

# ChatGPT is a Breakthrough in Science and Education but Fails a Test in Sports and Exercise Psychology

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## ABSTRACT

Released less than five months ago, ChatGPT became the center of attention of scholars worldwide. This artificial intelligence (AI) language model has over 100 million subscribers worldwide, generating many discussions concerning its accuracy, advantages, and threats to science and education. Its accuracy in law, linguistics, mathematics, and medicine has already been evaluated. Most results suggest that ChatGPT could generate a passing grade in these domains. However, its performance in sports science and psychology has yet to be tested. The large amount of information in this general area may yield more accurate performance. Still, specific subjects in the field, with controversial research findings, can lead to significant errors, which teachers and researchers could quickly spot. In this study, ChatGPT was tested on its accuracy on *exercise addiction*, a sports science and psychology subject associated with more than 1,000 publications. ChatGPT gave several correct answers to 20 questions but failed the test with 45%. Its performance was like in other already tested subjects. However, when prompted to write a general introductory editorial on AI's role in sports, ChatGPT performed well. Plagiarism detectors could not identify the AI-originated text, but AI detectors did. Therefore, it can be concluded that the system does a relatively good job on *general* issues but needs further development in more *specific* areas. Students and scholars cannot rely on ChatGPT to do their job. Still, future versions could yield dilemmas of originality since the system does not provide information for its source(s) of information.

**Keywords:** artificial intelligence; computers, information; language model; plagiarism.

## INTRODUCTION

OpenAI, an artificial intelligence (AI) research and deployment company, has launched the somewhat controversial (Shen et al., 2023) ChatGPT (Chat Generative Pretrained Transformer). In its mission, OpenAI aims to ensure that: “*artificial general intelligence benefits all of humanity*” (OpenAI, 2022). The expert staff at OpenAI have trained a model that they named ChatGPT capable of interaction in a conversational way. ChatGPT can reply to and follow-up questions in almost any subject in a dialogue format. It is a 175-billion-parameter Natural Language Processing (NLP) model that relies on learning algorithms using big data to provide person-like answers to user questions (Gilson et al., 2022).

Since its release to the general public on November 30, 2022, ChatGPT has attracted more than one million subscribers in one week (Baidoo-Anu & Owusu Ansah, 2023). Estimates show that in January 2023, two months after its launch, it reached 100 million monthly active users (Hu, 2023). A Google Scholar search on February 06, 2023, at 16.52 CET, yielded 4,340 records mentioning ChatGPT, with 151 articles including the term in their title. Most of these records are published as *preprints* due to the short time that has elapsed since the public can access ChatGPT.

Two major controversies behind the system are associated with: 1) *performance*, such as the accuracy of the information, and 2) *ethical*

concerns, such as using ChatGPT for plagiarism in educational and research settings (Cotton et al., 2023). While the latter is of uttermost importance, this paper evaluates the accuracy of the information generated by ChatGPT in a yet unexplored *specific research area*.

Regarding ChatGPT's *performance*, the programming/teaching method of the system is Reinforcement Learning with Human Feedback, making it highly conversational. However, as stated by its developers on November 30, 2022, ChatGPT may produce believable but inaccurate or senseless responses. For example, the system could refer to non-existent scientific studies (Thorp, 2023). Still, there are more limitations, some substantiated in the academic literature (Ventayen, 2023) and having the potential to be corrected, while others may be more hypothetical at this stage.

On the negative side, a recent study concluded that ChatGPT might not perform as well as commercial systems for biomedical abstracts or Reddit comments regarding translation accuracy. Still, translating spoken language may be of good service (Jiao et al., 2023). Additionally, apart from linguistics, ChatGPT was test-driven in mathematics, and the conclusion was that the system's math ability was lower than that of an average graduate student in mathematics (Frieder et al., 2023). Similarly, in four exams in law, ChatGPT exhibited mediocre performance, achieving low but passing grades (Choi et al., 2023). Furthermore, Blum (2022) tested the model and concluded that ChatGPT is programmed to prioritize *safety* (prevent damage such as lawsuits against OpenAI) above contextual consistency and truth. At the same time, information has a lower priority than consistency. If this conjecture is correct, one can anticipate that the performance accuracy of the system will be volatile for some time. Finally, Hanna (2023), using a philosophical perspective, criticizes ChatGPT by arguing that it lacks the rational human-mindedness, does not think, and overall is not intelligent (based on the philosophical definition of intelligence); therefore, the "I" in the "AI" is questionable.

On the positive side, a literature review concluded that scientific publishing would be greatly facilitated in the future, requiring less human work while allowing researchers to focus more on their scientific tasks (Aydin & Karaarslan,

2022). Another recent work supported this conclusion suggesting that ChatGPT could generate viable research questions, literature overviews, and test ideas (Dowling & Lucey, 2023). Due to human feedback, areas of consistent knowledge and major topics could generate more accurate answers than narrow specific topics, especially if they are accompanied by numerous controversial information in various databases.

In medicine, testing ChatGPT's ability to simplify radiology reports, 15 radiologists confirmed that the transformed scripts were complete, correct, and unlikely to harm patients. However, some contained inaccurate statements, omitted critical medical findings, and potentially hazardous phrases (Jeblick et al., 2022). ChatGPT also performed above the 60% threshold on the National Board Medicine Exam-FreeStep-1, from which the authors estimated that the system mirrors the knowledge of a third-year medical student (Gilson et al., 2022). In another recent study, ChatGPT performed at or close to the passing threshold on three United States Medical Licensing exams and showed a high level of agreement in its explanations (Kung et al., 2022). Further, in an Ophthalmic Knowledge Assessment Program, ChatGPT got 55.8% and 42.7% in correctness on two simulated exams (Antaki et al., 2023).

