Chronotype Depression And Physical Activity: A Relationship To Be Studied?

Abstract

Introduction: Preferences for certain times of day to perform daily activities have been the focus of several investigations. Individuals with evening preference exhibit higher scores for depressive symptoms and less involvement in physical activities compared to morning and intermediate chronotypes. On the other hand, physical activity is an intervention that has shown great promise in alleviating symptoms of major depressive disorder.

Evidence Acquisition: This study aimed to perform a narrative review of the available evidence of possible relationships between chronotype, depression, and physical activities. The electronic searches of the published literature were performed in the databases National Library of Medicine National Institutes of Health, in 2019, for the last five years in the adult population. The results were grouped into three categories, chronotype and depression in adults; depression and exercise/physical activity in adults; and chronotype and exercise/physical activity/sport in adults.

Evidence Synthesis: The importance of physical activities in combating depression is quite evident in the literature, showing an inverse relationship between the level of physical activity and depressive symptoms.

Conclusions: However, many studies on depressive individuals do not identify the chronotype as an important tool to integrate chronobiological aspects of human behavior in the treatment of this disease. This review provides evidence for the scarcity of studies on the relationship between chronotype, depression, and physical activity.

Keywords: Depression; Chronotypes; Physical activity; Exercise; Adults; Sport

Introduction

Circadian rhythmicity is present in a range of biological and behavioral functions in all species and every cell; there is an endogenous temporal mechanism capable of preparing the organism in advance for external oscillations such as in the light-dark cycle [1,2]. These endogenous diurnal variations are determined by our internal circadian clocks and external environmental cues called “zeitgebers”. As examples of external environmental cues are the light/dark cycle and social interactions among others [3, 4].

The circadian timing system comprises the central clock in the suprachiasmatic nucleus (SCN) located in the hypothalamus and peripheral clocks in the body’s peripheral tissues that are controlled by the so-called clock genes [5, 4, 6]. These circadian clocks are fixed, but undergo external stimulus adjustments including sunlight, food, stress, exercise, and temperature [7]. Circadian rhythms vary among people and are mainly influenced by age, sex, hereditary and environmental influences [8, 3]. The variation of circadian rhythms among people may be classified with the concept of circadian typology called chronotype comprising three circadian types: the morning, the intermediate and the evening type [9, 3].

The term chronotype was initially used by Horne and Ostberg to identify subjects with morning and evening preferences through the questionnaire called HO Morning / Evening, which has 19 questions with scores ranging from 16 to 86 points, the lowest scores are referring to people with afternoon characteristics and the highest scores refer to people with morning characteristics, where the afternoon will have a preference for the activities at late hours and the morning with a preference for the activities at early hours in the morning [10].

The importance for the investigation of chronotypes has grown quickly and it is now accepted that circadian preference is associated with physical and mental health, in terms of well-being, but also some diseases [11, 12, and 1]. Some studies have shown a relationship between evening chronotype and...
A major depressive disorder is a mental illness responsible for years of disability also is reflected as a list of risk factors with mortality and morbidity worldwide [16]. The official diagnosis of depression is subjective and rests on the documentation of a certain number of symptoms that significantly impair functioning for certain duration [17]. People with depression suffer from changes in body composition [18], sleep [19-21], cortisol levels [22, 23], and body temperature [24, 25]. It is important to explain the complex array of symptoms related to the circadian activity. Recent studies combining behavioral, molecular and electrophysiological techniques reveal those certain aspects of depression result from maladaptive stress in specific neural circuits.

Multiple research reports suggest that abnormalities in circadian rhythms are involved in the etiopathogenesis of mood disorders [26]. Due to the increasing number of cases of people with depression, several studies seek alternatives for the prevention and treatment of depression. For reference [26] the pharmacological, psychological, and light treatments of mood disorders have multiple effects on circadian function. Effects of antidepressant drugs on the free-running circadian period indicate that these medications affect the circadian pacemaker. Antidepressants are considered the first line of treatment; however, the response rate is considered low. Circadian rhythm and altered physical activity have long been recognized as core features of Major depression. Thus, physical activity has been suggested as non-pharmacological treatments that should complement traditional methods [27-31].

