

# The Effects of Physical Activity on the Perception of Feeling Alive

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This paper examines the effects of physical activity on the perception of feeling alive. It discusses the benefits of physical activity on both physical and mental health and how these can contribute to a greater feeling of being fully alive.

This paper is part of a larger research project that examines the feeling of being alive, what we can call peak experiences, moments of deeper understanding of the gift of life, or simply magic moments, and also how we can have more of these magic moments in our lives. In this paper, I am focusing on the effects of physical activity on that perception of feeling alive. This opening quote comes from an interview with a cage fighter, and it gives a rather extreme example of the power of physical activity to really bring us into the moment, heighten the senses, and to feel alive.

For me, the moment when I felt the most alive is when I was fighting. I had been training for a year and a half. The guy was a bit older than me. I was 29 and he was 42 at that time. Somebody knew him and said, 'you could hit him over the head with a crowbar and he would just laugh at you.' It was like, 'oh my God.' And I remember, the moment I was so nervous and scared before I went into the cage, and this is true for most of my fights. But the moment I stepped foot into the cage I was ready to go, and all the fear was gone. Everything just vanished and I was just there to fight. There's a photo of me moments before the cage before the fight started in the cage and you could just see it in my eyes. And yeah, that's the moment I felt most alive. You know with fighting, there's no place to run. There's no place to

hide. It's like you're stuck in a cage with somebody and this is the moment right? I am in my corner and I'm pacing and I've taped up. I got my gloves on. I'm saying to myself: 'What am I doing? This is crazy. I'm getting into a cage fighting another man. This is stupid, you know.' Oh, and you know I can hear the crowd going crazy because of the fight before me. It was a bloodbath before me, you know and when I got in the cage I remember looking down at my feet. The mat was yellow and it was just blood stained and it got me so like excited. You know, most people would freak out, but for me it was like the gladiator pit. You know, there were many fights before me. There's going to be many fights after me, but this is my moment. (*Interview #52*)

Cage fighting is obviously not everyone's preferred form of physical activity, but we can see clearly from the fighter's words how he became truly alive in the immediacy and danger of that moment. In the sections below, I discuss the benefits of physical activity for both physical and mental health and how it can make us feel more alive.

## **1. Benefits of Physical Activity on Physical Health**

Physical activity is generally regarded by medical professionals and health professionals as a crucial component of maintaining good physical health. Regular exercise has been shown to have a wide range of benefits for physical health, from improving cardiovascular health to reducing the risk of chronic diseases. As humans, although we spend so much time thinking and inside our minds, the reality is of course that we live within the physical frame of a body and the health of that body is a large determinant of how alive we can feel. The sections below discuss some of the ways that physical activity enhances the working of our bodies.

### ***Improves Cardiovascular Health***

One of the best known benefits of physical activity is its impact on cardiovascular health. Cardiovascular exercise, such as running, cycling, or swimming, helps to increase heart rate and improve the health of the heart and blood vessels. Regular aerobic exercise has been shown to lower blood pressure (Whelton et al., 2002), improve cholesterol levels (Cho et al., 2019),

and reduce the risk of heart disease (Berlin & Colditz, 1990). Regular physical activity can also improve the function of the endothelium, the inner lining of blood vessels, which can reduce the risk of heart attacks and strokes (Moyna & Thompson, 2004).

### ***Strengthens Bones and Muscles***

In addition to improving cardiovascular health, physical activity also helps to strengthen bones and muscles. Strength training, such as weightlifting or resistance band exercises, has been shown to increase bone density, particularly in postmenopausal women (Segev et al., 2018). Furthermore, regular strength training has been shown to improve muscle mass and strength, reducing the risk of age-related muscle loss (Reimers et al., 1998). This can lead to improved mobility, balance, and overall physical function in later life.

### ***Promotes Weight Loss and Improves Metabolism***

Physical activity is also important for maintaining a healthy weight and improving metabolism. Regular exercise has been shown to increase energy expenditure and promote weight loss (Catenacci & Wyatt, 2007). This is particularly true for high-intensity exercise, which has been shown to have a greater impact on metabolism than low-intensity exercise (Boutcher, 2010). In addition to promoting weight loss, regular physical activity has also been shown to improve insulin sensitivity and glucose metabolism, reducing the risk of type 2 diabetes (Gill & Cooper, 2008).