Due to its novelty, there are several academic fields in which the model was not explored. For example, no test of ChatGPT exists in social psychology. The system was tested on an essay and subject-specific open-ended performance to fill this gap while exploring how Chat GPT behaves in handling general and specific tasks. It was conjectured that the model would perform better on the general essay than on a specific multidisciplinary topic in sport science and psychology.

### Essay command

For originality, clarity, and comprehensiveness, ChatGPT was instructed to write a general text (quote): "Write a page-long editorial providing insight on the effect of artificial intelligence and tools like chat GPT will have on sports sciences," ChatGPT provided a very general, credible, and well-organized reply (2023.02.06). Although the answer was relatively brief, it would deserve a better than passing grade. The generated text has passed five

freely available but limited plagiarism tests at *grammarly.com* (5%), *scribbr.com* (0%), *quetext.com* (9%), *pagiarismdetector.com* (0%), and *papersowl.com* (0%).

However, using three free but limited AI text detectors, the results were significantly different. One from OpenAI named “AI Text Classifier” found that (quote): “*The classifier considers the text to be possibly AI-generated.*” The possible outcomes at this AI checker are 1) very unlikely, 2) unlikely, 3) unclear if it is, 4) possibly, or 5) likely. Another free AI text checker at *corrector.app* website (<https://corrector.app/ai-content-detector/>) has recognized that between 98.57% and 99.68% of the text is fake (or AI-generated). The third AI text detector at *writer.com* (<https://writer.com/ai-content-detector>) also revealed AI content ranging from 61% (first part) to 98% (second part). The figures were lower when the text was analyzed paragraph by paragraph. Still, this checker also did a better job than the plagiarism detectors. The results are given in parenthesis at the end of each paragraph below:

Artificial Intelligence (AI) and tools like ChatGPT are having a profound impact on various industries, including sports sciences. The integration of AI in sports has revolutionized the way athletes train, compete, and recover from injury. In this editorial, we’ll explore some of the ways in which AI and ChatGPT are changing the game in sports sciences. (49% fake)

*Enhanced Training and Performance Analysis: AI-powered tools and technologies are enabling coaches and trainers to gain new insights into athlete performance. By tracking player movements and analyzing performance metrics, AI algorithms can identify strengths and weaknesses, helping trainers to develop targeted training programs that can improve performance. AI can also analyze player statistics, helping teams to make informed decisions about lineup changes, game strategies, and player trades. (34% fake)*

*Injury Prevention and Rehabilitation: AI algorithms can analyze player movements, helping trainers to identify potential injury risks before they occur. This information can be used to develop injury prevention programs and protocols that can help to reduce the risk of injury. Additionally, AI-powered rehabilitation tools can help athletes*

*to recover from injury more quickly and effectively, enabling them to get back on the field or court as soon as possible. (28% fake)*

*Improved Fan Experience: AI and ChatGPT are also changing the way fans experience sports. AI algorithms can analyze player movements and match data, providing fans with real-time updates and insights into the game. Fans can also use ChatGPT to engage in natural language conversations about the game, getting answers to their questions and learning more about their favorite players and teams. (13% fake)*

*Advanced Analytics: AI is providing sports organizations with new ways to analyze player performance, game data, and team statistics. This information can be used to make informed decisions about everything from game strategy to player trades. AI can also help to identify patterns and trends in player performance, providing teams with valuable insights into player strengths, weaknesses, and tendencies. (86% fake)*

*Enhanced Broadcasts: AI is changing the way that sports are broadcasted, providing fans with a more immersive viewing experience. With AI-powered tools and technologies, broadcasters can provide real-time updates, statistics, and player insights, helping fans to stay engaged and informed throughout the game. (12% fake)*

*In conclusion, AI and tools like ChatGPT are having a profound impact on sports sciences, providing athletes, coaches, fans, and organizations with new ways to analyze performance, prevent injury, and enhance the overall sports experience. As AI continues to evolve and mature, we can expect to see even more exciting advancements and innovations in this field. (25% fake)*

The instruction given to ChatGPT referred to a very broad area making it relatively easy for ChatGPT to generate an adequate and relatively straightforward answer, which could indeed pass for an editorial, but certainly for the start of an introduction section of a student paper. The system may have a more challenging time with a narrower topic in the sports field, as shown by linguistics, mathematics, law, and medicine studies (Choi et al., 2023; Frieder et al., 2023; Jeblick et al., 2022; Jiao et al., 2023). But each academic area is unique; some are philosophi-

cal while others are more factual, such as those in natural sciences, and ChatGPT must adapt to handling this range of information.

Therefore, the next trial aimed to examine the accuracy of ChatGPT's responses in a specific subject of *sports science* and *psychology*, with over 1,000 publications (Szabo & Kovacsik, 2019). In a narrower study area, the complexity, range of controversial reports, and depth of information in various sources could challenge AI. While the many publications in an academic field could represent an excellent data resource for AI learning, the many dissonant pieces of information could lead to inaccuracy. Based on reports from other specific academic areas, it was presumed that ChatGPT would yield average accuracy in *exercise addiction* compared to the literature.

## METHOD

After registering for the service on the <https://openai.com/> website, ChatGPT (ChatGPT [Version 3] Jan 9 Version, Free Research Preview, interview date: 2023.01.22) responded to 20 questions on exercise addiction and closely related subtopics. The question and the obtained answers (word by word) are reproduced below with an *evaluation* based on three databases, including Google Scholar, PubMed, and Crossref. Resources for evaluation had to be up to date until 2021 as ChatGPT (Iu & Wong, 2023; OpenAI, 2022). The evaluation also crudely qualifies the answer as correct (1 point), fair (0.5 points), or incorrect (0 points) to yield a rough numerical estimate of accuracy.