In this sense, it is important to expand a discussion on the relationship between chronotype, depression, and physical activity. Understanding whether there is a relationship between the type of chronotype and depression, as well as whether physical activity can minimize these effects, is extremely important for the general health of the population suffering from depressive symptoms. Therefore, this study aimed to review the available evidence of possible relationships between chronotype, depression and physical activity. The evening types show more depressive symptoms than the morning ones. Thus, this study hypothesizes that physical activity can positively modulate responses of symptoms of depression in morning and afternoon patients.

Materials and Methods

Four comprehensive surveys were performed at the National Library of Medicine (Pubmed) in 2019, with the first combination using the terms: "Depression AND Chronotype AND (exercise OR physical activity) AND adults". However, only 7 results were found and did not present the relationship between the three variables [Physical Activity, chronotype and depression]. In this sense, the searches were separated (Figure 1), initially with the following terms “Chronotype AND depression AND adults”, being 139 articles identified. Inclusion criteria were: original articles; written in English; last 5 years; the relationship between depression and chronotype. Later the terms were used: "Depression AND (exercise OR physical activity) AND adults". In all, 2790 articles were found. Selection criteria were: written in English, original study; last 5 years; the relationship between exercise and physical activity with depression in adults. The last search used the following keywords: Chronotype AND (exercise OR physical activity OR sports) AND adults. In all 58 articles were found, the following criteria were applied: original article; written in English; present the relationship between chronotype and physical activity.

Analysis procedures

During the first screening, two reviewers (MJ or LT) evaluated the titles and abstracts of each citation and excluded irrelevant studies. For each potential study, two reviewers (FL or EL) examined the full article and assessed whether the studies fit within the inclusion criteria. In case of disagreement, a third evaluator would be contacted (NL).

Quality Assessment

The articles were evaluated based on internal validity (selection bias, performance bias, friction measurement bias and reports) and the validity construct (adequacy of the operational criteria used). In general, the quality of the evidence from the studies was assessed using three main measures: 1 limitation (poorly designed design, for example); 2- consistency of results; and 3- accuracy (ability to generalize findings and provide sufficient data). Studies that failed at these points were not added or selected (Figure 1).
Results

As a result of the first search, which identifies the relationship between chronotype and depression in adults, 7 studies were selected (Table I). The second search made it possible to identify the relationship between exercise / physical activity and depression in adults. At the end of the analyzes, 8 articles were selected (Table II). In the third search, we found 10 studies that evaluate the relationship of chronotype with exercise / physical activity in adults (Table III). Since the instruments developed to estimate chronotype are not equal the specific instrument used has been indicated in the tables (Tables 1-3).

The relationship between depression and Chronotype in adults

The evening is among people that exhibited more symptoms of depression than the morning and intermediate types [15, 32-40], but the underlying mechanism is still unclear. A possible reason could be the transformation of our modern society into a technological society that does not take into account the importance of chronotype on human health. Nowadays, many people spend an increasing amount of time in front of computer screens mainly during night time and these habit changes can force people to become more evening. Exposure to blue light from computer and cell phone screens can lead to disturbances in melatonin secretion and alterations in circadian physiology, alertness, and cognitive performance levels.