### ***Enhances Longevity and Reduces Risk of Chronic Diseases***

Finally, physical activity has been shown to enhance longevity and reduce the risk of chronic diseases. Anderson & Durstine (2019) report that regular physical activity can reduce the risk of several chronic diseases, including cancer, stroke, and dementia. Additionally, a large-scale study in Japan has shown physical activity improves overall lifespan, with regular exercise being associated with a lower risk of premature death (Inoue et al., 2008).

To summarize, physical activity is essential for maintaining good physical health and as a basic foundation for magic moments as they are defined above. From improving cardiovascular health to enhancing

longevity and reducing the risk of chronic diseases, the benefits of physical activity are numerous and wide-ranging. Whether it's through aerobic exercise, strength training, or simply engaging in regular physical activity, making physical activity a part of your daily routine is a crucial step towards feeling more alive.

## **2. Benefits of Physical Activity on Mental Health**

As well as the positive effects on our physical health, exercise and other physical activity have also been widely recognized as having a positive impact on mental health. During the Covid 19 pandemic when lockdown prevented many people from exercising, a study in Italy showed a correlation between the level of physical activity and mental health (Maugeri et al., 2020). In most cases, people were doing less physical activity and as such, their mental health and wellness was suffering. On the positive side, several key benefits that have been linked to regular exercise and physical activity are discussed below.

### ***Boosts Mood and Reduces Stress***

One of the most immediate benefits of physical activity is the release of endorphins, the body's feel-good hormones (Dinas et al., 2011). Regular exercise can help to reduce feelings of stress and anxiety (Mikkelsen et al., 2017). Additionally, physical activity has been shown to have a positive impact on depression (Dinas et al., 2011) helping to improve symptoms and increase overall happiness.

### ***Improves Self-Esteem and Body Image***

Physical activity has been shown to improve self-esteem and body image (Lopez et al., 2020). This can be particularly beneficial for individuals who may be struggling with body image issues, as physical activity can help to increase confidence and positive feelings about one's own body for both men (Bassett-Gunter et al., 2017) and women (Mama et al., 2011). Additionally, physical activity has been shown to increase feelings of empowerment and control (Blinde & Taub, 2008), and can also contribute to improved self-esteem (McAuley et al., 2000).

### ***Increases Focus and Productivity***

Physical activity has been shown to increase focus and productivity (Puig-Ribera et al., 2015). Exercise can help to clear the mind, improve concentration, and reduce symptoms of ADHD (Eliuk & Chorney, 2017). It can also increase overall energy levels (Wanigatunga et al., 2018). Additionally, regular physical activity can help to improve sleep quality (Wang & Boros, 2021) which can also have a positive impact on focus and productivity during the day.

Overall, research into physical activity clearly has shown how it can enhance reduce anxiety, depression, ADHD and other conditions which reduce quality of life. Even for people with no reported mental health issues, physical activity is correlated with an increase in overall feelings of happiness and well-being. This can be due to a combination of factors, including the release of endorphins, improved self-esteem, and increased focus and productivity. In these ways, physical activity can also provide a sense of accomplishment and satisfaction which can further contribute to happiness and well-being.

### **3. How Physical Activity Makes People Feel More Alive**

As discussed above, physical activity has been shown to have numerous physical and mental health benefits. One of the most important benefits of physical activity is the way it makes people feel more alive as shown by the responses in the interviews. This is because exercise has a positive impact on various aspects of well-being, including energy levels, mood, and overall outlook on life. Below, I will discuss we some of the ways in which physical activity makes people feel more alive.

