

Physical Exercise, Psychological and Neurological Health: Reviewing the Anxiety and Depression Variables

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Abstract

Anxiety and depression are the most commonly affected psychopathologies in the world, and it is estimated that the diagnosis and the sale of medication will increase more and more. They can affect children and elderly people of both sexes (but more prevalent in women) and from all social classes. From a physiological point of view, it is the dysregulation in the production, transference, and uptake of monoaminergic neurotransmitters (dopamine, norepinephrine, and serotonin). Antidepressant drugs act mainly on the production and non-degradation of these neurotransmitters. Studies show that exercise has the effect of producing these neurotransmitters mainly after sessions, and also improves neural health. In this review article these aspects will be discussed.

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Introduction

Psychopathological illnesses such as anxiety and depression have been increasing over the years. They are more prevalent than other psychopathological illnesses such as schizophrenia, panic syndrome, phobias, post-traumatic stress, etc. [1]. As a definition, anxiety is seen as a subjective emotional state of uneasiness or distress, arising from an anticipated situation of real or imagined threat [2]. Depression, on the other hand, is a state of deep sadness [3]. These psychopathologies can affect children, adolescents, college students, adults and the elderly [4–8]. Its prevalence appears to be higher in women [9]. A possible physiological explanation for this phenomenon is the hormonal fluctuations that occur in women, which influence the modulation of various neurotransmitters [10].

The main causes of anxiety can be other health problems, genetics, traumatic events, use of licit and illicit drugs, it is even believed that some medications can cause anxiety [11]. In this context, fear is something

normal when faced with some danger, however, when this fear is overwhelming and persistent, being accompanied by worry all the time, feeling tired, being irritable, having difficulty concentrating and sleeping poorly is already considered pathological [11]. Depression can also be due to several factors such as the loss of a loved one, genetics, trauma, social aspects (bullying, abuse or loneliness), molecular and neurochemical factors, among others [12]. It can include negative events in childhood that can be the cause of anxiety and depression in adulthood [4]. However, people react differently to a stressful event, due to the difference in perceived stress [13].

In some cases major depressive disorder can even lead to suicidal behavior, thus becoming a public health concern in several countries [14]. In this sense, for an individual to be considered healthy not only his body has to be free of pathologies [diabetes, obesity, osteoporosis, hypertension, cancer, among others], but also the psychological. The main means of treatment

are medication, psychotherapy, and regular exercise [15]. Other non-pharmacological means can also lead to a reduction of anxiety and depression symptoms, such as social and family support, relaxation techniques, spirituality and religiosity [16].

In this context, the main focus of this review is the alternative treatment related to regular physical exercise, specifically in the variables of anxiety and depression, and the neurochemical response associated with these psychopathologies. This may bring relevant information to physicians, physical education professionals, psychologists, and individuals interested in the subject. For this, the keywords "exercise and psychological health", "exercise and serotonin", "exercise and depression", "exercise and anxiety" and "exercise, anxiety and depression", "exercise and BDNF", "exercise and brain" and "exercise and dopanin" were searched in the google scholar, pubmed and scopus indexing bases.

Evidence for physical exercise in improving mental health

There are several studies with different modalities, the main methods being the use of questionnaires. There are specific questionnaires to analyze mood, anxiety, and depression. Most of these studies show a positive association between individuals who practice physical exercises and psychological health. There is evidence that aerobic exercises of 20 to 30 minutes have a calming effect after the session and may last for hours [17]. A review study found that strength training can improve age-related conditions of insomnia, anxiety, depression, and cognitive decline [18]. As well as

martial arts also having evidence with jiu-jitsu, kickboxing [19], tai chi [20] and taekwondo [21–23].

Other sports may also be viable options such as cycling [24], swimming [25], or high intensity interval training [26], intense training programs (Crossfit) [27], among others. The aforementioned evidence shows such benefits from children to the elderly.

Additionally, people who would acquire some type of disability [paraplegia, blindness, deafness, etc.] are more likely to acquire psychological problems due to disability and loss of independence [28]. The adapted sports arose so that these people could practice them [29], there are several possibilities depending on the degree and type of the individual's disability, such as sled field hockey, wheelchair basketball, goalball, sitting volleyball, among others [30]. The practice of sports by these people seems to be a good option to improve life satisfaction and quality of life, consequently decreasing the perception of anxiety and depression [31]. Perhaps, competitive participation is a potentiator of these benefits in this population [31].