### Questions, Answers, and Evaluation

#### Question No. 1: What is exercise addiction?

*Answer No. 1: Exercise addiction is a condition in which an individual becomes compulsively preoccupied with exercise to the point that it interferes with their daily life and relationships. Individuals with exercise addiction may feel an intense sense of guilt or anxiety if they are unable to exercise, and may continue to exercise even when they are injured or experiencing other negative health consequences. Exercise addiction is not recognized as a formal diagnosis, but rather is considered a behavioral addiction.*

**Evaluation No. 1:** The answer is correct

(Lichtenstein et al., 2021) up to the last sentence. However, this last sentence is ambiguous, as also confirmed by the *Grammarly* software: "Clarity: Your sentence may be unclear or hard to follow. Consider rephrasing. Still, the answer is relatively accurate." (1 point)

#### Question No. 2: How is exercise addiction assessed?

*Answer No. 2: Exercise addiction is typically assessed using self-report questionnaires or interviews. One commonly used questionnaire is the Exercise Addiction Inventory (EAI), which measures symptoms of exercise addiction such as withdrawal symptoms, tolerance, and continuation of exercise despite negative consequences. Another questionnaire is the Behavioral Addiction Scale for Exercise (BASE). These tools can help identify individuals who may be at risk for exercise addiction, but a formal diagnosis would require a comprehensive evaluation by a mental health professional. This evaluation would include an assessment of symptoms, as well as an examination of the individual's physical and psychological health.*

*It is worth noting that, while exercise addiction can be a serious issue, it is not yet a clinically recognized disorder and therefore not yet part of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5).*

**Evaluation No. 2:** The answer has accurate parts, like identifying the EAI correctly and the need for comprehensive evaluation. However, the Behavioral Addiction Scale for Exercise (BASE) **does not exist**. Further, the response fails to identify other instruments, some existing before the EAI, that are common in this field of research. Indeed, Sicilia and his colleagues (2021) have identified 17 tools, of which ChatGPT mentions only one. (0.5 points)

#### Question No. 3: What is the prevalence of exercise addiction?

*Answer No. 3: The prevalence of exercise addiction varies depending on the population studied and the criteria used to define it. Studies have estimated that the prevalence of exercise addiction in the general population ranges from 1% to 5%. However, in certain populations such as athletes and fitness enthusiasts, the prevalence may be higher, with estimates ranging from 15%*

to 20%. It is worth noting that this is a relatively new area of research and prevalence rates may change as more studies are conducted and the criteria for exercise addiction are refined.

Additionally, it is important to note that the concept of exercise addiction is still debated within the scientific community and some researchers argue that the concept of addiction is not the most appropriate framework to understand excessive exercise.

**Evaluation No. 3:** The first sentence is correct. The second sentence is incorrect because, in the general population, the prevalence rates of exercise addiction are between 0.3% to 0.5% (Mónok et al., 2012). Based on a more recent estimate, it can range between 1.9% and 3.0% (Di Lodovico et al., 2019). The figures concerning athletes are also inaccurate since they could range from 2.7% to 42% (Juwono et al., 2021). Finally, the last two sentences appear as waffling phrases because the answers could only be distantly related to the question. (0 points)

**Question No. 4: Which are the most common models for exercise addiction?**

*Answer No. 4: There are a few different models that have been proposed to explain the development and maintenance of exercise addiction.*

*One model is the Behavioral Model, which suggests that exercise addiction develops as a result of classical and operant conditioning. This model suggests that the individual learns to associate exercise with positive reinforcement, such as the release of endorphins, which leads to the development of compulsive exercise behavior.*

*Another model is the Psychological Model, which suggests that exercise addiction develops as a result of underlying psychological issues such as low self-esteem, body image concerns, or a need for control. This model suggests that individuals with exercise addiction use exercise as a way to cope with these issues and that the compulsive exercise behavior serves as a form of self-medication.*

*A third model is the Social Model, which suggests that exercise addiction develops as a result of social and cultural factors such as the emphasis placed on physical appearance and the promo-*

*tion of exercise as a means to improve physical health.*

*It's worth noting that these models are not mutually exclusive and that exercise addiction may be influenced by a combination of factors.*

**Evaluation No. 4:** The named models of exercise addiction **do not exist**. ChatGPT built three convincing and rationally explained theoretical models which do not exist. A naive reader could take its response for granted, and for an unspecialized teacher, they may seem logical, thinking it is legitimate, especially if references accompany them. However, a review of several models of exercise addiction (Szabo et al., 2018) does not mention any of the three generated by ChatGPT. (0 points)

**Question No. 5: In which form of sports or physical activity is exercise addiction the most prevalent?**

*Answer No. 5: Exercise addiction is most commonly associated with endurance sports such as running, cycling, and swimming, as well as bodybuilding and other forms of resistance training. These activities tend to involve repetitive and prolonged physical exertion, which can make it easier for individuals to become compulsively preoccupied with exercise.*

*Research studies have shown that athletes and fitness enthusiasts who participate in endurance sports are at a higher risk for exercise addiction, as well as other disordered eating patterns, than those who participate in other sports or physical activities. This is thought to be because endurance sports place a great emphasis on physical performance and body weight, leading to a preoccupation with physical appearance and the need to control weight, which can contribute to the development of exercise addiction.*

*It is important to note that exercise addiction can occur in any form of physical activity and it is not limited to a specific type of sport. It is a result of the psychological and emotional relationship an individual has with exercise, not the activity itself.*

**Evaluation No. 5:** The correct answer to this question, based on a review especially addressing this question (Di Lodovico et al., 2019), is that the prevalence of exercise addiction is the

highest in ball-games athletes (15.3%), followed in order by strength disciplines (10.7%), health and fitness exercises (6.0%) and endurance sports (3.5%). In another review (Marques et al., 2018), the prevalence of exercise addiction ranged between 3% and 7% in regular leisure exercisers and university students and between 6% and 9% in athletes. Therefore, the answer given by ChatGPT is incorrect. (0 points)