#### ***Increases Energy Levels and Vitality***

One of the most immediate benefits of physical activity is the increase in energy levels and vitality that it provides. As discussed above, regular physical activity has been shown to increase energy levels, reduce fatigue, and enhance overall physical and mental vitality. This takes place at least partly through the release of endorphins, which are natural chemicals that

can improve mood and reduce stress. Endorphins act as analgesics, which means they diminish the perception of pain, and as sedatives, but it appears that endorphins go beyond reducing negative feelings. Endorphins also trigger a positive feeling in the body that can be comparable to morphine (Bruce, 2022). Although endorphins and morphine may utilize different brain areas, they often bind to the same neuron receptors and can have similar functions such as exerting biological effects upon the endocrine pancreas (Huang et al., 2011; Ipp et al., 1978). The release of endorphins through physical exercise is probably best known through the phenomenon of “runner’s high”, the feeling that people after a run or a hard workout often describe as euphoric. “Runner's high” can be accompanied by a short-term positive and energizing outlook on life. More importantly, recent research suggests that it may also lead to long-term positive consequences. In particular, the beta-endorphin which emerges from physical activity appears to be one mechanism in which adult neurogenesis takes place in the hippocampus and may contribute broadly to brain health (Swanson, 2021). Through increasing the sense of vitality in our bodies both short-term and long-term, these endorphins can potentially help us to feel more alive.

Additionally, because regular physical activity improves sleep quality, this can further enhance energy levels and overall vitality. A Norwegian study into the relationship between sleep quality and life satisfaction concluded that better sleep quality, longer mean sleep duration, less variability in sleep duration and less variability in rise time were all associated with greater life satisfaction (Ness & Saksvik-Lehouillier, 2018). In other words, physical activity helps us to sleep better and to have more life satisfaction, especially when it is carried out as part of a regular lifestyle.

### ***Provides a Sense of Accomplishment and Satisfaction***

Physical activity also provides a sense of accomplishment and satisfaction, which can greatly improve overall well-being. Regular physical activity has been shown to improve self-esteem, body image, and overall feelings of

accomplishment for both adults (Ebbeck et al., 1995) and adolescents or younger children (Kirkcaldy et al., 2002). This is because exercise provides a sense of control and mastery, which can be particularly beneficial for individuals who struggle with feelings of anxiety or low self-esteem. Additionally, physical activity can provide a sense of structure and routine, which can be a source of comfort and satisfaction (Cronshaw, 2022).

As an example of this sense of accomplishment and satisfaction, here is a report by a personal trainer on attempting to beat his own personal best in weightlifting. In his words, we can see the marshalling of all his training and physical and mental resources in order to achieve a personal goal, and how success in this challenge gives him powerful rewards.

Getting a personal record is one way for me to feel alive. For example, like a heavy compound lift, in my case like a deadlift. There was one that got lifted a couple of months ago, the heaviest weight that I'd ever lifted.

When you're going to lift a weight that is absolutely at the maximum range of your capabilities as an organism, you know you have to psych yourself up. It has to be the right day. You have to be in the right physical state mental state. It's a fight with this tremendously enormous iron bar. It's you against this bar and if you fail, technically fail so your form is off, there is a possibility of serious injury involved in something like that. You could screw up the back. You can pull a hamstring, could tear a muscle, and there's all sorts of things that can go wrong if your form isn't there, so you have to be dialled in technically.

And you also have to be amped up so that your adrenaline is pumping. Then you step up to the bar, and this is the moment of expectation. And if you succeed there is this tremendous victory, and if you fail, there's all of these risks involved. Not to mention just failing - the lift and feeling disappointed and let down by yourself and all of this preparation because you only get to do it once every few months.

You know the lift itself probably only takes a couple seconds, right? If it's really straining like you know, 3 seconds of ... it's dragging this weight up

with all of your force. You get to the top. You drop it down and then it's just like every positive neuro chemical biological signal you can imagine just floods your brain in your body and you feel like Superman. And you know it basically just comes down to you, you get this huge flood of testosterone. Any victory in a sports game or sealing a deal or you know, winning a match, a fight or something like that. Testosterone is what signals this success to you. It reinforces this behaviour. It makes you feel like you're higher on the status totem pole and all of these evolutionary things. And I think it might just come down to that flood of testosterone and not dopamine 'cause that's anticipatory, but it feels pretty incredible. And then if everyone in the gym is standing around watching, you know, it just heightens it so much more right? And you are so up for the next two days. And it lasts for a bit, you feel like I did something. I used my physicality to make something happen that I was previously incapable of doing. And yeah, it just feels like what's next, like what else can I do? What possibilities are there? (Interview #51)

Here, we can see the massive focus of energies into a single moment of life and the great feelings that can result from success. The desire to be higher on the 'totem pole' shows how this kind of feat is also socially-driven. As with the cage-fighting example quoted earlier, extreme weight-lifting of this type is not for everyone, but it does demonstrate the tremendous level of physical and mental satisfaction that can result from physical activity. It also raises the role of body chemicals such as adrenaline and testosterone.