Furthermore, as regular physical exercise is related to body aesthetics, it can change the person's belief about himself, consequently improving self-esteem and quality of life. Other health benefits can be observed in research such as: prevention and treatment of hypertension [mainly aerobic exercises] [32], sarcopenia [exacerbated decrease in muscle mass, one of the most interesting exercises being strength training] [33], osteoporosis [decreased bone density] [34], Alzheimer's disease and other dementias [35]. In summary, the improvement in physical conditioning resulting from exercise positively impacts health status [36]. Figure 1 shows the various benefits of regular physical exercise.

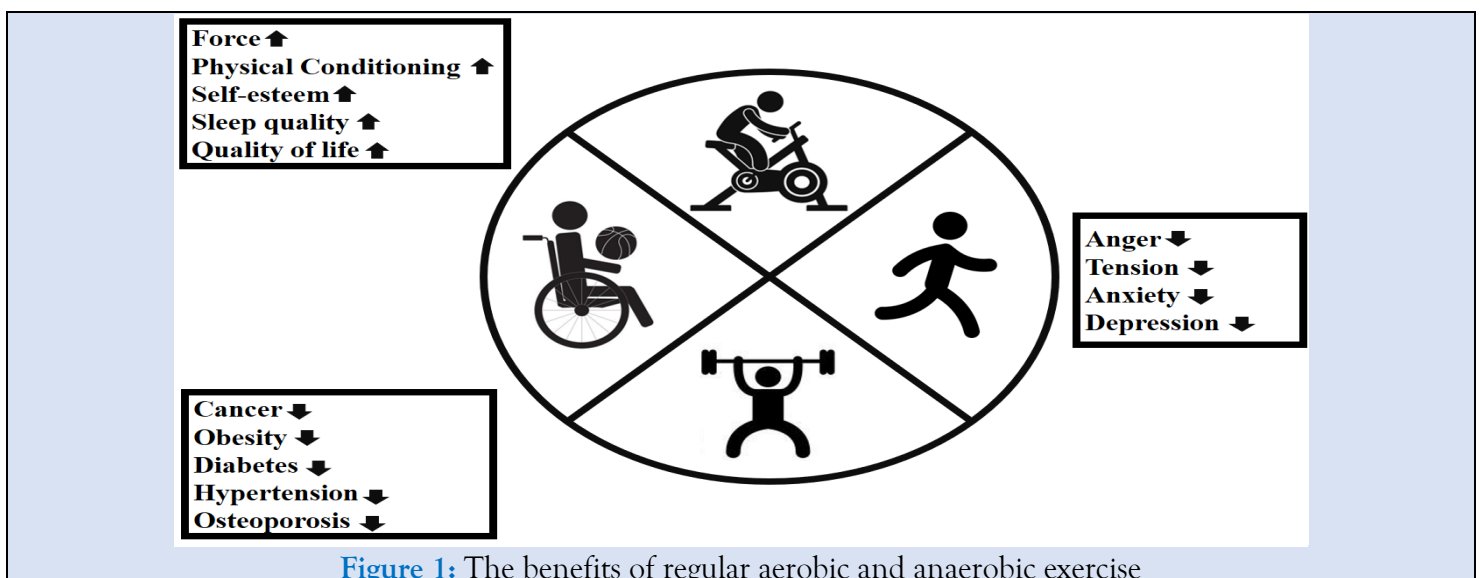


Figure 1: The benefits of regular aerobic and anaerobic exercise

Regarding exercise recommendations for adults, 150 to 300 minutes of moderate intensity exercise, or 75 to 150 minutes of rigorous intensity exercise or a combination of moderate and vigorous intensity exercise is suggested [37]. The physical education professional who is working with this public should have knowledge of the reasons that motivate them to practice, so that strategies can be made to increase the chance of permanence [38]. Additionally, the motivation of men and women appear to be similar for these practices [39] and in an appropriate and adapted way can be practiced from children to the elderly [40,41].

Neurotransmitters and physical exercise

Neurotransmitters are an important class of messenger molecules that govern chemical communications in the brain [42]. There are several neurotransmitters with different functions such as mood regulation, voluntary and involuntary movements [organ function], and other functions. The neurotransmitters responsible for mood regulation are serotonin, dopamine, and norepinephrine [43]. These neurotransmitters most likely exert an effect on the brain regions responsible for emotions such as: insula lobe, amygdala, cingulate gyrus, prefrontal cortex, and anterior cingulate cortex [44]. Psychopathologies such as anxiety and depression are physiologically associated with disturbances in the synthesis, release, transport and reuptake of these neurotransmitters [43].