**Question No. 6: What is the relationship between exercise addiction to eating disorders?**

*Answer No. 6: There is a strong relationship between exercise addiction and eating disorders. Individuals with exercise addiction often have a preoccupation with body weight and shape, and may use exercise as a means to control their weight. This can lead to disordered eating patterns, such as restrictive dieting, binge eating, or purging, in an effort to control body weight.*

*Similarly, individuals with eating disorders, such as anorexia nervosa or bulimia nervosa, may also engage in compulsive exercise as a means of controlling their weight. They may have a distorted body image, and may see themselves as overweight even when they are underweight. This can lead to excessive exercise, which can have serious consequences on their physical health.*

*The relationship between exercise addiction and eating disorders is complex, and these conditions often occur together, referred to as “dual diagnosis” or “co-occurring disorders”. They can be treated simultaneously or in a sequential manner, depending on the specific case and the professional’s judgement. It is crucial to have a comprehensive assessment by a mental health professional trained in both areas to make a proper diagnosis and treatment plan.*

**Evaluation No. 6:** The answer is vague but correct, considering a literature review (Godoy-Izquierdo et al., 2021). However, it fails to mention that the condition is referred to as secondary exercise addiction when there is a relationship between the two. (a generous 1 point)

**Question No. 7: Is there a cultural difference in exercise addiction?**

*Answer No. 7: Research suggests that there may be cultural differences in the preva-*

*lence and expression of exercise addiction. Some studies have found that individuals from Western cultures are more likely to develop exercise addiction than those from other cultures. This may be due to cultural and societal factors such as the emphasis placed on physical appearance and the promotion of exercise as a means to improve physical health in Western cultures.*

*Additionally, research has suggested that people from certain cultures may be more likely to engage in certain types of physical activity that are associated with a higher risk of exercise addiction. For example, studies have found that individuals from Asian cultures are more likely to engage in martial arts, which may place them at a higher risk for exercise addiction than individuals from Western cultures who are more likely to engage in endurance sports.*

*It is also worth noting that cultural norms and expectations can influence how exercise addiction is perceived and treated. In some cultures, excessive exercise may be seen as a sign of discipline and dedication, while in others it may be viewed as a sign of a mental health disorder.*

*It is important to keep in mind that culture is not the only factor that can influence exercise addiction and that individuals from any culture can develop this disorder.*

**Evaluation No. 7:** Most studies on exercise addiction are conducted in western nations (Szabo et al., 2015). A search on PubMed, Crossref, and Google Scholar (February 2023) yielded no information supporting the answer given by ChatGPT. However, the answer seems adequate because it is logical and formulates a valid hypothesis that merits evaluation in future research. If fictive or resembling references were added, the answer could mislead peer reviewers and teachers in assessing research reports and academic papers, despite ChatGPT’s incorrect answer. (0 points)

**Question No. 8: Is exercise addiction more prevalent among men than women?**

*Answer No. 8: Research suggests that exercise addiction may be more prevalent among men than women. Studies have found that men are more likely than women to engage in excessive exercise and to have a preoccupation with body weight and shape. Men also tend to have more muscle mass than women and may be more*

likely to engage in resistance training and bodybuilding, which may place them at a higher risk for exercise addiction.

However, it is worth noting that this is a relatively new area of research and the findings are not consistent across all studies. Some studies have found no significant difference in the prevalence of exercise addiction between men and women, while others have found that women are at a higher risk.

Additionally, it is important to note that while men may be at a higher risk for exercise addiction, women are at a higher risk for disordered eating, and the two can be closely related. Therefore, it is crucial to have a comprehensive assessment by a mental health professional trained in both areas to make a proper diagnosis and treatment plan.

**Evaluation No. 8:** Only the first sentence in the answer directly addresses the posed question; the rest of the response appears as speculative waffling or unsolicited reasoning. However, ChatGPT's answer is incorrect. Indeed, although a review suggested that there may be gender differences in exercise addiction (Dumitru et al., 2018), another review published in the same period revealed no sex differences (Nogueira et al., 2018). In this context, other studies suggest that if scholars consider a minimum exercise volume, there are no differences between the sexes (e.g., Pálfi et al., 2021). Finally, at least one early study disclosed higher exercise addiction in women than men (Pierce et al., 1997). Therefore, the correct answer would be something like this: "current research evidence is ambiguous" (short form), or "the answer to this question may depend on many factors, which could be the reason for numerous controversial information related to this question" (long form). (0 points)

**Question No. 9: What is the difference between primary and secondary exercise addiction?**

**Answer No. 9:** The difference between primary and secondary exercise addiction refers to the different reasons why individuals develop exercise addiction.

Primary exercise addiction, also known as "pure" exercise addiction, is characterized by an individual's compulsive engagement in exercise that is not related to any other underlying condition, such as body dysmorphia or an eating disorder.

The individual engages in excessive exercise simply because they find it pleasurable and they cannot stop.

Secondary exercise addiction, also known as "symptomatic" exercise addiction, is characterized by an individual's compulsive engagement in exercise that is related to an underlying condition, such as body dysmorphia or an eating disorder. Individuals engage in excessive exercise to achieve a certain weight, body shape, or muscle mass, rather than for the pleasure of it.

It is important to note that both forms of exercise addiction can have serious consequences on an individual's physical and mental health, and it is crucial to have a comprehensive assessment by a mental health professional trained in both areas to make a proper diagnosis and treatment plan.

It is also important to note that exercise addiction is not an officially recognized disorder, and these terms are used in research studies, but not in clinical practice.

**Evaluation No. 9:** Based on Godoy-Izquierdo and colleagues (2021), while there are inaccuracies in the answer (i.e., "The individual engages in excessive exercise simply because they find it pleasurable ..." [addiction manifests in a compulsive and obligatory form of exercise, which is unlikely to be pleasurable], the answer is generally correct. (1 point)

**Question No. 10: Is there a connection between personality traits and exercise addiction?**

**Answer No. 10:** Research suggests that there may be a connection between certain personality traits and the development of exercise addiction.