The interviewee is a personal trainer and very aware of research into workouts and he understands what he is saying when he says that your "adrenaline is pumping at these moments." A definition from an extreme sports website concurs with the importance of adrenaline stating:

"In an adrenaline rush, the body's blood flow, digestion, and pain sensitivity are all suppressed. Blood vessels in the body constrict themselves to allow the majority of blood to flow to the most important places such as the heart and lungs. Digestion is slowed in order to conserve energy and the body experiences a temporary decrease in its ability to feel pain. These



suppressions allow our bodies to last longer, work harder, and ultimately perform tasks that sometimes seem super-human” (*Effects of Adrenaline on Your Body & Why We Love the Thrill*, 2016).

Earlier in this paper, I have discussed the role of endorphins such as dopamine and the role of adrenaline, and it is clear from the interviewee’s words that he sees also testosterone as a key body chemical that makes us feel more alive. Nathan (2016) distinguishes dopamine and testosterone as follows:

Dopamine is a neurotransmitter within the brain and body that plays important roles in emotion, motor control, focus maintenance, working memory, and is involved in reward and pleasure pathways.... Testosterone is a sex hormone that is involved in libido, vitality, bone density, fat distribution, muscle strength and mass, face and body hair, the production of sperm in males, and the production of red blood cells.

While testosterone is usually associated with men and is generally associated with higher levels of well-being in men, low levels of testosterone in women can also be related to low levels of well-being. One study (Goldstat et al., 2003) concludes that “testosterone therapy improves well-being, mood, and sexual function in premenopausal women with low libido and low testosterone.” Another study, however, notes that too much testosterone can have negative implications for women’s mood and “that high free testosterone levels may play a significant role in depression of overweight premenopausal women” (Stanikova et al., 2019). The role of testosterone is a complex one which is still not fully understood and while it seems to provide a boost to men’s sense of well-being and feeling alive, it can potentially have negative influence on women’s mood.

More generally, however, it is clear that physical activity provides clear opportunities for both men and women to have a sense of accomplishment and success especially when carried out long-term with clear goals and benchmarks. For example, in her book *Marathon Women*, Katherine

Switzer writes:

When I go to the Boston Marathon now, I have wet shoulders—women fall into my arms crying. They're weeping for joy because running has changed their lives. They feel they can do anything. (*Switzer, 2017*)

### ***Offers Opportunities for Peak Experiences***

This paper opened with one example of how physical experience can offer opportunities for peak experiences (Maslow, 2013). When my brother turned fifty, he decided to start running marathons, specifically as an opportunity to have more peak experiences in his life. His first marathon which was through the mountains and finished with 800 steps upwards to the finish line certainly provided that kind of opportunity. Below is another example from an interview about a commonly described peak experience—a bungee jump. This is another type of physical activity that people do to deliberately achieve peak experiences.

So I just went to the mountain top on my first bungee jump. I was in university at the time and I was reading a lot of Japanese death poetry, generally haiku or tanka poems that were written by Samurai, Haiku poets or Zen monks in the moments before they died right before they commit seppuku or whatever. And so it encapsulates their thoughts about the moment. And I was fascinated with this. And I thought this bungee jump would be a great opportunity to practice this. I went up to this platform and I sat down and meditated for a few minutes and I convinced myself, to whatever extent I was capable, that that this was the moment in which I would end my life by jumping off of this platform to my death. Everyone else goes up there and they jump off the platform. And I went up there and I stood there, and to the guy I said, 'don't count for me.' Everyone else gets a count, I didn't want to count. Instead of jumping, I just fell off. I hit the bottom and it pulled me back up. And it was like a feeling of sort of being reborn or seeing the world with fresh eyes. Of being just full of life and when I got to the top, the guy looked at me and he goes 'Radical... spiritual, man.' Clearly I had

experienced something deeper than just a rush. (*Interview #51*)

Here, we can see how the physical activity enabled a peak experience which affected the person deeply rather than being the effect of short-term body chemicals.