The production of these neurotransmitters is done via signaling in which specific genes are responsible for their production [45]. Antidepressant drugs increase the signaling of serotonin, norepinephrine, and dopamine production [46], in addition to inhibiting an enzyme called monoamine oxidase (which degrades these neurotransmitters), thus increasing their availability in neurons [47]. Unfortunately, antidepressant drugs [which are used in the treatment of anxiety and depression] take several weeks to take effect inducing adaptive changes in the brain structures affected by these psychopathologies [48]. There are even people who do not respond well to drug treatment [49]. The commercialization of these neurotropic drugs began in the 1950s [50] and contemporarily many are the factors that can influence the type of drug that will be prescribed such as local practices, knowledge of the literature, clinical guidelines and even pharmaceutical sponsorships [51].

Physical exercise has the non-pharmacological effect on serotonin, norepinephrine and dopamine signaling [52]. Studies in several countries have shown higher production of these neurotransmitters during high intensity interval training [53], aerobic training [54], pilates [55], taekwondo [56] and the combination of strength and aerobic training [57]. Increases in serotonin concentration is related to physical and mental fatigue during exercise [58]. Thus, a possible potentiator of the drug's effect [19].

The amino acid tryptophan is an obligate substrate for the production of serotonin in the brain, intestine, and pineal gland [59]. the physical exercise has the effect of increasing circulating tryptophan by up to 102% and is thus related to the antidepressant effect of exercise [60]. It has been speculated that in the long term regular physical exercise can replace medication [61], but this needs to be tested in the scientific literature. This habit may be important for three reasons: 1) prevention of possible relapses [62]; 2) for patients with renal problems [decreased glomerular filtration rate] the medications are associated with proteins that are removed by renal route, and in this case may leave an accumulation of toxic metabolites in circulation [63] and 3) such medications may be expensive [64].

Brain-derived neurotrophic factor and physical exercise

In 1982 it was discovered that a protein produced in the hippocampal region called Brain-Derived Neurotrophic Factor [BDNF] exerts neural benefits in pigs [65]. Since then, a number of studies have been done both with animals and humans [65]. The serotonin is modulated by BDNF [66], that is, its low levels are associated with anxiety and depression [67]. The BDNF is related to the following neurological benefits: it increases neuroplasticity and neurogenesis, aids in mood regulation, improves memory and synaptic quality, increases neuron survival, and consequently is a protective factor against the development of Parkinson's, Alzheimer's, anxiety, and depression [68]. Due to these neural benefits, it may even be a factor in improving school performance [69]. Exercise is known to increase the production of BDNF, thus serving to protect against the onset of Alzheimer's disease and depression [70]. The intensity of physical exercise seems to be linked with higher production of BDNF [71]. The activities with evidences registered in literature are Crossfit [71], judô [72,73], tai chi [74],

boxing, taekwondo, a running [75], resistance training [76], combined training [aerobic + strength training] [70], basketball [77], a dance [78], yoga and meditation [79]. An interesting study found that intensity in resistance training did not appear to increase production, however, individuals trained longer than 7 weeks produced more BDNF [76].

Due to this mechanism, there are benefits in brain structure. One study when comparing the gray matter structure of competitive level judokas and healthy individuals who do not exercise, greater gray area was observed in judo practitioners ($p < 0.05$) [80]. Likewise, 12 weeks of twice weekly resistance training in eight

elderly subjects increased gray matter density in the posterior and anterior lobe of the cerebellum, superior frontal gyrus in the frontal lobe, and anterior cingulate cortex in the limbic lobe ($p < 0.001$) [81]. As well, as aerobic exercises such as dancing [82] and running [83]. Being crucial for healthy brain aging [84]. Figure 2 illustrates the main neurological benefits of regular exercise. However, care should be taken with brain concussion from strike combat sports (boxing, taekwondo, kickboxing, mixed martial arts, muay thai, savate, kung fu), rugby and some soccer situations, so that there is no neural and cognitive impairment.

