

# Physical Fitness: A Pathway to Health and Resilience

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## ABSTRACT

Various groups representing a number of different perspectives (for example, operational, architectural, community, institutional, and individual resilience) use the term *resilience*. We define resilience as the ability to withstand, recover, and grow in the face of stressors and changing demands. Physical fitness is one pathway toward resilience because it is associated with many traits and attributes required for resilience. In addition, physical fitness confers resilience because regular exercise and/or physical activity induces positive physiologic and psychological benefits, protects against the potential consequences of stressful events, and prevents many chronic diseases. This article presents a brief historical overview of the health-promoting effects of exercise and physical activity, followed by a discussion on the concept of hardiness and mental toughness and how they relate to resilience and physical fitness; how physical fitness promotes resilience; the clinical implications of a sedentary lifestyle; and the relevance of physical fitness and resilience to Army Medicine's Performance Triad.

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*...physical fitness is not only one of the most important keys to a healthy body; it is the basis of dynamic and creative intellectual activity.*

President-Elect John F. Kennedy<sup>1</sup>

Various groups representing a number of different perspectives (for example, operational, architectural, community, institutional, and individual resilience) have defined the term resilience. For the purposes of this article, we define resilience as the ability to withstand, recover, and grow in the face of stressors and changing demands.<sup>2</sup>

In recent reviews and papers on resilience, one factor that continues to appear as promoting and/or conferring resilience is physical fitness<sup>3,4</sup> and regular physical activity.<sup>5-7</sup> Thus, we focus on the role of physical fitness in overall individual resilience. The benefit of physical fitness on resilience is in part based on the recognition that physical fitness, achieved through physical activity and/or regular exercise, can induce positive physiologic and psychological benefits, protect against the potential consequences of stressful events, and prevent many chronic diseases.<sup>8-11</sup> After a brief historical overview of the health-promoting effects of exercise and physical activity, the following topics are discussed: the concept of hardiness and mental toughness and how they relate to resilience and physical fitness; how physical fitness promotes resilience; the clinical implications of a sedentary lifestyle; and the relevance of physical fitness and resilience to Army Medicine's Performance Triad. Throughout this article, the terms physical activity and exercise are used interchangeably, depending on the literature,

recognizing that exercise represents a planned, structured, and regular form of physical activity.

## HISTORICAL OVERVIEW

The quest for physical fitness has been unremitting, however, its importance and application have changed and/or transitioned over time with both high and low points. Hunting and gathering for survival were the initial impetus for fitness, which was later followed by the recognition that selected physical movements and activities were important for developing the body and preventing and curing diseases.<sup>12-14</sup> In fact, the importance of regular exercise and physical activity has been touted for over 7,000 years.<sup>12,13</sup> In China, the philosophical teachings of Confucius encouraged participation in regular physical activity, as physical inactivity was recognized as associated with certain diseases.<sup>12</sup> The Chinese developed many perspectives on how to achieve and maintain health, and they deemed exercise essential for increasing strength, prolonging life, preventing and curing diseases, and minimizing the accumulation of fat.<sup>12</sup> Quigong, Cong fou (later Kung Fu), and Tai-Chi were some of the gymnastic/movement forms developed in China sometime around 3,000 BC.<sup>12</sup> Among the Greeks, Herodicus (circa 450 BC) was the first to promote physical activity, and he even considered exercise a form of medicine. Nonetheless, Hippocrates is usually considered the father of exercise and medicine.<sup>13</sup> These 2 Greeks were followed by Galen (129-210 AD)<sup>15</sup> who was perhaps the most advanced, as he wrote not only about when to exercise, but he also described various types of exercises, identified qualities of exercise, specific places to exercise, and factors to think about prior to exercise.<sup>13</sup> Although the

importance of exercise and physical fitness diminished during various periods of time, such as after the fall of the Roman empire when the church became the dominant influence,<sup>16</sup> during the period of industrialization,<sup>12</sup> and notably during the 1920s (often called the Roaring Twenties) when relaxation and enjoyment were key.<sup>12</sup> However, the importance of exercise remains widely recognized. It is interesting to reflect on the comment of Edward Stanley, the 15th Earl of Derby, who stated in an address at Liverpool College on December 20, 1873 that:

Those who think they have not time for bodily exercise will sooner or later have to find time for illness.<sup>14</sup>

It is discouraging to realize we have made little progress over the centuries.

