or physical and mental health, where mountaineering activities may have an impact (although the evidence is not wholly definitive). These impacts are reviewed below.

### **5.1 Impact of Mountaineering Activities on Anti-Social Behaviour and Crime Reduction**

Outdoor adventure activities, including mountaineering and climbing, are widely used by programmes which work with ‘at risk’ youth and young offenders. For example, the Fairbridge Trust, Outward Bound, Airborne Initiative and Hafotty Wen have used outdoor activities as a setting in which to promote aspects of personal development and, hopefully, to reduce anti-social and criminal behaviour. Some adventure activity programmes have been shown to reduce recidivism rates and are considered to be more cost effective than custodial sentences (Golins, 1980).

A study by Kelly and Baer (1971, cited in Golins, 1980) showed that the recidivism rate for participants one year after their involvement in an Outward Bound course (20%) was significantly lower than a control group (40%), and remained lower after a period of five years (38% compared to 53%, although this was not statistically significant).

In a wide ranging review of demanding physical activity programmes for young offenders Taylor et al (1999) list a series of mechanisms which may contribute to the achievement of programme objectives. These are not based on systematic empirical evidence, but on the evaluations of programme providers and participants:

- Outdoor physical activities can act as a hook as they are often attractive to some young offenders. The value placed on them can also act as an incentive for offenders to change their behaviour in order to continue participating.
- The activities have an intrinsic value. One offender stated that the experience of climbing, abseiling and canoeing provide a high greater than available through drugs.
- A new and unfamiliar environment provides an opportunity to experiment with changed behaviour.
- The activities are valuable as a learning medium. The structure and purpose of demanding physical activities provide an environment to find simple solutions to seemingly complex problems and to develop competence and confidence. Although the immediate focus might be the activity, the deeper focus is on issue of personal and social development.
- Demanding physical activities have direct benefits of health, self-confidence and self-esteem.

- Demanding physical activities have social benefits such as the development of teamwork, social skills and making new friends.
- Outdoor physical activities promote structure to life. The highly structured nature of such activities, and the need for a degree of self-organisation, have the potential to demonstrate the characteristics and benefits of structure.

However, Taylor et al (1999) emphasise that positive outcomes are unlikely to be achieved unless such programmes are designed, structured and delivered in particular ways:

- Voluntary participation is essential.
- A range of activities should be available.
- Facilities should be reasonably local and sustainable over time.
- Young offenders should be integrated with other users.
- There should be a system of rewards which recognises achievement.
- Programmes need to be between six and twelve weeks at least.
- There should be a continuous review of participants' progress.
- High quality and well-trained staff are required.
- Support should continue after the end of the programme. This point is also made by Golins (1980:38) who refers to the need for a "panoply of supportive aftercare services."

Taylor et al (1999) acknowledge that, although there is a strong theoretical case, there is a lack of systematic objective research evidence about the actual effectiveness of such programmes. The research which does exist is limited and supplies a verdict of 'not proven'.

Nichols (2007) reports on the work of Hafotty Wen outdoor activity centre in Wales and a 24 hour walk across 14 peaks above 3,000 feet. Participants from bail hostels and drug rehabilitation units undertook four days training before taking part in the event. An evaluation found that the offending rate in the period two years after attending the course (46.6%) was lower than the predicted reconviction rate (68.4%) and this was statistically significant. However, if characteristics of individuals were taken into account (e.g. attending a rehabilitation centre or were in custody meant they had reduced opportunities to offend) the incidence of re-offending (66.6%) was only marginally lower than the prediction rate. Further, there was a high degree of self-selection, which might explain some of the behaviour change.

Astbury and Knight (2003) report on the work of the Fairbridge Trust, where activities such as climbing and canoeing are used in its six month programme to seek to improve the life chances of disadvantaged and disaffected young people aged 14-25. It was found that the personal and social skills of the participants improved (including: communication; reviewing; facing up to consequences; taking responsibility - although the social skills were not sustained 12 months after the programme) and had a positive impact on job and educational performance, stable housing arrangements and positive attitudes to self and others. The nature of the sports/activities was considered important in gaining the involvement of young people

and for acting as a catalyst to the development of positive participant/mentor relationships. However, the success of the programme was attributed to the *supportive relationships* that were developed between staff and participants (this is a widespread finding for such programmes).