Some studies have found that individuals with exercise addiction tend to have higher levels of perfectionism, which is characterized by a need to be perfect and a fear of failure. These individuals may use exercise as a way to control their body weight and shape, and to achieve a sense of perfection.

Other studies have found that individuals with exercise addiction tend to have higher levels of impulsivity, which is characterized by a lack of self-control and a tendency to act on impulses without thinking about the consequences. These

*individuals may engage in excessive exercise without considering the negative consequences it may have on their physical and mental health.*

*Additionally, studies have also found that people with exercise addiction may have higher levels of anxiety and depression, and lower levels of self-esteem.*

*It is worth noting that these personality traits are not specific to exercise addiction, and can also be found in other behavioral addictions or mental health disorders. It's also important to note that the relationship between personality traits and exercise addiction is complex and still being studied. It's not a direct causality and the development of exercise addiction can be influenced by many factors such as social and cultural factors, genetics and life events.*

**Evaluation No. 10:** Parts of the answer relating to perfectionism (Bircher et al., 2017; Çakın et al., 2021; González-Hernández et al., 2021) and self-esteem (Bruno et al., 2014) are correct. However, the answer is incomplete as ChatGPT fails to mention the connection of exercise addiction with narcissism (Bircher et al., 2017; Bruno et al., 2014; Cook et al., 2018), extroversion (Andreassen et al., 2013). Furthermore, anxiety and depression usually surface as state measures in most exercise addiction research; in their trait aspects, higher exercise involvement appears to be related to lower anxiety and depression rather than higher, as implied by ChatGPT (Weinstein & Weinstein, 2014). Finally, there is robust theoretical and empirical support for exercise addiction being a compulsive rather than an impulsive behavior (Berczik et al., 2012). (0.5 points)

**Question No. 11: How many case studies were published on exercise addiction?**

*Answer No. 11: Exercise addiction is a relatively new area of research, and the number of case studies published on the topic has increased in recent years. However, the exact number of case studies published on exercise addiction is difficult to determine as it depends on how one defines "exercise addiction" and the sources one uses to search for the studies. It also depends on the criteria used to define a "case study".*

*A quick search on academic databases such as PubMed or Google Scholar for "exercise addiction case study" returns several hundred results,*

*however, not all of these are actual case studies, some might be review articles or studies that mention case studies but not present them.*

*It is worth noting that while case studies can provide valuable insights into the experiences of individuals with exercise addiction, they are limited in their generalizability to the larger population and are typically used as a starting point for more robust research methods such as controlled trials.*

**Evaluation No. 11:** The answer to this question is highly speculative. First, the academic literature has extremely few exercise addiction case studies. Juwono and Szabo (2020) identified 12, then screened for testimonials on the internet to locate 100 cases that did not surface in academic writings. The sentence: "It also depends on the criteria used to define a 'case study' is incorrect because case studies are well-defined in the literature (i.e., Gerring, 2004). Further, Google Scholar returned no records on 2023.02.07 if the exact word order "exercise addiction case study" was searched and yielded three records if the words were searched (in any order) in the title. PubMed generated 41 records if the words appeared anywhere in the article. However, only one paper could be located with these words in the title and four when the terms were searched in both article's title and abstract. Finally, no literature suggests that the number of published case studies has increased recently, as their average has been less than one in a year since 1995. (0 points)

**Question No. 12: What is the relationship between exercise frequency and exercise addiction?**

*Answer No. 12: The relationship between exercise frequency and exercise addiction is complex, and research on this topic is still ongoing. Some studies have found that individuals with exercise addiction tend to engage in excessive exercise, and may exercise more frequently than individuals without exercise addiction. However, it is important to note that excessive exercise is not the only criteria for exercise addiction, it also includes other aspects such as compulsivity, tolerance, withdrawal, and negative consequences.*

*On the other hand, some studies have found that individuals with exercise addiction may exercise less frequently than healthy controls, but with a*



*higher intensity and longer duration. This suggests that the relationship between exercise frequency and exercise addiction is not straightforward, and that other factors such as the intensity and duration of exercise, as well as the individual's psychological and emotional relationship with exercise, are also important to consider.*

*It is important to note that while exercise is generally beneficial for physical and mental health, excessive exercise can have serious consequences on an individual's physical and mental health. It is crucial to have a comprehensive assessment by a mental health professional trained in both areas to make a proper diagnosis and treatment plan if you suspect that you or someone you know may have an exercise addiction.*

**Evaluation No. 12:** The answer mirrors the controversial information available to ChatGPT but agrees with some conclusions of review papers (e.g., Simon Grima et al., 2019). Generally, it is also in line with Bruno and colleagues (2014), who argue that exercise frequency may not be directly related to exercise addiction. Szabo and Kovacsik (2019) have supported this thesis and showed that passion might affect this association. Other studies, on the other hand, report an association between exercise frequency and exercise addiction scores, but some are small (e.g., Costa et al., 2013). This question is broad and worded in a rather general way, which facilitated ChatGPT's job of giving an overall correct answer. (1 point)

**Question No. 13: What is the relationship between passion and exercise addiction?**

*Answer No. 13: Passion and exercise addiction are related concepts but have distinct characteristics. Passion refers to a strong and persistent desire to engage in a particular activity that is enjoyable and fulfilling. Passion can be a positive and healthy aspect of an individual's life and can lead to the development of skills and the achievement of personal goals.*

*On the other hand, exercise addiction is characterized by a compulsive preoccupation with exercise that interferes with daily life and relationships. Individuals with exercise addiction may feel an intense sense of guilt or anxiety if they are unable to exercise and may continue to exercise even when they are injured or experiencing other negative health consequences.*