#### PERSONALITY TRAITS/ATTRIBUTES ASSOCIATED WITH RESILIENCE

Although the term resilience, as it is used today, emerged from work on children living under conditions of deprivation,<sup>17-20</sup> it is now applied to diverse disciplines<sup>5-7</sup> and populations.<sup>21-24</sup> Identifying how and why some individuals are seemingly able to bear up, and sometimes thrive, under adverse conditions with no observable negative physical or psychological outcomes, is a continuous quest.<sup>5-7,25-33</sup> Personality traits associated with resilience include hardiness and mental toughness.<sup>9,34-46</sup> The term hardiness, as considered by Kobasa et al,<sup>34,37-43</sup> was typified by “interrelated orientations of commitment (vs alienation), control (vs powerlessness), and challenge (vs threat).”<sup>41</sup> This original characterization was later refined by Maddi,<sup>11</sup> who proposed that hardiness is an attitude (or set of attitudes) and personality trait that helps an individual restructure stressors into growth opportunities rather than allowing them to be or become catastrophes.

Bartone et al<sup>47,48</sup> developed the dispositional hardiness scale to assess hardiness, and this scale has been used in a number of studies to relate hardiness characteristics in persons exposed to challenging occupations and experiences.<sup>45,49-52</sup> Bonanno<sup>53</sup> noted that hardiness is one of the pathways to resilience. Crust et al<sup>36</sup> developed the model of mental toughness by applying the traits of hardiness to reflect the unique demands of sports and exercise; the trait of confidence was added to control, commitment, and challenge.<sup>35,36,44,46,54,55</sup> As noted by Crust et al<sup>36</sup>:

Mentally tough individuals are considered to be competitive, resilient to errors or stress, and have high self-confidence and low anxiety.

The literature clearly shows that both hardiness and mental toughness are highly related to resilience.<sup>28,56-58</sup> In addition to the personality traits of hardiness and

mental toughness, other psychological attributes and social-cognitive variables have been associated with resilience, including self-esteem, self-efficacy and motivation.<sup>20,21,59-62</sup> How do these closely associated traits or attributes relate to physical fitness and physical activity?

#### PERSONALITY TRAITS/ATTRIBUTES ASSOCIATED WITH PHYSICAL FITNESS

Interestingly, regular physical activity and aerobic fitness have been shown to be associated with specific personality traits and psychological attributes<sup>63-72</sup> associated with resilience. For example, anxiety and depression are inversely related to maximal aerobic capacity, a primary indicator of physical fitness.<sup>73,74</sup> Moreover, our unpublished data show a significant positive association between aerobic capacity and hardiness ( $r=0.24$ ), and an inverse relation with perceived stress ( $r=-0.26$ ) and trait anxiety ( $r=-0.17$ ). Of note, Skirka et al<sup>10</sup> reported significantly higher hardiness scores, less perceived stress, and fewer psychological symptoms in varsity college athletes than college nonathletes, which further supports a strong association between regular exercise, aerobic fitness, and hardiness. Furthermore, mental toughness, the personality trait associated with athletes and athletic competition, has been shown to mitigate the relationship between high stress and depressive symptoms.<sup>57</sup>

Two determinants of physical activity, self-esteem and self-efficacy, be they enduring traits or modifiable attributes, are essential for resilience.<sup>65,66,75</sup> Self-efficacy generally reflects how self-confident a person is with regard to undertaking a particular action under challenging situations,<sup>67,72,76,77</sup> and self-esteem signifies one's sense of self-worth or personal value.<sup>68</sup> Multiple studies have shown that children and young adults who participate in regular exercise score higher on measures of self-esteem and self-efficacy<sup>67,70-72,76,78-80</sup> and competitiveness<sup>81</sup> compared to sedentary, untrained controls. Moreover, these two attributes are improved through regular physical activity.<sup>69,72</sup> Netz et al<sup>72</sup> conducted a meta-analysis of 36 studies examining how physical activity interventions affected well-being in healthy adults. Moderate intensity aerobic exercise was shown to be most beneficial and had a strong effect on self-efficacy, in addition to conferring improvements in aerobic capacity and strength. Ekeland et al<sup>69</sup> likewise conducted a systematic review of 12 studies to assess how exercise affected self-esteem in children and young people. They concluded that exercise has positive short-term effects on self-esteem and that it might be an important strategy for improving self-esteem. Interestingly, one hypothesis as to how physical activity enhances self-efficacy and self-esteem is that it requires the application of self-management strategies (eg, thoughts, goals, plans, and acts) to achieve a goal.<sup>76</sup>