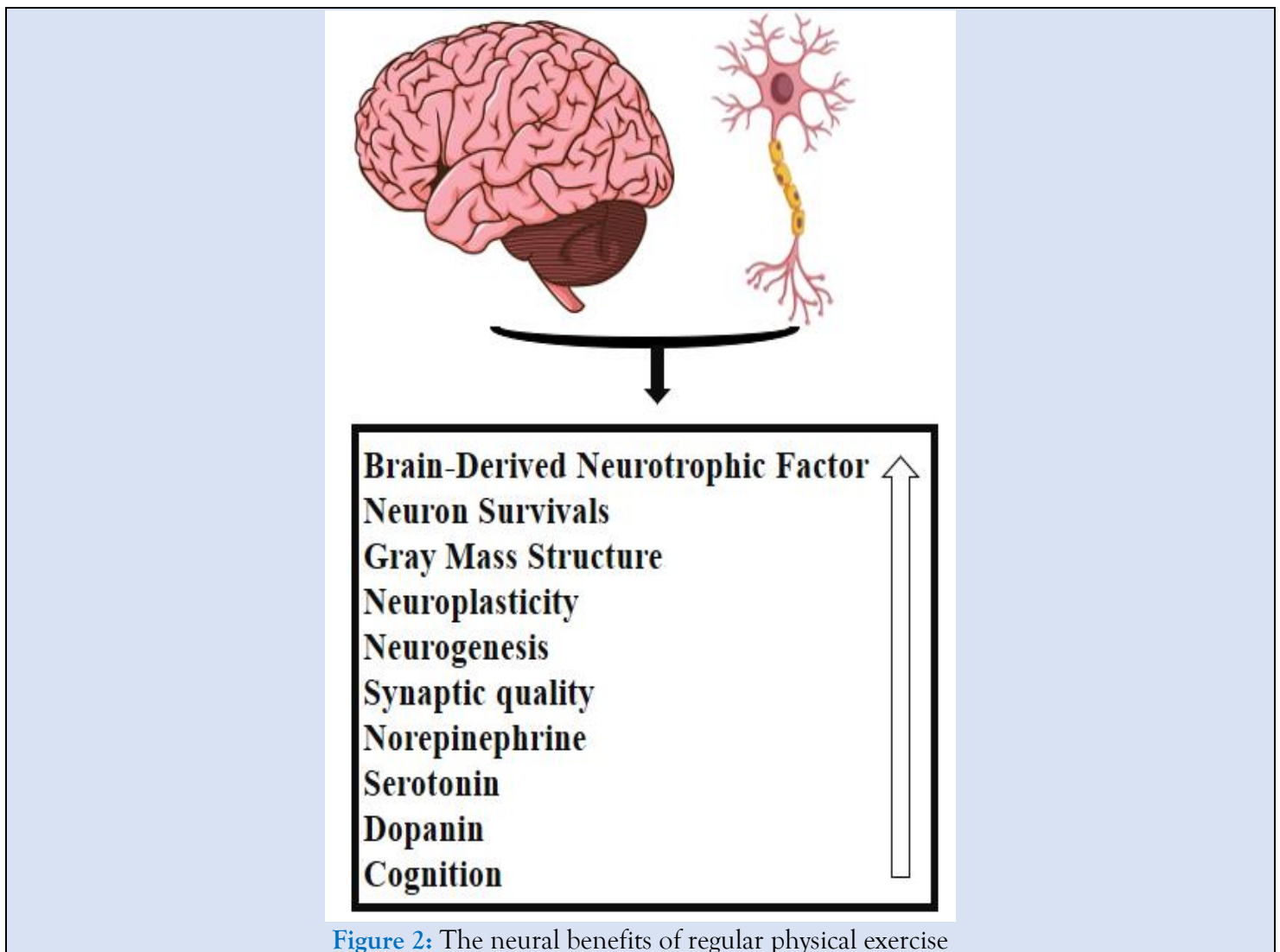


Figure 2: The neural benefits of regular physical exercise

Some considerations

The studies analyzing the production of serotonin, dopamine, norepinephrine, and BDNF were done via blood collection. In this sense, some of these substances are able to pass the blood-brain barrier and fall into the bloodstream [85]. Alternatively, serotonin also enters the circulation by passing through the intestinal wall to

be distributed to the tissues [including the brain] [86]. Studies analyzing brain structure, on the other hand, have used magnetic resonance or diffusion tensor [80–82].

In a cheaper way the studies that propose to investigate the psychological profile of a population use questionnaires. Although Behnke et al. [87] affirm that

the use of questionnaires is a valid and reliable method for providing information. It is even a form of use for the diagnosis of psychopathologies in psychiatric clinics (besides the patient report in this case) [88]. The limitation is the possibility of volunteers/patients lying due to discomfort and shame. It is up to the doctors and researchers to explain the importance of trust and sincerity in filling out these questionnaires.

Conclusion

There is consensus in the scientific literature of the psychological and neurological benefits of regular

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