*A passion for exercise can certainly lead to increased participation in physical activity, but it does not automatically lead to exercise addiction. However, individuals who are passionate about exercise may be at a higher risk for developing exercise addiction if they are not able to balance their desire to exercise with other aspects of their life.*

*Some individuals who have a passion for exercise may start to develop an addiction when they can't control the urge to exercise, they start to neglect other aspects of their lives, they are not able to stop exercising even when they are injured or exhausted, and they feel guilty or anxious when they don't exercise.*

*It is important to find a balance between enjoying exercise and having a passion for it, and being aware of the negative consequences that excessive exercise can have on one's physical and mental health. If you suspect that you or someone you know may have an exercise addiction, it is important to seek professional help.*

**Evaluation No. 13:** ChatGPT provides an insightful answer on the relationship but fails to differentiate between two forms of passion, harmonious and obsessive, the basis of most current exercise addiction research (e.g., Kovacsik et al., 2018; Szabo & Kovacsik, 2019). The statement, "... individuals who are passionate about exercise may be at a higher risk for developing exercise addiction ..." is inaccurate because passion is generally not directly linked to the risk of exercise addiction. However, obsessive passion is closely associated with it, while harmonious passion may have a protective role (Bureau et al., 2019; Lichtenstein et al., 2020). (0.5 points)

**Question No. 14: Can you cite a case study on exercise addiction published in an academic journal?**

*Answer No. 14: Yes, one example of a case study on exercise addiction published in an academic journal is "A case study of exercise addiction: implications for assessment and treatment" by Jane Sims and Mark Griffiths, which was published in the Journal of Behavioral Addictions in 2014.*

*This case study describes the case of a 27-year-old male who was compulsively engaging in exercise despite experiencing negative consequences.*

*The case study describes the individual's physical, psychological and social symptoms, and his history of exercise and his psychological characteristics. The case study also describes the assessment and treatment of this individual, including the use of cognitive-behavioral therapy and self-help strategies.*

*It is important to note that case studies are a research method that present a detailed description of an individual, providing insights into a specific phenomenon, in this case exercise addiction, but they are not generalizable to the larger population and are typically used as a starting point for more robust research methods such as controlled trials.*

**Evaluation No. 14:** Incorrect. First, there is no such article with the title cited by ChatGPT. Second, Mark Griffiths has never heard of Jane Sims (personal communication via e-mail communication, February 05, 2022). (0 points)

**Question No. 15: Is exercise addiction related to age?**

*Answer No. 15: Research on the relationship between age and exercise addiction is limited and inconclusive. Some studies have found that exercise addiction may be more prevalent among younger adults, while others have found that it may be more prevalent among older adults.*

*One study found that exercise addiction is more common among young adults aged 18–25, with a prevalence rate of 6.3%, while another study found that the highest prevalence rate of exercise addiction was among adults aged 35–44, with a rate of 8.3%.*

*It is possible that the relationship between age and exercise addiction may be influenced by other factors such as life stage and societal expectations. For example, younger adults may be more likely to be in college or starting their careers and may be more susceptible to societal pressures to maintain a certain body weight and shape. On the other hand, older adults may be more likely to develop exercise addiction as a way to cope with aging and the associated physical changes.*

*It is worth noting that the relationship between age and exercise addiction is complex and that further research is needed to fully understand the*

*relationship. Additionally, it is important to keep in mind that exercise addiction can occur at any age and that individuals of all ages can develop this disorder.*

**Evaluation No. 15:** The answer to this question is dubious. First, the study ChatGPT refers to (Costa et al., 2013) is misinterpreted because older adults had a lower prevalence of exercise addiction than those in the 25–44 years age group. Second, most research (e.g., Costa et al., 2013; Lichtenstein et al., 2021; Szabo, 2021) indicates an inverse relationship between age and exercise addiction. To check the consistency of answers, this question was re-posed to ChatGPT 2.5 weeks later, on February 08, 2022. The answer was different and incorrect. Quote: “No, exercise addiction is not necessarily related to age. It can affect people of any age and is more related to individual factors such as personality, mental health, and behavior patterns. However, some older adults may develop a tendency towards exercise addiction as they age due to increased concerns about physical health and fitness.” Based on two identical questions, the answers provided at two different times are inconsistent, do not specifically address a “relationship”, and, thus, both answer versions are incorrect. (0 points)

**Question No. 16: What is the treatment for exercise addiction?**

*Answer No. 16: The treatment for exercise addiction typically includes a combination of psychological therapies and lifestyle changes.*

*One effective therapy for exercise addiction is cognitive-behavioral therapy (CBT), which helps individuals identify and change negative thoughts and behaviors related to exercise. CBT can help individuals learn to manage their exercise habits and develop a more balanced relationship with physical activity.*

*Another therapy that can be used to treat exercise addiction is motivational interviewing (MI), which helps individuals identify and overcome any ambivalence they may have about changing their exercise habits.*

*In addition to psychological therapies, individuals with exercise addiction may also benefit from working with a nutritionist or a dietitian to develop a healthy eating plan that supports their physical and mental health.*

*It is also important for individuals to learn how to set realistic and healthy goals for physical activity, and how to balance physical activity with other aspects of their lives such as work, family, and le*

*sure activities. This can be done by working with a physical therapist or personal trainer.*

*It is also important to note that exercise addiction is not a clinically recognized disorder, and therefore is not included in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5). Therefore, the treatment of exercise addiction is not well established and can vary depending on the professional's judgement and the individual's specific case.*

*It is important to have a comprehensive assessment by a mental health professional trained in both areas to make a proper diagnosis and treatment plan, and to take into account the individual's physical and psychological health, as well as the specific reasons that led to the exercise addiction.*

**Evaluation No. 16:** This answer is correct as it mentions the most popular treatment methods, such as CBT and MI (Weinstein & Weinstein, 2014). The connection between recognition as a dysfunction in DSM-5 and treatment is very insightful. (1 point)