Another example of deliberately seeking a peak experience were the several interviewees who described their skydiving experience. In this description, we can see how the high-danger experience heightens sensory acuity and changes a person's sense of time in ways that accentuate the feeling of being alive at that moment.

Skydiving, because it was a whole-body sensation, like every part of your body had sensation... there was the cold sensation in your skin and the cognitive sensation of what was going on, just everything working at once and it was really a stunning experience... that would probably be when I felt most alive because there was so much going on.... how much can happen in a split second, perceptively... because I can clearly remember thinking about a huge number of things but clearly it was only instants, moments, but I processed a lot, I perceived the passage of time differently... I remember thinking, ok I need to look at the horizon, I feel a little finky here. I remember going this is 125 degrees, this is terminal velocity, and I can remember all my thought processes, a lot went on in those 10 seconds... it seemed like it lasted longer  
(Interview #28)

### ***Encourages Mindfulness and Presence in the Moment***

Physical activity can also encourage mindfulness and presence in the moment, which can greatly improve overall well-being. According to a review (Gapin et al., 2011), physical activity has been shown to improve focus, attention, and overall mindfulness. This is because exercise generally requires individuals to be fully present in the moment and focused on their physical movements, which can help to reduce stress and improve overall mood. Additionally, physical activity can provide a sense of peace and tranquillity, which can greatly enhance overall well-being. This example

shows how the shared physical activity combined with the beauty of nature and social togetherness created a perfect magic moment arising from mindfulness.

I climb mountains occasionally.... the year before last... I was in Assisi in Italy, there were a good six of us, we were walking from Assisi to Stiletto... we stopped to have lunch... we had these homemade sandwiches, beautiful foccacio bread and olive oil... we sat there and we didn't talk... six of us sitting there in the sunshine, there was olive groves and vinyards and just peace, we didn't talk at all for 20 minutes... we all just felt a sense of... this is special... we talked about it afterwards, not at the time... that's just one moment.

*(Interview #13)*

### ***Enjoyment***

One of the simplest ways that physical activity and exercise can make us feel more alive is the sense of enjoyment that they can add to our lives. Physical activity can get us out of our own heads and back into simply noticing and enjoying what is around us which is related to the above point on mindfulness. Again, we see interviewees talking about how the reconnection with natural beauty makes them feel alive.

Well, it was a recent moment, down at the exercise unit at the seafront, looking out over the sea with the sun rising and the birds singing around, and the wind blowing, just doing a few exercises, like magic you know... *(Interview #14)*

And we can also see how it raises sensory awareness in a manner similar to mindfulness.

I was swimming in Cyprus, .... it was just a lovely temperature, it was sunny, it was a perfect sunny day, perfect blue sky, and it was a beautiful area and I just felt so right in the water... and it felt really really nice. *(interview #25)*

### ***Supports Social Interaction***

Social interaction and connection to other people is a fundamental part of

well-being. This was shown clearly during the imposed lockdowns of the Covid 19 pandemic (Marler et al., 2021). While the level of social interaction varies between people, humans have evolved in a social capacity and it is part of our DNA to interact with other members of our species (Pierce & White, 1999). One of the other ways in which physical activity can contribute to a feeling of aliveness is through the creation and maintenance of social connections and overall social support. This is clearly true for team sports such as soccer and rugby where the participants tend to meet on a regular basis and develop social relationships in an enjoyable context which positively affect their lives. In the example below, we can see how the activity, baseball, is both intrinsically enjoyable and also connects the person to her social circle.

... really alive, hmm probably playing baseball as a little girl... it was very fun and energetic .... it was fast and had a lot of energy in it... and my parents used to come and watch... I used to play with my friends .... I'd like to connect with the ball and hit and throw and run... and I liked practicing it... I liked working at the pitching part of it even... my dad would help me with the pitching part of it... he'd say, let's throw the ball around and he'd go out to the park with me because we had a park right behind our house, and my dad would throw the ball around with me and help me with it... and get better and better, so practice made me a lot better... and pitching, when I started pitching, he would catch for me, doing that I became better at it ... yeah he was a great dad. (*Interview #30*)

For more solitary physical activities such as running, there are still many clubs where people participate together, and there are also smartphone apps where people connect to each other. Even weightlifting alone at home which may be seen as a primarily solitary activity tends to lead people to connect with similarly minded people online through discussion forums which can have positive social interaction effects on well-being.