These evaluations suggest that mountaineering-related activities can be important in engaging with at-risk youth and developing social and personal skills. However, in addition to the environment and activities, it is also important to note that positive social relationships are also a significant element in the relative success of such programmes. The physical environment and activities are a context for, but not the sole cause of, socialisation.

## 5.2 Mountaineering Activities in Education

Scanlan and Lund (2000) suggest that an indoor climbing wall can provide a number of benefits to teaching physical education, although it should be noted that the benefits listed are not supported with research findings. They present a list of the top 10 reasons climbing is a suitable adjunct to physical education because, in addition to the physical well-being benefits, it can:

- Build teamwork, responsibility and perseverance;
- Introduce climbing as a lifetime leisure sport;
- Provide a source of motivation to pupils;
- Be used as a source for integrated learning (vocabulary, reflection);
- Act as an activity for integrating children with disabilities.

As a result of these presumed benefits, Scanlan and Lund (2000) advocate that schools invest in building an indoor wall – providing schools with a resource that can be used for positive publicity and positive public relations.

The benefits of including rock climbing (indoor and outdoor) as a physical education programme for pupils who had not been successful in the traditional school setting is described by Hansen and Parker (2009). The article explains the process of developing climbing as a suitable physical education programme in order to enhance development goals such as decision making and respecting others. Hansen and Parker (2009: 23) explain that the climbing experience challenged the participants but led to positive learning outcomes:

“All of the climbers in the club felt periods of frustration, weakness and self-doubt. However, when several small goals were met (e.g. putting on a harness and tying into a rope, climbing a certain height off the ground, climbing progressively harder routes, or belaying a fellow club member or facilitator), a new perspective of self and of the group emerged”.

Interestingly, the move from an indoor environment to the outdoor environment initially cause some regression in the skills of the young people, but following the first successful climb, it is claimed that this led to a deeper understanding of personal and social responsibility. Hansen and Parker (2009: 23) argue that the content of rock

climbing can help young people “achieve goals that may help them to progress towards productive adulthood”.

Although the articles by Scanlan and Lund (2000) and Hansen and Parker (2009) make claims for the benefit of climbing in education, these are not supported with robust research evidence. They are largely descriptive studies that promote climbing in PE without empirical evidence of its benefit.

## **6 CONCLUSIONS**

### **General**

- This review found that there is a limited amount of specialist literature and research on the economic and social impacts of mountaineering activities.
- It was possible to draw on broader literature on economic impact and physical activity to make some informed judgements about the value of mountaineering activities.

### **Economic Impact**

- Specialist research evidence on economic impact of mountaineering is limited and in most cases dated. It is often included in more general research on outdoor activities.
- Nevertheless, the economic impact of those engaged in outdoor activities, including mountaineering activities, is important and can be interpreted as supporting notable levels of employment in rural economies.

### **Physical Activity and Health**

- The specialist research evidence on the direct benefits of mountaineering and rock climbing to physical health is limited.
- It is likely that mountaineering and climbing make a positive contribution to physical health and can have an impact on cardiovascular, musculoskeletal, metabolic, endocrine and immune systems.
- Much of the research on mountaineering and rock climbing highlights the potential negative physiological impact of the activities (which can be minimised problems through adequate nutrition and hydration, and appropriate fitting and use of equipment.
- The potential risks of physical activity are far outweighed by its benefits.
- Although the benefits of engaging in mountaineering activities are assumed rather than evidenced, it is appropriate to advocate mountaineering activities as a form of physical activity for health reasons.

### **Mental Health and Psychological Well-Being**

- The direct evidence of the benefits of mountaineering activities to mental health and psychological well-being is limited.

- It is reasonable to assume that mountaineering activities have the capacity to improve mental health and psychological well-being.
- The outdoor aspect of mountaineering activities and the ability to set and achieve goals can contribute to positive mental health and psychological well-being.
- For those with mental health issues or low confidence and self-esteem, the less demanding activities of rambling or low-level hill-walking may be more suited than the more demanding activities of mountaineering and rock climbing.

## **Future Research**

As has been noted throughout this document, there is a general lack of specialist and dedicated research on the economic and social impacts of mountaineering. This might be explained, in part, because of the relatively low numbers of participants in what are specialist activities – despite their economic importance in certain geographical areas. It has been possible to derive some statements from more general literature on outdoor activities and physical activity and such analyses can be accepted on the balance of probabilities. However, it must also be recognised that much of the material contained in this report is derived from broader sources and the potential limitations of such evaluations must be acknowledged.