Among patients undergoing cognitive-behavioral therapy [41] those characterized as evening types have significantly more depressive symptoms, insomnia and irregular sleep-in relation to the intermediate and morning patients. A meta-analysis [42]

<table>
<thead>
<tr>
<th>Authors</th>
<th>Objective</th>
<th>Sample</th>
<th>Depression Assessment</th>
<th>Chronotype Assessment</th>
<th>Relevant Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Reference 48)</td>
<td>To report suicidality according to chronotype and seasonal pattern in patients with MDD.</td>
<td>120 subjects (18 to 74 years old).</td>
<td>HAMD</td>
<td>MEQ</td>
<td>There was no significant difference in depression scores between morning and evening patients. However, patients with evening preference have a higher suicidal risk when compared to morning patients.</td>
</tr>
<tr>
<td>(Reference 47)</td>
<td>To understand the associations between different dimensions of chronotype, depressive symptoms, and emotional eating.</td>
<td>10000 subjects (25-74 years old).</td>
<td>CES-D</td>
<td>Original MEQ</td>
<td>Preferences for morning hours were associated with lower scores of depressive symptoms.</td>
</tr>
<tr>
<td>(Reference 36)</td>
<td>To study the relationship between chronotype and depression in a more representative sample size of the Finnish adult population.</td>
<td>10503 subjects</td>
<td>Self-report questionnaires, with four questions.</td>
<td>MEQ</td>
<td>The evening show more depressive symptoms than the morning ones, even after controlling for possible confounding factors (sex, age, education, living conditions, alcohol consumption, smoking and sleep).</td>
</tr>
<tr>
<td>(Reference 33)</td>
<td>To examine the association between chronotypes and the presence of depressive and anxiety disorders in a large cohort, while taking into account relevant Sociodemographic, somatic health, and sleep factors.</td>
<td>2596 participated in the second year.</td>
<td>MDD and IDS</td>
<td>MCTQ</td>
<td>Individuals with evening chronotype are more likely to have depressive disorder, even when adjusted for health factors, Sociodemographic data, and sleep-related factors.</td>
</tr>
<tr>
<td>(Reference 32)</td>
<td>To explore the role of cognitive reactivity and pathological worry in the association between eveningness and depression.</td>
<td>1654 subjects, being 1227 depressions and 427 healthy controls.</td>
<td>LEIDS-R</td>
<td>MCTQ</td>
<td>Results show that evening type scored higher on a specific psychological factor of vulnerability to depression.</td>
</tr>
<tr>
<td>(Reference 49)</td>
<td>To examined whether differential relation of depression and seasonality to the morning and evening components of morningness-eveningness might be confirmed in analyses of a big dataset.</td>
<td>2398 subjects</td>
<td>CES-D</td>
<td>A short (40-item) version SWPAQ</td>
<td>Depression was found to be significantly linked to earliness-lateness, but only morning component of earliness-lateness demonstrates such a link.</td>
</tr>
<tr>
<td>(Reference 38)</td>
<td>The purpose of this study was to investigate and analyze the role of depression in its effects on chronotype and sociality.</td>
<td>2772 men</td>
<td>PHQ-9</td>
<td>CSM</td>
<td>Depressive symptoms and suicidal tendencies are significantly related to individuals with evening chronotype when compared to morning.</td>
</tr>
</tbody>
</table>

Siberia.

© Under License of Creative Commons Attribution 3.0 License
identified that both short and long sleep duration is related to the increase in depressive symptoms in people characterized as evening types [42]. Short duration, mainly due to increased daytime tiredness [43], while, and long sleep duration due to decreased physical activity [44].

Regarding well-being satisfaction, evening types have less satisfaction with life and are subject to developing psychiatric problems [45]. Dissatisfaction occurs mainly because evening people need to adapt to morning routines which causes an imbalance between personal and external rhythms. The time of taking antidepressants can also clarify this relationship since medications taken at night can cause an excitatory effect and delaying sleep onset. As a consequence, people wake up earlier than they would like favoring changes to the internal clock46.

Besides [33] investigated those subjects characterized as evening tend to report variation in daytime mood, with the morning time being the period of greatest instability, these changes leave the subjects exposed to negative feelings that favor depression.