Overall, we can see that physical activity fosters a positive outlook on life and to improve the chances of us feeling more alive in everyday life. As

discussed above, physical activity has been shown to improve mood, reduce feelings of anxiety and depression, and enhance overall well-being. It can also provide a sense of control and mastery over our physical and mental state, which can be a powerful source of self-confidence and optimism.

## 5. Conclusion

There are clearly many different types of physical activity that can have a positive impact on both physical and mental health and also contribute to more magic moments or the perception of feeling truly alive. Aerobic exercise, strength training, yoga and mind-body exercises, and outdoor activities are all physical activities that have benefits for mental health and can help us to feel more alive. The specific benefits of each type of physical activity will obviously vary, depending on the intensity and duration of the activity, as well as individual factors such as age and fitness level.

From increasing energy levels and vitality to fostering a positive outlook on life, the various ways in which physical activity makes people feel more alive are numerous and wide-ranging. Whether it's through running, cycling, or simply engaging in regular physical activity, making exercise a part of a daily routine is a crucial step towards maintaining good health and well-being. And when that is combined with social interaction and being in the context of nature, or within the context of personal goals, it raises the likelihood of magic moments becoming more common in our lives.

## References

- Anderson, E., & Durstine, J. L. (2019). Physical activity, exercise, and chronic diseases: A brief review. *Sports Medicine and Health Science*, 1(1), 3–10.  
<https://doi.org/10.1016/j.smhs.2019.08.006>
- Bassett-Gunter, R., McEwan, D., & Kamarhie, A. (2017). Physical activity and body image among men and boys: A meta-analysis. *Body Image*, 22, 114–128.  
<https://doi.org/10.1016/j.bodyim.2017.06.007>
- Berlin, J. A., & Colditz, G. A. (1990). A Meta-Analysis of Physical Activity in the Prevention of Coronary Heart Disease. *American Journal of Epidemiology*, 132(4),

612–628. <https://doi.org/10.1093/oxfordjournals.aje.a115704>

Blinde, E., & Taub, D. (2008). Personal empowerment through sport and physical fitness activity: Perspectives from male college students with physical and sensory disabilities - ProQuest. *Journal of Sport Behavior*, 22(2), 181–202.

Boutcher, S. H. (2010). High-Intensity Intermittent Exercise and Fat Loss. *Journal of Obesity*, 2011, e868305. <https://doi.org/10.1155/2011/868305>

Bruce, D. F. (2022). *Exercise and Depression*. WebMD.  
<https://www.webmd.com/depression/guide/exercise-depression>

Catenacci, V. A., & Wyatt, H. R. (2007). The role of physical activity in producing and maintaining weight loss. *Nature Clinical Practice Endocrinology & Metabolism*, 3(7), Article 7. <https://doi.org/10.1038/ncpendmet0554>

Cho, A.-R., Moon, J.-Y., Kim, S., An, K.-Y., Oh, M., Jeon, J. Y., Jung, D.-H., Choi, M. H., & Lee, J.-W. (2019). Effects of alternate day fasting and exercise on cholesterol metabolism in overweight or obese adults: A pilot randomized controlled trial. *Metabolism*, 93, 52–60. <https://doi.org/10.1016/j.metabol.2019.01.002>

Cronshaw, S. (2022). Web workouts and consumer well-being: The role of digital-physical activity during the UK COVID-19 lockdown. *Journal of Consumer Affairs*, 56(1), 449–464. <https://doi.org/10.1111/joca.12375>

Dinas, P. C., Koutedakis, Y., & Flouris, A. D. (2011). Effects of exercise and physical activity on depression. *Irish Journal of Medical Science*, 180(2), 319–325.  
<https://doi.org/10.1007/s11845-010-0633-9>

Ebbeck, V., Gibbons, S. L., & Loken-Dahle, L. J. (1995). Reasons for adult participation in physical activity: An interactional approach. *International Journal of Sports Psychology*, 26(2), 262–275.