It is clear that there are substantial gaps in the understanding of the economic and social impacts of mountaineering. However, as it would be costly to remedy such deficiencies, we have not recommended a research agenda until we receive feedback on the contents of the report and the clients' identified priorities.

## REFERENCES

Andersen, D.M. (2010), 'Estimating the Economic Value of Ice Climbing in Hyalite Canyon: An application of travel cost count data models that account for excess zeros', *Journal of Environmental Management*, 91, 1012-1020.

Ainslie, P.N., Campbell, I.T., Lambert, J.P., MacLaren, P.M. and Reilly, T. (2005) Physiological and Metabolic Aspects of Very Prolonged Exercise with Particular Reference to Hill Walking, *Sports Medicine*, 35(7), 619-647

Astbury, R. and Knight, B. (2003) *Fairbridge Research Project: Final Report*, London, Charities Evaluation Services

Backe, S., Ericson, L., Janson, S. and Timpka, T. (2009) Rock Climbing Injury Rates and Associated Risk Factors in a General Climbing Population, *Scandinavian Journal of Medicine and Science in Sports*, 19, 850-856

Baker, S.J. (1980) An Intensive Alpine Climbing Expedition and its Influence on Some Anthropometric Measurements, *British Journal of Sports Medicine*, 14(1 & 2), 126-130

Balas, J., Strejcova, B., Maly, L. and Martin, A.J. (2009) Changes in Upper Body Strength and Body Composition after 8 Weeks Indoor Climbing, *Isokinetics and Exercise Science*, 17, 173-179

Barton, J., Hine, R. and Pretty, J. (2009) 'The Health Benefits of Walking in Greenspaces of High Natural and Heritage Value', *Journal of Integrative Environmental Sciences*, vol. 6, no. 4, pp. 261-278

Barton, J. and Pretty, J. (2010) 'What is the Best Dose of Nature and Green Exercise for Improving Mental Health? A multi-study analysis', *Environmental Science and Technology* (published on-line April 2010).

Biddle, S. and Mutrie, N. (2001) *Psychology of Physical Activity: Determinants, well-being and interventions*, London and New York, Routledge

Booth, J., Marino, F., Hill, C. and Gwinn, T. (1999) Energy Cost of Sport Rock Climbing in Elite Performers, *British Journal of Sports Medicine*, 33, 13-18

British Heart Foundation (not dated) *Is Moderate or Vigorous Physical Activity More Beneficial for Health?* British Heart Foundation Centre  
<http://www.bhfactive.org.uk/downloads/Is%20moderate%20or%20vigorous%20physical%20activityFAQweb.pdf>

British Mountaineering Council (2008) *Strategic Plan 2009-2012*, Manchester, BMC

British Mountaineering Council (2003), 'Mountains of People' at [www.thebmc.co.uk/News.aspx?id+602](http://www.thebmc.co.uk/News.aspx?id+602) accessed on 26 April 2010.



Burtscher, M. (2004) Exercise Capacity for Mountaineering: How Much is Necessary?, *Research in Sports Medicine*, 12, 241-250

Burtscher, M., Philadelphia, M., and Likar, R. (1993) Sudden Cardiac Death During Mountain Hiking and Downhill Skiing, *The New England Journal of Medicine*, 329(23), 1738-1739

Chakraborty, K. and Keith, J.E. (2000), Estimating the Recreation Demand and Economic Value of Mountain Biking in Moab, Utah: An application of count data models, *Journal of Environmental Planning and Management*, 43(4), 461-469.

Chief Medical Officer (2004) *At Least Five a Week: Evidence on the Impact of Physical Activity and its Relationship to Health*, London, Department of Health

Christie, M. and Matthews, J. (2003), *The Economic and Social Value of Walking in England*.