Our search demonstrates a lack of consensus in the literature on the type of chronotype and the increase in symptoms of depression.
Table 3. Summary of studies involving Chronotype and Exercise/Physical Activity in adults.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Objective</th>
<th>Sample</th>
<th>Chronotype Assessment</th>
<th>Exercise Or</th>
<th>Relevants Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Reference 85)</td>
<td>The Aim Of This Study Was To Measure The Response Of Morning Cyclists To A Standardized Bout Of Exercise Performed At Different Times Of The Day.</td>
<td>20 Cyclists Who Were Categorized As Morning.</td>
<td>Mepq</td>
<td>All The Cyclists Had Participated In Recreational Cycle Races For The Past 2 Years And Trained At Least Twice Per Week. In Addition, These Cyclists Had Completed A Local, Annual 109 Km Cycle Race, Or A Similar Event, In Less Than 4 H Within The Past 2 Years</td>
<td>Cyclists Classified As Morning, Submitted To The Same Physical Effort (Load And Intensity), At Different Times Of The Day, Demonstrate Higher Perception Of Effort, In Other Words, It’s More Difficult To Perform The Task At Night When Compared To The Execution In The Morning Period.</td>
</tr>
<tr>
<td>(Reference 86)</td>
<td>The First Aim Was To Assess The Effect Of Marathon Start Time On Chronotype In Marathon Runners. The Second Aim Was To Determine The Extent To Which Either A High Level Of Physical Activity Or Climate Explains The Bias Towards Morningness Observed In South African Athletes And Controls. The Third Aim Was To Determine Whether Any Relationship Exists Between Chronotype, Per3tntr Polymorphism Genotype, Training Habits And Marathon Performance.</td>
<td>381 Caucasian Male Marathon Runners (South African-Dutch)</td>
<td>Meq</td>
<td>Training History Data Included Actual And Preferred Training Time-Of-Day Information On Weeks Days And Weekends, As Well As Training Duration, Intensity And Distance (Run Groups); While Race History Data Included Personal Best Marathon And Half-Marathon Times.</td>
<td>There Was Predominance In The Morning In Two Situations. When Comparing A Group Of South African Runners With Dutch Runners; Also When Comparing The Group Of Runners (South Africans And Dutch) With Their Respective Control Groups.</td>
</tr>
<tr>
<td>(Reference 87)</td>
<td>To Compare 200 M Swimming Time-Trial (Tt) Performance, Rate Of Perceived Exertion And Mood State At 06h30 And 18h30 In Trained Swimmers</td>
<td>26 (18 Men And 8 Women) Trained Caucasian Swimmers (25-50 Years Old)</td>
<td>Meq</td>
<td>The Swimmers Performed A 200 M Freestyle Tt At Either 06:30 A.M And 6:30 P.M. Each Session Was Separated By A Minimum Of 3 Days To Allow For Recovery.</td>
<td>The Results Show That Swimmers Who Trained In The Morning Were Faster In The Time Trial In The Morning, While Those Who Trained At Night Were Faster In The Test At Night. However, There Was No Difference Between Morning And Evening Performance When The Swimmers Were Considered As A Single Group.</td>
</tr>
</tbody>
</table>
depression. Some studies found an association between higher depression scores to the evening chronotype. A large cohort study using the Munich Chronotype Questionnaire found an association of depressive and/or anxiety disorders with late chronotype after adjusting for Sociodemographic, somatic health, and sleep-related factors [33]. Also, the same research group demonstrated that depress genic cognitions are more prevalent in the evening suggesting a possible link between chronotype and depression [32]. Another research carried out in Finland, showed that the night chronotype is related to depression, in a sample with an age range of [25-74] years old, and the association remains after controlling for sex, age, education, living conditions, consuming alcohol, smoking and sleep [36]. A Finnish population-based study showed that morning preference and high alertness in the morning were associated with lower scores of depressive symptoms and emotional eating [47]. The first two studies used the Munich Chronotype Questionnaire that measures the phase of sleep positions for both free and working days whereas the later used Morningness–Eveningness Questionnaire that evaluates the phase preferences of individual behavior over a 24h day. Reference [48] also studied patients diagnosed with major depressive disorder. There was a relationship between suicide risk in the evening chronotype and hypomanic personality traits. The risk of suicide was also observed in university students with symptoms of depression at night. Suicide risk was also observed in university students with symptoms of depression and evening chronotype [38]. Depression was also found to be significantly associated with earliness-lateness, but only the morning component of earliness-lateness demonstrates such association [49].