*Effects of Adrenaline on Your Body & Why We Love the Thrill*. (2016, November 4). Head Rush Technologies.  
<https://headrushtech.com/blog/effects-adrenaline-why-we-love-thrill/>

Eliuk, K., & Chorney, D. (2017). Calming the Monkey Mind. *International Journal of Higher Education*, 6(2), 1–7.

Gapin, J. I., Labban, J. D., & Etnier, J. L. (2011). The effects of physical activity on attention deficit hyperactivity disorder symptoms: The evidence. *Preventive Medicine*, 52, S70–S74. <https://doi.org/10.1016/j.ypmed.2011.01.022>

- Gill, J. M. R., & Cooper, A. R. (2008). Physical Activity and Prevention of Type 2 Diabetes Mellitus. *Sports Medicine*, 38(10), 807–824.  
<https://doi.org/10.2165/00007256-200838100-00002>
- Goldstat, R., Briganti, E., Tran, J., Wolfe, R., & Davis, S. R. (2003). Transdermal testosterone therapy improves well-being, mood, and sexual function in premenopausal women. *Menopause*, 10(5), 390.  
<https://doi.org/10.1097/01.GME.0000060256.03945.20>
- Huang, H.-H., Farmer, K., Windscheffel, J., Yost, K., Power, M., Wright, D. E., & Stehno-Bittel, L. (2011). Exercise Increases Insulin Content and Basal Secretion in Pancreatic Islets in Type 1 Diabetic Mice. *Journal of Diabetes Research*, 2011, e481427. <https://doi.org/10.1155/2011/481427>
- Inoue, M., Iso, H., Yamamoto, S., Kurahashi, N., Iwasaki, M., Sasazuki, S., & Tsugane, S. (2008). Daily Total Physical Activity Level and Premature Death in Men and Women: Results From a Large-Scale Population-Based Cohort Study in Japan (JPHC Study). *Annals of Epidemiology*, 18(7), 522–530.  
<https://doi.org/10.1016/j.annepidem.2008.03.008>
- Ipp, E., Dobbs, R., & Unger, R. H. (1978). Morphine and  $\beta$ -endorphin influence the secretion of the endocrine pancreas. *Nature*, 276(5684), Article 5684.  
<https://doi.org/10.1038/276190a0>
- Kirkcaldy, B. D., Shephard, R. J., & Siefen, R. G. (2002). The relationship between physical activity and self-image and problem behaviour among adolescents. *Social Psychiatry and Psychiatric Epidemiology*, 37(11), 544–550.  
<https://doi.org/10.1007/s00127-002-0554-7>
- Mama, S. K., Quill, B. E., Fernandez-Esquer, M. E., Reese-Smith, J. Y., Banda, J. A., & Lee, R. E. (2011). Body Image and Physical Activity among Latina and African American Women. *Ethnicity & Disease*, 21(3), 281–287.
- Marler, E. K., Bruce, M. J., Abaoud, A., Henrichsen, C., Suksatan, W., Homvisetvongsa, S., & Matsuo, H. (2021). The impact of COVID-19 on university students' academic motivation, social connection, and psychological well-being. *Scholarship of Teaching and Learning in Psychology*, No Pagination Specified-No Pagination Specified. <https://doi.org/10.1037/stl0000294>
- Maslow, A. H. (2013). *Toward a Psychology of Being*. Simon and Schuster.