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Self-management strategies require commitment, control, and motivation, and although each strategy is important, motivation appears to be key in terms of regular physical activity.<sup>70,78,82-85</sup> Research has shown that motivation is very important with regard to commencing and maintaining participation in regular physical exercise.<sup>76,84</sup> According to the literature, motivation is some force or stimulus that leads an individual to undertake a particular task or activity in which they have a specific objective or derive personal meaning.<sup>78,82,83</sup> Overall, these studies strongly suggest that personality traits (hardiness and mental toughness) and other attributes (self-esteem, self-efficacy, motivation, self-management strategies) may contribute to the buffering effect of physical fitness and how fitness confers resilience. Further, one must be motivated to be committed, and possess self-efficacy and self-esteem to accept a challenge. Clearly, strong relationships exist between and among hardiness or mental toughness, self-efficacy, self-esteem, and motivation; all essential resources for resilience, and all associated with physical fitness.

### PHYSICAL FITNESS AND STRESS RESILIENCE

That physical fitness is essential for health and well-being is not in question, as noted in the earlier historical overview. However, scientific data documenting the essentiality of physical activity for health did not emerge until the late 1800s and early 1900s when epidemiological studies demonstrated that sedentary persons were more likely to have coronary heart disease than those who led active lifestyles.<sup>16,86-90</sup> Since those first studies, the literature has become replete with evidence that physical fitness and regular exercise confer resilience and serve as a resistance resource in a variety of ways, including blunting stress reactivity in response to both physical and psychosocial stressors, conferring multiple physiologic and psychological benefits, serving as a buffer against stress, and protecting against stress-related disorders and many chronic illnesses.<sup>57,74,78,91-95</sup> A conceptual model of the personality traits and attributes associated with physical fitness and resilience is presented in the Figure.

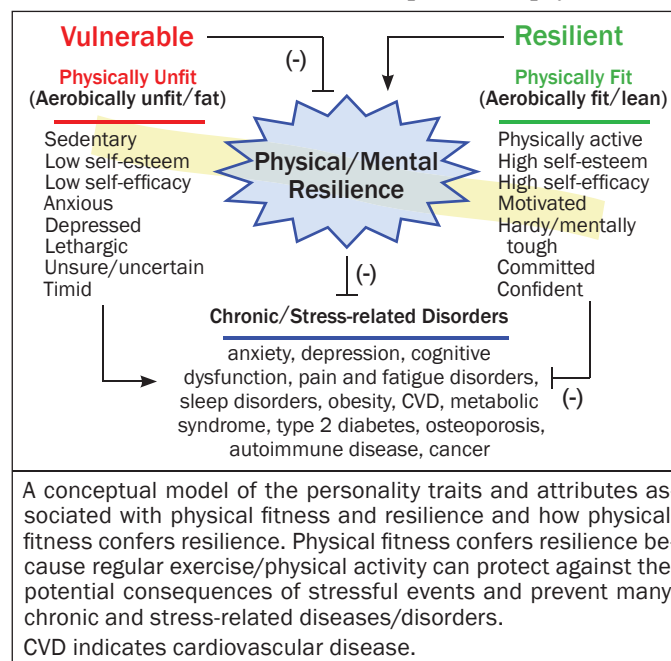
#### Physical Fitness Blunts Stress Reactivity in Response to Both Physical and Psychosocial Stressors: Physiologic and Psychological Benefits