Physical activity and depression in adults

The benefits of physical exercise / physical activity programs are pointed out as important tools in the treatment of depression. Although the mechanisms are still quite confusing, some hypotheses move towards the anti-inflammatory effect that physical exercise promotes [50], such as lower levels of interleukin-6 (IL-6) and C-reactive protein [51].

Others point to the fact that depressed individuals have a decrease in hippocampus neurogenesis, in this sense [52], points out the antidepressant effect of exercise on the capacity that it has to increase the hippocampus neurogenesis, which occurs due to a possible increase in endorphins – b [53] also, by the increase in the brain-derived neurotropic factor (BDNF), which are responsible for neural development and survival [54].

There are also physiological mechanisms that justify the relationship between physical activity and changes in the hypothalamic-pituitary-adrenal axis (HPA) in depressed individuals [55], in hormonal changes in serotonin [56] and noradrenaline levels [57]. However, physical exercise is capable of promoting changes in the function of HPASS, capable of causing changes in the levels of serotonin [56], and noradrenaline [57].

The literature points out those depressive individuals tend not to be involved in physical activity programs; therefore, psychological factors influence the responses of the activity/exercise effect on the treatment of depression. Reference [58] observed that self-efficacy, that is, the individual's ability to perform a certain behavior, is related to the start of a physical exercise program by people with high symptoms of depression self-efficacy during interventions in people with depression.

There is confusion between the role of habitual physical activity and physical exercise as a dose-response for the treatment of depression. Reference [59] demonstrated that 16 weeks of aerobic exercise of light to moderate intensity is sufficient to decrease the symptoms of depression, anxiety and stress, and positive changes in the physical fitness of depressed patients compared to the control group. Also, aerobic physical exercise causes an antidepressant effect regardless of intensity, a fact observed by reference [60] in which the subject chose the intensity of the exercise session and at the end of 8 weeks there was a significant improvement in symptoms. In this sense, coaches must know the importance of performing the exercise in psychological aspects and not worry only about physiological changes.

Despite the studies that seek to explain the relationship between the level of physical activity and depressive symptoms present a significant number of subjects; a major limitation of these studies is that they assess physical activity through questionnaires [61-65]. The results demonstrate a reduction in depressive symptoms with increased levels of physical activity.

Other studies have already investigated the relationship between physical activity and depression using different measurement variables. Physical activity was included in the routine of patient visits for 14 weeks and an increase in the number of steps/day monitored by a pedometer was observed, the study suggests that physical activity be included in the treatment of depression [27].

Reference [66] compared three forms of treatment for depression [antidepressant/exercise / behavioral therapy after 12 weeks, all of which had significant improvement in symptoms. Also, in the elderly, it was identified that antidepressant medication is effective for a response fast, but after 16 weeks of aerobic exercise [70-85% HR reserve], per-forming three weekly sessions, the effects on depression levels are comparable to the use of medication and the use of medication plus exercise [67].

Physical activity was also associated with improvements in depression scores in a study that monitored women for 32 years (1974-2005). Depression scores and physical activity were measured in the years 1974, 1992, 2000 and 2005. The authors conclude that the higher the depression scores the lower the level of physical activity and over the years the decrease in physical activity also pointed to an increase in depression scores [68].