<http://www.ramblers.org.uk/info/publications/pubsfree>

Coalter, F. (2009a) *The Value of Sport Monitor: Physical Fitness and Health*, Sport England

[http://www.sportengland.org/research/value\\_of\\_sport\\_monitor.aspx](http://www.sportengland.org/research/value_of_sport_monitor.aspx)

Coalter, F. (2009b) *The Value of Sport Monitor: Psychological Health*, Sport England

[http://www.sportengland.org/research/value\\_of\\_sport\\_monitor.aspx](http://www.sportengland.org/research/value_of_sport_monitor.aspx)

Cerin, E., Leslie, E., Bauman, A. and Owen, N. (2005). Levels of Physical Activity for Colon Cancer Prevention Compared with Generic Public Health Recommendations: Population Prevalence and Sociodemographic Correlates. *Cancer Epidemiology, Biomarkers and Prevention*, 14(4), 1000-1002

Cheng, J.F., Ressurreccion, D., Tzeng, B. and Diamond, M. (2004) Efficacy and Safety of an Indoor Rock Climbing Program as a Complementary Physical Therapy and Recreational Activity for Children with Cerebral Palsy, *American Journal of Physical Medicine and Rehabilitation*, 83(3), 243-244

Davidson, R. (1994) Levels and Use and Safety on the Hills. In, *Mountain Safety in the UK* (Seminar Report), Edinburgh, The Scottish Sports Council

Dengler, J.H. and Gajdosik, C.G. (2002) Effect of Rock Climbing on Hallux Range of Motion, *Journal of Orthopaedic Sports Physical Therapy*, 32(3), A-55

Department of Health, Physical Activity, Health Improvement and Prevention (2004) *At Least Five a Week: Evidence on the Impact of Physical activity and its Relationship to Health – A Report from the Chief Medical Officer*, Department of Health

DiLorenzo, T.M., Bargman, E.P., Stucky-Ropp, R., Brassington G.S., Frensch, P.A. and LaFontaine, T. (1999) Long-term Effects of Aerobic Exercise on Psychological Outcomes, *Preventive Medicine*, 1999, 28, 75-85

Duckham, R.L., Bassett, D.R., Fitzhugh, E., Swibas, T. and McMahan, A. (2009) The Effects of Hiking Poles on Performance and Physiological Variables During Mountain Climbing, *Journal of Exercise Physiology online*, 12(3), 34-41

Edensor, T. (2000) Walking in the British Countryside: Reflexivity, Embodied Practices and Ways to Escape, *Body and Society*, 6(3-4), pp. 81-106

European Heart Network (1999) *Physical Activity and Cardiovascular Disease Prevention in the European Union*, Brussels, EHN

Farrell, L. and Shields, M.A. (no date) *Playing Sport and Feeling Healthy: Evidence from the Health Education Monitoring Study*, University of Melbourne mimeograph

Fitzpatrick Associates (2005) *Economic Value of Trails and Forest Recreation in the Republic of Ireland*, Final Report, September

Fix, P. and Loomis, J. (1998) Comparing the Economic Value of Mountain Biking Estimated Using Revealed and Stated Preference, *Journal of Environmental Planning and Management*, 41(2), 227-236.

Fox, K.R. (1999) The Influence of Physical Activity on Mental Well-being, *Public Health Nutrition*, 1999, 2(3a), 411-418

Fox, K.R. (2000) The effects of exercise on self-perceptions and self-esteem, In: Biddle, SJH; Fox, KR and Boutcher, SH (eds), *Physical Activity and Psychological Well-Being*, London: Routledge, 88-117

Fredrickson, L. and Anderson, D. (1999) A Qualitative Exploration of the Wilderness Experience as a Source of Spiritual Inspiration, *Journal of Environmental Psychology*, 19, 21-39

George Street Research and Jones Economics (2004) *Economic Impact and Development Opportunities for Outdoor and Environment Related Recreation in the Highlands and Islands*, Research Report: Walking and Mountaineering 2003/04, Report to Highlands and Islands Enterprise

<http://www.hie.co.uk/hie%20-%20tourism/niche-tourism---walking-and-mountaineering-factsheet.pdf>

Goel, A. and Addison, A.K.L. (1992) Fell Walking Injuries in Cumbria: A Review, *British Journal of Sports Medicine*, 26(3), 143-144

Golins, G.L. (1980) *Utilizing Adventure Education to Rehabilitate Juvenile Delinquents*, ERIC Clearinghouse on Rural Education and Small Schools, Las Cruces, N.M.

<http://www.eric.ed.gov/PDFS/ED187501.pdf>

Grombach, A. (2002) *UK Tourism Study data presented by VisitScotland to It's Wild Conference*, Aviemore, May 2002.