The 2 main neuroendocrine/neural systems that mediate the stress response are the hypothalamic-pituitary-adrenal axis, with the resultant release of cortisol, and the sympathetic nervous system, which releases the catecholamines epinephrine (adrenaline) and norepinephrine. Activation of these stress systems mediates the fight or flight response, which entails the rapid mobilization of energy from storage sites to critical muscles and the brain (getting one ready for action, increasing

alertness/arousal). Moreover, increased heart rate, blood pressure, and breathing rate facilitate the rapid transport of nutrients and oxygen to relevant parts of the body. Together, these stress systems orchestrate the physiologic and behavioral adaptations to stress. However, chronic activation can lead to dysregulation of multiple physiologic and behavioral systems, leading to maladaptive stress responses, including anxiety and depression.<sup>96,97</sup> Physical fitness and aerobic fitness have been related to a reduction in stress reactivity, physiologically and psychologically, for both physical and mental/psychosocial stress.<sup>65,98-107</sup>

Interestingly, neuroendocrine and physiologic responses to exercise at the same absolute workload are significantly lower in physically fit than unfit persons.<sup>108-111</sup> Additionally, physically active people show reduced sympathoadrenal reactivity to physical stressors.<sup>109,110</sup> When untrained persons are enrolled in a regular exercise program for 8-12 weeks, their response to the same physical stress prior to beginning exercise training is significantly higher than after the training.<sup>112</sup> Thus, when trained and untrained persons have to work at the same rate, the untrained person will experience significantly more stress than someone who is physically fit and aerobically trained.<sup>108-110</sup> Therefore, the higher the level of aerobic fitness, the greater the ability to tolerate high workloads and be minimally stressed by low ones.

Physical training also appears to confer protection against nonphysical stressors, mental and/or psychological.<sup>98,111,113,114</sup> Rimelle et al<sup>115</sup> documented significantly lower cortisol and heart rate responses to psychosocial



stress in trained men compared to untrained men. Moreover, significantly greater calmness and better mood, and a trend toward lower state anxiety were noted in the trained relative to untrained men. In addition, others have noted blunted cortisol responses<sup>115</sup> and reduced cardiovascular responses<sup>98,99,115</sup> to psychological laboratory stressors in physically active as compared to less active persons. Webb et al<sup>111</sup> administered a dual challenge of physical and mental stress and noted that low-fit participants had greater cortisol responses compared to high-fit individuals. Importantly, in a meta-review of 34 studies, Crews et al<sup>99</sup> reported that aerobically fit individuals had reduced responses to psychosocial stress in comparison to controls. These findings are consistent with those from the Aerobics Center Longitudinal Study, which found a significant inverse dose-response relationship between aerobic fitness and depressive symptomatology and a positive association between fitness and emotional well-being.<sup>116</sup>

In addition to cross-sectional studies, longitudinal studies have demonstrated positive effects of exercise training and regular physical activity, and negative effects of exercise withdrawal on mood and depressive symptoms.<sup>68,117-121</sup> Nabkasorn et al<sup>117</sup> studied adolescent females with depressive symptoms and noted significant decreases in total depressive score, as well as in 24-hour urinary cortisol and epinephrine excretion, following 8 weeks of physical training (jogging). Importantly, studies by Berlin et al<sup>118</sup> and Weinstein et al<sup>121</sup> demonstrated that when someone who exercises regularly is forced to withdraw from exercise for 2 weeks, negative mood increases significantly and correlates with decreases in fitness.<sup>118,121</sup> In addition, a reduction in parasympathetic nervous system activity, as measured by heart rate variability, predicted the development of negative mood after deprivation of exercise.<sup>121</sup> These findings are relevant to understanding both short-term exercise withdrawal and exercise initiation, and how they affect overall stress resilience and reactivity.

Despite the multiple positive findings, not all are consistent,<sup>65,122,123</sup> particularly with regard to catecholamine release, with both blunted and augmented responses noted in high- versus low-fit persons.<sup>112,123</sup> Along those same lines, de Geus et al<sup>65</sup> were unable to detect changes in psychological make-up (for example, personality traits of neuroticism, introversion, hostility, anger expression) or acute neurophysiologic reactivity (for example, heart rate, blood pressure, urinary catecholamine excretion, or cardiac beta-adrenergic drive) after 4 and 8 months of training. Thus, although the majority of studies support positive effects of regular exercise and aerobic fitness, not all studies are consistent.