In addition to regular physical activity, sedentary behavior, that is, the daily time spent performing sedentary activities is also related to depression. Reference [69] compared the average time that men and women with an average age of 64 years, spend watching TV, and noticed that people who spend six or more hours a day watching TV have higher depression scores when compared to people who stay less than 2 hours a day. In children and adolescents, the longer the screen time, that is, sedentary behavior, the greater the risk of developing depression, with the
lowest risk being observed in less than one hour/day and the risks are significantly increased above two hours/day [70]. Evaluated in adults the time spent in physical activities and the time in sedentary activities, using an accelerometer, the study concluded that the increase in depressive symptoms is related to the decrease in light physical activity and increase in sedentary behavior [71].

There is also evidence that the total weekly energy expenditure (EE) is related to depression scores. Men and women were divided into a group with a GE of 7kcal / kg/week and an EE group of 17.5kcal / kg/week (public health dose), both groups subdivided into 3 and 5 times a week of aerobic exercise on a bicycle in the laboratory, beyond the control group (flexibility exercises 3 times a week). Groups with EE within the recommended for health, after 12 weeks of training, showed a significant reduction in depression scores, while the other two groups showed values similar to the control group [72].

Another study with 9580 men was evaluated for depressive scores and level of physical activity, with the following groups: inactive (0 MET • min • week−1), low (1-499 MET • min • week−1), medium (500-999 MET • min • week−1) and high (≥1000 MET • min • week−1). When comparing the inactive group with the low, medium and high groups, the probability of developing depression is 24%, 51% and 51%, respectively [73].

Several review articles and Meta analyzes were also published to clarify the relationship between physical exercise and physical activity with depression [61,74-77]. However, it is not still unclear, the ideal dose of physical activity / physical exercise that should be “administered” daily or at intervals of days for the treatment of depression, nor if the reduction of the time allocated to sedentary activities would be enough to prevent or treat depression.

**Physical activity and Chronotype in adults**

The estimates that 1 in 4 adults don’t meet the global needs for physical activity. That is, even with all the global campaigns and recommendations for regular physical activity, as a strategy for the prevention and treatment of diseases as people who don’t perform or are necessary. Besides, as changes in countries’ economic patterns, the sedentary lifestyle, (greater access to transport, technology and urbanization) [78].

Strategies must be implemented to break the barriers (lack of motivation, time, energy and adequate equipment) that prevent people from starting and staying in physical activity programs [79]. In this sense, identifying the chronotype profile of sedentary individuals can contribute to these individuals starting an exercise program. That is, the time to perform physical activity should be linked to that individual’s preference period, increasing the probability of activities happening [80].

Our findings show that the studies that evaluated the relationship between chronotype and physical activity are mostly transversal, and present many methodological differences, such as the profile of the subjects, exercise models, instruments to characterize chronotype and physical activity, factors that make it difficult to compare studies.

Subjects characterized as morning people have an independent relationship with the frequency of self-reported exercise [80]. Morning people also show less perceived effort during a walking activity performed in the morning when compared to nighttime exercise in the morning [81]. Furthermore, morning people have significantly more physical activity than evening and intermediate [82]. Also, the evening profile shows a reduced amount of physical activity and greater involvement in sedentary activities, monitored by accelerometer [83]. These findings were also observed84, in which the evening showed a lower amount of physical activity and more time sitting in minutes/day, assessed by questionnaire when compared to the morning ones.

Reference [84], also observed that when separating the investigated sample and evaluating only the working subjects, all chronotypes show less physical activity when compared to the morning. The authors point out those evening subjects difficult to do physical activities in the morning or afternoon periods. And the evening periods they are usually in work activities or studies, while in the morning people find it easier to do activities, so they tend to be more active.

In groups of athletes such as cyclists with a morning chronotype, they had a greater perception of effort in performing activities in the afternoon/night when compared to exercises in the same load and intensity performed in the morning85. Already, when comparing the type of chronotype, of a group of South African runners and with Dutch runners, there was morning predominance in South Africans, also the greater number of morning runners when comparing runners (South Africans and Dutch) with sedentary control groups (South African and Dutch). In addition, the best personal brands in half marathons and marathons for South African runners were achievements in morning tests86. Usually, runners wake up early to train and this is associated with preferences for realizing activities. In swimmers, the morning chronotype was associated with lower fatigue scores, better time against the clock, and lower perceived effort scores [87].