- Maugeri, G., Castrogiovanni, P., Battaglia, G., Pippi, R., D'Agata, V., Palma, A., Di Rosa, M., & Musumeci, G. (2020). The impact of physical activity on psychological health during Covid-19 pandemic in Italy. *Heliyon*, 6(6), e04315.  
<https://doi.org/10.1016/j.heliyon.2020.e04315>
- McAuley, E., Blissmer, B., Katula, J., Duncan, T. E., & Mihalko, S. L. (2000). Physical activity, self-esteem, and self-efficacy relationships in older adults: A randomized controlled trial. *Annals of Behavioral Medicine*, 22(2), 131–139.  
<https://doi.org/10.1007/BF02895777>
- Mikkelsen, K., Stojanovska, L., Polenakovic, M., Bosevski, M., & Apostolopoulos, V. (2017). Exercise and mental health. *Maturitas*, 106, 48–56.  
<https://doi.org/10.1016/j.maturitas.2017.09.003>
- Moyna, N. M., & Thompson, P. D. (2004). The effect of physical activity on endothelial function in man. *Acta Physiologica Scandinavica*, 180(2), 113–123.  
<https://doi.org/10.1111/j.0001-6772.2003.01253.x>
- Ness, T. E. B., & Saksvik-Lehouillier, I. (2018). The Relationships between Life Satisfaction and Sleep Quality, Sleep Duration and Variability of Sleep in University Students. *Journal of European Psychology Students*, 9(1), Article 1.  
<https://doi.org/10.5334/jeps.434>
- Pierce, B. D., & White, R. (1999). The Evolution of Social Structure: Why Biology Matters. *Academy of Management Review*, 24(4), 843–853.  
<https://doi.org/10.5465/amr.1999.2553257>
- Puig-Ribera, A., Martínez-Lemos, I., Giné-Garriga, M., González-Suárez, Á. M., Bort-Roig, J., Fortuño, J., Muñoz-Ortiz, L., McKenna, J., & Gilson, N. D. (2015). Self-reported sitting time and physical activity: Interactive associations with mental well-being and productivity in office employees. *BMC Public Health*, 15(1), 72.  
<https://doi.org/10.1186/s12889-015-1447-5>
- Reimers, C. D., Harder, T., & Saxe, H. (1998). Age-related muscle atrophy does not affect all muscles and can partly be compensated by physical activity: An ultrasound study1Presented in part at the 34th German Congress of Sports Medicine in Saarbrücken/Germany, October 19–22, 1995 [8].1. *Journal of the Neurological Sciences*, 159(1), 60–66. [https://doi.org/10.1016/S0022-510X\(98\)00134-8](https://doi.org/10.1016/S0022-510X(98)00134-8)
- Segev, D., Hellerstein, D., & Dunskey, A. (2018). Physical Activity-does it Really

Increase Bone Density in Postmenopausal Women? A Review of Articles Published Between 2001-2016. *Current Aging Science*, 11(1), 4–9.

<https://doi.org/10.2174/1874609810666170918170744>

Stanikova, D., Zsido, R. G., Luck, T., Pabst, A., Enzenbach, C., Bae, Y. J., Thiery, J., Ceglarek, U., Engel, C., Wirkner, K., Stanik, J., Kratzsch, J., Villringer, A., Riedel-Heller, S. G., & Sacher, J. (2019). Testosterone imbalance may link depression and increased body weight in premenopausal women. *Translational Psychiatry*, 9(1), Article 1. <https://doi.org/10.1038/s41398-019-0487-5>

Swanson, C. (2021). A Runner's High for New Neurons? Potential Role for Endorphins in Exercise Effects on Adult Neurogenesis. *Biomolecules*, 11(8), 1077. <https://doi.org/10.3390/biom11081077>

Switzer, K. (2017). *Marathon Woman: Running the Race to Revolutionize Women's Sports*. Da Capo Press.

than, N. (2016, March 10). *Dopamine and Testosterone: Making the Connection in Male Libido*. <https://sanescohealth.com/blog/male-libido-dopamine-testosterone/>

Wang, F., & Boros, S. (2021). The effect of physical activity on sleep quality: A systematic review. *European Journal of Physiotherapy*, 23(1), 11–18. <https://doi.org/10.1080/21679169.2019.1623314>

Wanigatunga, A. A., Simonsick, E. M., Zipunnikov, V., Spira, A. P., Studenski, S., Ferrucci, L., & Schrack, J. A. (2018). Perceived Fatigability and Objective Physical Activity in Mid- to Late-Life. *The Journals of Gerontology: Series A*, 73(5), 630–635. <https://doi.org/10.1093/gerona/glx181>

Whelton, S. P., Chin, A., Xin, X., & He, J. (2002). Effect of aerobic exercise on blood pressure: A meta-analysis of randomized, controlled trials. *Annals of Internal Medicine*, 136(7), 493–503. <https://doi.org/10.7326/0003-4819-136-7-200204020-00006>