Hakim, A.A., Curb, D.J., Petrovitch, H., Rodriguez, B.L., Yano, K. Ross, G.W., White, L.R. and Abbott, R.D. (1999) Effects of Walking on Coronary Heart Disease in Elderly Men: The Honolulu Heart Program, *Circulation*, 100(1), 9-13

Hanley, N. and Wright, R.E. (2003) Valuing Recreational Resources Using Choice Experiments: Mountaineering in Scotland. In N. Hanley, W.D. Shaw, and R.E. Wright (eds) *The New Economics of Outdoor Recreation*, pp.59-73

Hansen, K. And Parker, M. (2009) Rock Climbing: An Experience with Responsibility, *JOPERD*, 80(2), 17-23 and 55

Hardy, C. J. and Rejeski, W. J. (1989) Not What, but How One Feels: The Measurement of Affect During Exercise, *Journal of Sport and Exercise Psychology*, 11, 304-317

Heberlein, T.A. and Fredman, P. (2002) *Motivation, Constraints and Visits to the Swedish Mountains*, European Tourism Research Institute Working Paper 2002:2.

Higgins, P. (2000) The Contribution of Outdoor Recreation and Outdoor Education to the Economy of Scotland: Case Studies and Preliminary Findings, *Journal of Adventure Education and Outdoor Learning*, 1(1), 69-82

Highlands and Islands Enterprise (1996) *The Economic Impacts of Hill-Walking, Mountaineering and Associated Activities in the Highlands and Islands of Scotland*, Highlands and Islands Enterprise

Kuo, F. E. and Taylor, A. F. (2004) A Potential Natural Treatment for Attention-Deficit/Hyperactivity Disorder: Evidence from a National Study, *American Journal of Public Health*, 94(9), 1580-1586

Lawlor, D.A. and Hopker, S.W. (2001) The Effectiveness of Exercise as an Intervention in the Management of Depression: Systematic Review and Meta-regression Analysis of Randomised Controlled, *British Medical Journal*, 2001, 322, 1-8

Lirgg, C.D., DiBrezza, R. and Gray, M. (2006) Effect of Climbing Wall Use on the Grip Strength of Fourth-Grade Students, *Research Quarterly for Exercise and Sport*, 77(1) Suppl, A-64

Logan, A.J., Mason, G., Dias, J. and Makwana, N. (2005) Can Rock Climbing Lead to Dupuytren's Disease? *British Journal of Sports Medicine*, 39, 639-644

McMorran, R., Price, M.F. and McVittie, A. (2006) *A Review of the Benefits and Opportunities Attributed to Scotland's Landscapes of Wild Character*, Scottish Natural Heritage Commissioned Report No. 194 (ROAME No. F04NC18)

Mermier, C.M., Robergs, R.A., McMinn, S.M. and Heyward, V.H. (1997) Energy Expenditure and Physiological Responses During Indoor Rock Climbing, *British Journal of Sports Medicine*, 31, 224-228