#### Physical Fitness Serves as a Buffer against Stress and Stress-Related Disorders

Physical activity may provide a protective effect against stress-related disorders, as physically fit persons appear to be less susceptible to life stressors, in particular with regard to illnesses: physical fitness may serve as a buffer against stress,<sup>63,124,125</sup> with stress being highly associated with various illnesses.<sup>20,34,73,124,126,127</sup> A comprehensive review of the literature from 1982 to 2008 in which exercise was examined as a stress-buffer concluded that the majority of studies, both cross-sectional and prospective, found exercise to be an effective buffer, but the amount and type of exercise necessary for protection were not stated.<sup>93</sup> The concept of stress buffering was first proposed by Kobasa et al,<sup>34</sup> and later by others<sup>9,11</sup> who clearly showed that regular exercise and hardiness interact to decrease illness in the face of serious life stressors.<sup>34</sup> Persons who scored high in hardiness and participated in regular exercise were usually more healthy than those high only in hardiness or exercise alone.<sup>34</sup> Collectively, the data suggest that participation in leisure physical activity is important to the stress-buffering effect of exercise.<sup>128</sup>

Physical fitness and regular exercise also appear to buffer against depression<sup>63,68,125,129-134</sup> and anxiety.<sup>100,125,134-136</sup> In fact, the beneficial effects of physical activity on positive mood are well recognized.<sup>83,137</sup> Rethorst et al<sup>131</sup> conducted a meta-analysis of all studies investigating the effects of exercise on depression, and 12 of 16 exercise treatment groups with clinically depressed patients were classified as “recovered” or “improved” after the treatment. Similarly, a number of prospective studies have demonstrated reductions in state anxiety.<sup>129,138</sup> Manger et al<sup>129</sup> had persons diagnosed with posttraumatic stress disorder (PTSD) undergo a 12-session aerobic exercise program and showed significant reductions in PTSD, anxiety, and depression following the intervention. Moreover, these positive results were stable over 1 month of follow-up.<sup>129</sup> Finally, Wipfli et al<sup>135</sup> conducted a meta-analysis (based on 49 randomized, controlled trials) examining the effects of exercise on anxiety, and demonstrated clear reductions in anxiety among those who exercised compared to the respective control groups. Of interest was their finding that exercise was more effective in reducing anxiety relative to other anxiety-reducing treatments.<sup>135</sup>

#### CLINICAL IMPLICATIONS OF A SEDENTARY LIFESTYLE

The short- and long-term consequences of low physical fitness and a sedentary lifestyle are clear. Physical inactivity serves a major role in the rising prevalence of obesity, cardiovascular disease (CVD), hypertension, type II diabetes mellitus (T2DM), metabolic syndrome, insulin resistance, hyperlipidemia, and breast and colon cancers,

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to name a few.<sup>91,94,95,116,139,140</sup> Of course, excess energy intake also contributes to obesity,<sup>78,94,95</sup> but lack of physical activity is the leading contributor<sup>91,94,95,116,139,140</sup> and also the fourth leading cause of death worldwide.<sup>95</sup> In contrast to a sedentary lifestyle, high aerobic fitness is inversely related to obesity, metabolic syndrome, CVD, hypertension, and T2DM.<sup>74,141-145</sup>

In addition to the major chronic diseases mentioned above, low aerobic fitness has been associated with fibromyalgia (FM),<sup>146,147</sup> chronic fatigue syndrome (CFS),<sup>148,149</sup> osteoarthritis,<sup>150-152</sup> rheumatoid arthritis,<sup>150,153,154</sup> and inflammatory muscle disorders.<sup>155,156</sup> Low aerobic fitness is also associated with elevations in serum C-reactive protein (CRP), a well-known marker of inflammation. Many studies have shown that maximal aerobic capacity is inversely related to CRP,<sup>142,157</sup> and that exercise interventions, both aerobic and resistance in nature, reduce levels of CRP.<sup>157-159</sup> However, not all studies showed a significant effect.<sup>160-162</sup> A meta-analytic study by Kelley et al<sup>162</sup> of 5 randomized controlled trials reported an approximately 3% reduction in CRP levels across the exercise groups, which was not significant. However, the studies that were negative found other positive benefits of exercise, regardless of its effect on CRP.