**Question No. 17: What are the most common symptoms of exercise addiction? Can you cite your source of information?**

*Answer No. 17: The most common symptoms of exercise addiction include:*

- *A preoccupation with exercise, to the point that it interferes with other aspects of life*
- *A sense of guilt or anxiety if exercise is missed or curtailed*
- *A need to exercise more to achieve the same level of satisfaction*
- *Withdrawal symptoms such as anxiety, restlessness, or irritability when not exercising*
- *Continuing to exercise despite injuries or illnesses*
- *Prioritizing exercise over other activities or responsibilities*
- *Neglecting other aspects of life, such as work, school, or family, due to excessive exercise*

*It is worth noting that exercise addiction is not*

*an officially recognized disorder and these symptoms are based on the research studies on the topic.*

*This information is based on several studies and reviews that have been conducted on the topic of exercise addiction. For example, one review article "Exercise addiction: A comprehensive review" by Roberts, Markland and Fenton, published in the Journal of Behavioral Addictions in 2015, provides a comprehensive overview of the research on exercise addiction and describes the symptoms and characteristics of the disorder. Another review article "Exercise addiction: a review of the psychological literature" by Hausenblas, Downs and Nigg, published in the Journal of Psychology and Health in 2002, provide a summary of the literature on exercise addiction, including the characteristics and symptoms of the disorder*

**Evaluation No. 17:** The symptoms listed by ChatGPT are generally typical and correct. However, it misses an important one: mood modification, satisfaction, or euphoria after exercise (Juwono & Szabo, 2020). Even more problematic is that the titles, authors, and journals cited by ChatGPT are incorrect. For example, the Journal of Psychology and Health does not exist, and an expert reviewer or a teacher in the subject area quickly spots this fact. (0.5 points)

**Question No. 18: Are there any books on exercise addiction?**

*Answer No. 18: Yes, there are several books on the topic of exercise addiction. Here are a few examples:*

*"Exercise Addiction: When Fitness Becomes an Obsession" by Dr. Jennifer J. Nasser, MD – This book provides a comprehensive overview of the topic of exercise addiction, including its causes, symptoms, and treatment options.*

*"The Exercise Fix: Why Everything You've Been Told About Exercise Is Wrong" by Dr. Jordan Metzl – This book explores the topic of exercise addiction, and provides practical advice and tips for developing a healthy relationship with exercise.*

*"The Athlete's Way: Training Your Mind and Body to Experience the Joy of Exercise" by Christopher Bergland – This book offers a ho-*

*listic approach to exercise, and explores the topic of exercise addiction, providing strategies for maintaining a healthy balance between physical activity and other aspects of life.*

*“Exercise and Mental Health” by Michael Otto and Jasper Smits – This book provides a comprehensive overview of the relationship between exercise and mental health, including the topic of exercise addiction and its causes, symptoms, and treatment options.*

*These books provide a range of perspectives and can be helpful for individuals seeking to understand more about exercise addiction, its causes, symptoms, and treatment options. It’s important to consult with a mental health professional for a proper diagnosis and treatment plan.*

**Evaluation No. 18:** Incorrect answer. The book “Exercise Addiction: When Fitness Becomes an Obsession” is written by Laura Kaminker. The second book, “The Exercise Fix: Why Everything You’ve Been Told About Exercise Is Wrong,” could not be located. The third book, “The Athlete’s Way: Training Your Mind and Body to Experience the Joy of Exercise,” correctly identifies the author and the title but is not about exercise addiction. Finally, “Exercise and Mental Health” is written by William P. Morgan, and Stephen E. Goldston; while it touches on the topic, it is not specifically about exercise addiction. In this context ChatGPT is mostly inaccurate and cannot be granted any credit. (0 points)

**Question No. 19: What could be the main reason behind exercise addiction?**

*Answer No. 19: The main reason behind exercise addiction may vary depending on the individual and their specific circumstances. However, some common reasons that have been identified in research include:*

*Psychological factors: Some individuals may develop exercise addiction as a way to cope with negative emotions such as anxiety, depression, or stress. Exercise may provide a temporary sense of relief from these emotions, but over time, it can become a compulsive behavior.*

*Social factors: Societal and cultural pressures to maintain a certain body weight and shape may lead some individuals to develop exercise addiction. Additionally, some people may feel that ex-*

*cessive exercise is expected of them or that it is an integral part of their personal identity.*

*Biological factors: Exercise releases endorphins, chemicals in the brain that can produce feelings of pleasure and euphoria. Some individuals may become addicted to the rush of endorphins that exercise provides and engage in excessive exercise to achieve that feeling.*

*Personal factors: Some individuals may have a personal history of addiction, trauma, or other mental health conditions that make them more susceptible to exercise addiction.*

*It is important to note that the reason behind exercise addiction is often multifactorial and the development of the disorder is influenced by a combination of psychological, social, biological, and personal factors. It’s also important to have a comprehensive assessment by a mental health professional trained in both areas to make a proper diagnosis and treatment plan.*

**Evaluation No. 19:** This answer can be considered correct based on the interactional model of exercise addiction (Egorov & Szabo, 2013). Despite not mentioning the model, ChatGPT deserves full credit for this answer. (1 point)

**Question No. 20: What is the “runners’ high”?**

*Answer No. 20: The “runner’s high” is a term used to describe a state of euphoria or pleasure that some individuals experience while running or engaging in other forms of endurance exercise. It is characterized by feelings of well-being, reduced stress, and a sense of calm. The phenomenon was first described in the 1970s by German scientists, who observed that long-distance runners experienced a release of endorphins, which are chemicals in the brain that can produce feelings of pleasure and euphoria.*

*The mechanism behind the runner’s high is not well understood, but it is thought that the release of endorphins and other neurotransmitters, such as dopamine, serotonin, and norepinephrine, may play a role. Additionally, the release of endocannabinoids, which are chemicals that are similar to the active ingredient in marijuana, has also been linked to the runner’s high.*