- Midmore, P. (2000), *The Economic Value of Walking in Rural Wales*, Report for the Ramblers' Association in Wales, March
- Morgan, K. and Bath, P. (1998) Customary Physical Activity and Psychological Well-Being: A Longitudinal Study, *Age and Ageing*, 27, 35-40
- Morris, N. (2003) *Health, Well-Being and Open Space: Literature Review*, Report, Edinburgh College of Art and Heriot-Watt University
- Morrison, A.B. and Schöffl, V.R. (2007) Physiological Responses to Rock Climbing in Young Climbers, *British Journal of Sports Medicine*, 41, 852-861
- Murphy, M.H., Nevill, A.M., Murtagh, E.M. and Holder, R.L. (2007) The Effect of Walking on Fitness, Fatness and Resting Blood Pressure: A Meta-analysis of Randomised, Control Trials, *Preventive Medicine*, 44, 377-385
- Newidiem (2004), *The Active Economy. The Value of Adventurous Outdoor Activities to North West Wales*, Research commissioned by Snowdonia-Active
- Nichols, G. (2007) *Sport and Crime Reduction*, Abingdon, Routledge
- Nicoloff, G. and Schwenk, T. (1995) Using Exercise to Ward Off Depression, *Physician and Sportsmedicine*, 23, 44-58
- Noakes T.D. (1998) Sudden Death and Exercise. In: *Encyclopaedia of Sports Medicine and Science*, T.D. Fahey (Editor), Internet Society for Sport Science  
<http://www.sportsci.org/encyc/suddendead/suddendead.html>
- North, T., McCullagh, P. and VuTran, Z. (1998) Effect of Exercise on Depression, *Exercise and Sports Science Review*, 18, 379-415
- Outdoor Industry Foundation (2006) *The Active Outdoor Recreation Economy: A \$730 billion annual contribution*, Boulder County, US, Outdoor Industry Foundation
- Pretty, J., Griffin, M., Peacock, J., Hine, R., Sellens, M. and South, N. (2005) *A Countryside for Health and Well-Being: The Physical and Mental Health Benefits of Green Exercise*, Report for the Countryside Recreation Network
- Price, M.F., Dixon, B.J., Warren, C.R. and Macpherson, A.R. (2002) *Scotland's Mountains: Key Issues for their Future Management*, Battleby, Scottish Natural Heritage
- Rankinen, T. and Bouchard, C. (2002) Dose-response Issues Concerning the Relations between Regular Physical Activity and Health. In T. Rankinen and C. Bouchard, (eds) *Dose-response Issues Concerning the Relations between Regular Physical Activity and Health*, Washington: President's Council on Physical Fitness and Sports; 2002, Research Digest series 3, no 18
- Scanlan, T. and Lund, J. (2000) Climbing Mountains and Teaching Physical Education, *Teaching Elementary Physical Education*, March, 17-20

Scarpa, R. and Thiene, M. (2005), Destination Choice Models for Rock Climbing in the Northeastern Alps: A Latent Class Approach Based on Intensity of Preferences, *Land Economics*, 81(3), 426-444.

Scottish Environment Link (2001), *Scottish Environment Audit Series*, No. 5, Tourism and the Natural Environment

Scottish Natural Heritage (1998), *Jobs and the Natural Heritage: The Natural Heritage in Rural Development*, Perth, Scottish Natural Heritage

Scottish Natural Heritage, Scottish Enterprise, Visit Scotland and Forestry Commission Scotland (2005) *The Walker's View of Walking in Scotland*, commissioned by Scottish Natural Heritage, Scottish Enterprise, VisitScotland and Forestry Commission Scotland  
[http://www.visitscotland.org/walking\\_summary.pdf](http://www.visitscotland.org/walking_summary.pdf)

Scottish Parliament (2002) *The Economics of Tourism - SPICe Briefing 02/97*, Edinburgh, The Information Centre, Scottish Parliament

Scully, D., Kremer, J., Meade, M., Graham, R., and Dudgeon, K. (1998) 'Physical exercise and psychological well being: a critical review', *British Journal of Sports Medicine*, vol. 32, pp. 111-120

Sharp, B. (2007) *Scottish Mountaineering Incidents (1995-2005)*, Research Report no.109, Edinburgh, **sportscotland**

**sportscotland** (2008a) *Sports Participation in Scotland 2007*, Research Report no. 108, Edinburgh, **sportscotland**

**sportscotland** (2008b) *The Potential of Sport: Maximising Sport's Contribution to National and Local Outcomes*, Edinburgh, **sportscotland**  
<http://www.sportscotland.org.uk/NR/rdonlyres/55E5B549-E79E-44F6-A2B7-8003625DF865/0/Thepotentialofsport.pdf>

**sportscotland** (2007) *The Economic Importance of Sport in Scotland 2004*, Research Digest no. 101, Edinburgh: **sportscotland**  
[www.sportscotland.org.uk/ChannelNavigation/Resources/TopicNavigation/Collections/Research/The+economic+importance+of+sport+in+Scotland+2004.htm](http://www.sportscotland.org.uk/ChannelNavigation/Resources/TopicNavigation/Collections/Research/The+economic+importance+of+sport+in+Scotland+2004.htm)

Strauss, R.M. (2004) Mountaineer's Heel, *British Journal of Sports Medicine*, 38, 344-35

Taylor, P., Crow, I., Nichols, G. and Irvine, D. (1999) *Demanding Physical Activity Programmes for Young Offenders under Probation Supervision*, London, The Home Office

Taylor, J. and McGregor, C. (1999), *Cairngorms Mountain Recreation Survey 1997-98*, Perth, Scottish Natural Heritage