With regard to FM, exercise as an intervention has been shown to be beneficial, particularly in relation to pain management. Ellingson et al<sup>147</sup> conducted a prospective study and emphasized how a sedentary lifestyle was likely deleterious for pain regulation in FM. Likewise, Curtis et al<sup>163</sup> conducted a study wherein women with FM who engaged in a 75-minute yoga class twice weekly for 8 weeks reported reduced pain and catastrophizing, and increased acceptance of pain. Chronic fatigue syndrome is another debilitating disorder characterized by minimal physical activity during daily life and lower muscle strength and aerobic capacity compared to healthy sedentary subjects.<sup>149,154</sup> As with FM, when persons with CFS are entered into a regular exercise program, significant benefits in terms of physical capacity, quality of life, fatigue severity, and depressive symptomatology are reported.<sup>164,165</sup> Interestingly, Heins et al<sup>166</sup> reported that physical activity is intentionally limited in CFS patients, possibly because they expect negative bodily symptoms and catastrophize in such a way as to negatively affect their performance. This underscores the importance of the exercise-derived resilience resources self-efficacy, self-esteem, and motivation, which, unfortunately, were not measured in the above studies.

Overall, the clinical implications of a sedentary, physically inactive lifestyle are profound, and the literature clearly demonstrates that having a valid measure of

physical fitness, in particular aerobic fitness, may be one of the best indicators of resilience, as well as long-term health and risk of chronic diseases. Most of the above mentioned chronic diseases/disorders are also associated with depression, anxiety, low self-efficacy, and other barriers to critical resilience resources. Promoting regular physical activity in these populations has been shown to exert profound beneficial changes, and should be the key intervention for all such populations who are able to engage in regular physical activity.

### LIMITATIONS AND FUTURE DIRECTIONS

Limitations of studies examining how physical fitness contributes to resilience must be acknowledged. First, many studies examining reactivity to both physical and psychosocial stress did not quantify aerobic fitness or regular physical activity. This is essential for being able to accurately interpret the results, as they may be important confounders. Secondly, the intimate relation between hardiness/mental toughness, and aerobic capacity/physical activity must be further evaluated to document their interrelationship. Certainly, the mental toughness model was specifically developed for athletes who are physically fit and have self-confidence, so one would expect them to have many resilience resources. However, what happens when they become injured? In addition, many people with chronic diseases are able to cope and are physically unfit (they may be unable to engage in regular exercise), so physical fitness is important, but not an absolute.<sup>23,24</sup>

### CONCLUSIONS

Physical fitness is associated with many traits and attributes required for resilience. As such, it is one pathway toward resilience. Promoting physical fitness as a pathway to resilience is based on solid, scientific evidence as noted in many ancient and current sources showing that physical fitness blunts stress reactivity, confers physiologic and psychological benefits, serves as a buffer against stress, and can protect against stress-related disorders and chronic illness. Perhaps the role of physical fitness as a pathway to resilience was most eloquently stated by then President-Elect John F. Kennedy in 1960 when he said:

...physical fitness is not only one of the most important keys to a healthy body; it is the basis of dynamic and creative intellectual activity. ...intelligence and skill can only function at the peak of their capacity when the body is healthy and strong; hardy spirits and tough minds usually inhabit sound bodies.<sup>1</sup>

### RELEVANCE TO THE PERFORMANCE TRIAD

Physical activity is a key component of the Performance Triad and is clearly essential to optimal performance.

However, physical activity in the absence of adequate fueling (ie, healthy dietary patterns, appropriate timing and types of nutrients) and an adequate quantity and quality of sleep and recovery is not the solution. Excessive activity can lead to overtraining, musculoskeletal injuries, and similar problems. Only when physical activity is balanced with a healthy diet and restorative sleep will the benefits described above be realized.

#### ACKNOWLEDGMENTS

This research was supported by a grant from Comprehensive Soldier and Family Fitness (CSF2; HT9404-12-1-0017; F191GJ).

We appreciate the support in preparation and review of this article by LTC Sharon A. McBride, MS, USA.

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