*It is worth noting that not everyone experiences the runner’s high and that the intensity and du-*

*ration of the experience can vary among individuals. Additionally, the runner's high should not be confused with the addiction to exercise, which is a disorder characterized by excessive engagement in physical activity despite negative consequences.*

**Evaluation No. 20:** The answer is generally appropriate. Despite the availability of more in-depth knowledge, ChatGPT generated a valid answer that mostly agrees with Dietrich (2004). (1 point)

## DISCUSSION

There is great worry about academic dishonesty and scholastic integrity associated with the birth of Chat GPT (e.g., Cotton et al., 2023). However, such worry may be exaggerated and partially unfounded in some *specific* academic subjects. This research involved a test containing 20 questions that ChatGPT answered open-endedly and probably failed with 9/20 points if the passing grade was 50% or 60%. This performance nearing half of the accurate answers can be considered good in the development phase of a language model. From a pragmatic perspective, the situation is different. Its answers were verified and compared against the extant literature. These results are like those reported in other subjects, including law (Choi et al., 2023), mathematics (Frieder et al., 2023), and specialized medicine, such as ophthalmology (Antaki et al., 2023). Overall, ChatGPT's academic performance was mediocre. With such a performance, students might pass an exam, but probably only by luck if the tutor is superficial or needs to thoroughly with the taught subject. Similarly, only researchers getting a sloppy surface review could pass the peer review stage with a paper generated by ChatGPT.

Noteworthy is that ChatGPT comes up with nonexistent references (Question 14; Thorp, 2023), theories (Question 4), mismatched book titles or authors (Question 18), and research content, summaries, or conclusions (Questions 2, 3, 15). However, the developers at OpenAI warn users about the model's shortcomings and explicitly state that sometimes it can come up with inadequate, or even nonsensical, answers. Therefore, the results obtained in sports science and psychology in this research, like in other academic subjects (Antaki et al., 2023; Choi et al.,

2023; Frieder et al., 2023), could be anticipated. While in the course of its further development, ChatGPT will likely perform better, in agreement with Hanna (2023) it won't perform miracles as it uses existing information. Still, blending such information into insightful research questions could help teaching, learning, and research.

Researchers don't have a crystal ball to predict how the model will perform in the future. Still, it can be conjectured that there will be a threat to academic or scholastic honesty upon the perfection of the system because its output could already pass sophisticated plagiarism detection systems (Ventayen, 2023). The short editorial in this paper also passed five less sophisticated but freely available plagiarism check tools, indicating that ChatGPT paraphrases well, which can be helpful in particular learning or writing instances. However, the language model fails most of the already existing AI text detectors, so it can be expected that these services will soon surface at an increasing rate.

ChatGPT's fair use verification will likely result in a catch-22 scenario like doping vs. anti-doping in sports or viruses and antivirus programs in IT fields. Therefore, an important question preoccupying many scholars is to what extent ChatGPT will facilitate human work. Will OpenAI's mission (2022), "*artificial general intelligence benefits all of humanity*," be eventually accomplished? Perhaps it will. In academic works, people usually fear novelty for a while, as discussed by (Besancenot and Vranceanu (2015). These authors point out that progress in the advancement of knowledge typically proceeds in stages. There are periods of growth followed by stagnant intervals during which the implementation of new tools or concepts is generally avoided.

Many studies have attributed this pattern of scientific advancement to researchers' preference for conformity, where they prefer to work within fields that align with their peers. Considering this argument and the uncertainty of using ChatGPT, especially when its accuracy is still relatively mediocre, as shown in this and similar recent studies, it is unlikely that ChatGPT will receive all credits in academic works. Nevertheless, covertly its use will likely become widespread, while the fact that ChatGPT (at this time)

does not cite its source(s) of information. The information on which ChatGPT generates its answers comes from various (yet) unidentified and uncredited sources. Therefore, citing ChatGPT (even as a secondary source) is unacceptable.

At this time, the danger is that the non-inquisitive mind can take ChatGPT replies for granted. In contrast to the current work, where time-demanding meticulous verification of each answer was performed, even scholars (and students) may skip the verification stage. Indeed, whether the time and cognitive effort to check ChatGPT's answers outweigh the system's benefits is still an open question (Sobania et al., 2023). This need for verification, associated with mental effort and work time, along with the inability to cite the source of the (original) information, poses limitations to ChatGPT users in critical works like research reports or student dissertations. Therefore, interactions between factors associated with work, personality, and pressure will be strong determinants of the emotional balance between the risks of unorthodox use versus the benefits gained from the risk.

### Take-home messages:

1. Chat GPT provides credible and relatively accurate answers to general questions.
2. In specific academic fields, its performance is mediocre, often ( $\approx 50\%$ ) erroneous.
3. Plagiarism detectors, in general, are inadequate

for detecting AI-generated texts.

4. AI text detectors are already relatively efficient in detecting fake, AI-created text.
5. Currently, the information from ChatGPT must be checked against reliable resources.

### Strengths and Limitations

The strength of the work is that it tested ChatGPT's performance in a combined field of social sciences for the first time. Furthermore, the study compared the answers given to general and subject-specific questions. Another strength probably is that the answers were verified against the literature.

Still, this exploratory work is not without limitations. First, it tests the performance of the AI model on only 20 questions. Further, the answers were contrasted with the literature by the human "machine" that has not all the information, especially in a scholastic field with over 1,000 publications; thus, human error in evaluation is possible. Furthermore, in this context, the grading could have been biased. Finally, in this work, ChatGPT had only one chance (apart from Question 15) to answer user questions, which is usually how the public or students would be expected to use the system. But more frequent posing of the same question apparently might result in sequentially improved answers (Sobania et al., 2023), which was not the case in the current work (see Evaluation No. 15).

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