Tiessen, T. (2006) *Rock Climbing*  
[http://www.alive.com/4495a12a2.php?subject\\_bread\\_cramb=6](http://www.alive.com/4495a12a2.php?subject_bread_cramb=6)

Scottish Natural Heritage, Scottish Enterprise, Visit Scotland and Forestry Commission Scotland (2005) *The Walker's View of Walking in Scotland*, commissioned by Scottish Natural Heritage, Scottish Enterprise, VisitScotland and Forestry Commission Scotland  
[http://www.visitscotland.org/walking\\_summary.pdf](http://www.visitscotland.org/walking_summary.pdf)

### **Web Source**

American Heart Association, *General Physical Activities Defined by Level of Intensity*  
[www.heart.org/presenter.jhtml?identifier=3046917](http://www.heart.org/presenter.jhtml?identifier=3046917)

# APPENDIX 1: THE RESEARCH APPROACH

## On-line Resources

The University of Stirling's extensive on-line library catalogue and search tools were used as the primary method of identifying literature. *StirGate* was the main search tool used. This library resource enables keyword searches to be undertaken on up to 100 databases simultaneously. *StirGate* includes the following library resources which would likely be relevant to the identification of mountaineering literature:

- British Education Index
- Conference Paper Index
- ERIC
- Greenfile
- IBSS
- Leisure Tourism Database
- PsycINFO
- Swetswise
- Cochrane Library
- EconLit
- GeoBase
- Health Source
- ISI Web of Knowledge
- MEDLINE
- SPORTDiscus
- Wiley Journals

In order to identify relevant information sources, the following keywords were used: *hill-walking, mountaineering, climbing, alpine/alpinism, hiking, adventure sport* and *walking*. In some cases the searches were refined by using additional keywords to assist in identifying the most relevant literature. The additional key words searched included:

- Economic
- Health
- Tourism
- Well-being
- Crime

In many cases it was not necessary to use the additional keywords because the number of hits was small enough in order to review all the references that were identified through the database search.

## Report Bibliography/References

Bibliographies and references presented at the end of reports and journal articles were also used to identify relevant material.

## Document Delivery Service

The University of Stirling Library provides a service where books, reports and journal articles not available on-line or directly through the Library can be ordered. This service was used to access many of the texts listed in the References at the end of the report.

## Websites

The following websites were also searched for relevant literature:

Alpine Club - [www.alpine-club.org.uk](http://www.alpine-club.org.uk)  
Association of Mountaineering Instructors - [www.ami.org.uk](http://www.ami.org.uk)  
British Mountaineering Council - [www.thebmc.co.uk](http://www.thebmc.co.uk)  
British Mountain Guides - [www.bmg.org.uk](http://www.bmg.org.uk)  
Countryside Recreation Network - [www.countrysidecreation.org.uk](http://www.countrysidecreation.org.uk)  
Fix the Fells - [www.fixthefells.co.uk](http://www.fixthefells.co.uk)  
International Mountaineering and Climbing Federation - [www.theuiaa.org](http://www.theuiaa.org)  
Long Distance Walkers Association - [www.ldwa.org.uk](http://www.ldwa.org.uk)  
Mountaineering Ireland (formerly MCI) - [www.mountaineering.ie](http://www.mountaineering.ie)  
Mountain Leader Training - [www.mltuk.org](http://www.mltuk.org)  
Munro Magic - [www.munromagic.com](http://www.munromagic.com)  
Ramblers - [www.ramblers.org.uk](http://www.ramblers.org.uk)  
Scottish Climbing Archive - [www.scotclimb.org.uk](http://www.scotclimb.org.uk)  
Scottish Mountaineering Club - [www.smc.org.uk](http://www.smc.org.uk)  
Scottish Natural Heritage - [www.snh.org.uk](http://www.snh.org.uk)  
Scottish Environment Link - [www.scotlink.org](http://www.scotlink.org)  
The Wainwright Society - [www.wainwright.org.uk](http://www.wainwright.org.uk)

## Organisations

A number of organisations were also contacted directly in order to identify relevant material. The organisations included:

- Countryside Access and Activities Network (CAAN)
- Countryside Council for Wales
- Countryside Recreation Network
- Natural England
- Scottish Natural Heritage

The Countryside Recreation Network kindly circulated a request for relevant information to its network of members.

Contacts at several UK and European universities were also contacted to assist in the identification of relevant literature.