Another relevant point is the results found in88, in which, in addition to determining the type of chrono- type of the evaluated subjects, they characterize the amplitude of each individual’s chronotype. Amplitude is characterized as a component of circadian rhythm and is related to the ability to tolerate an unpleasant situation [8]. In the study by reference [88], Involvement in sports activities was related to the chronotype amplitude, but not to the type.

A specific group of people (Live in the Arctic Circle) [89] observed that after a physical exercise program, VO2max had a smaller increase in morning subjects when compared to the evening. However, the larger increase in their strength indexes is better in the type morning when compared to the type evening. It is important to highlight that few studies address this theme and the influence of the environment with little external light and the behavior of each chronotype.

**Physical activity, Chronotype and depression in adults**

The relationship between physical activity, chronotype and
depression has not been extensively studied in the adult population. In this review, we identified that most studies that relate to two of the three variables studied are cross-sectional; the assessment of physical activity is done in a subjective way, as well as depression, which is based on the use of a questionnaire and not a clinically diagnosed sample. However, some studies that did not present the keywords used in our research seek to clarify some possible explanations for this relationship.

A randomized control trial study with evening types used practical interventions including light exposure, fixed meal times, caffeine intake, and exercise to shift the late timing of evening types to an earlier time. The phase advance of 2 h in evening types improved self-reported depression and stress, isometric grip strength performance, and reaction time suggesting a simple strategy to improve mental wellbeing and performance [90]. As recently observed by [91], actigraphy data showed reduced physical activity levels and daily rhythm disturbances among people with depressive and anxiety disorders. Using a less frequent measure of chronotype, the sleep midpoint on free days, the authors did show an association between evening chronotype with physical activity and depression. The strength of this work was the assessment of sleep and physical activity by actigraphy [91].

In a study of preclinical medical students, evening chronotype was associated with less happiness in comparison to the morning-type and intermediate-type individuals. Also, depression and physical activity were among the factors that predict happiness among Turkish preclinical medical students [92]. Another survey, also with medical students from China, found that nocturnal types perform little physical activity, a lot of sedentary behavior and make a greater intake of drinks with caffeine [93].

Recently [94], investigated the social jetlag of workers and related it to different variables [physical activity, depression, lifestyle, work routine]. It was observed that the largest social jetlag was related to people with a type evening chronotype, with the highest scores of depression scores, and poor sleep quality characteristics observed in women, young people, blue collar workers and those who use smoking, but they were also physically active both at work and at leisure. Precise mechanisms linking chronotype, depression and physical activity are unclear. The relationship between depression and chronotype can be explained by the relationship between the sleep-wake circadian cycle and the secretion of neurotransmitters, such as serotonin, noradrenaline and dopamine [95]. We know that in the modern lifestyle, this relationship is influenced by the pace of life of people, high level of physical and psychological stress, due to extensive work hours and sleep deprivation. As well as the relationship between physical activity and depression, as physical activity increases the levels of serotonin, dopamine and norepinephrine in the hippocampus region, which increases the feeling of well-being. However, in relation to chronotype and physical activity, it seems that the main characteristics are in the fact that morning type individuals tend to be more active, the relationship can be clarified by the fact that these subjects do not have problems waking up early, and that is why they are able to better adapt the routine, work/study with time for exercise. The types evening is unable to wake up early and generally the night have no time available because they are involved in work and/or study.

However, with the increase in the number of people diagnosed with depression, with the current situation experienced in the world, longitudinal investigations are urgently needed to monitor people clinically diagnosed with depression, submitted to physical exercise programs, appropriate to preference schedules, to clarify the relationship between these variables, as well as to better prescribe physical exercise to prevent and minimize the effects caused by depression.

**Conclusion**

The influence of chronotype on performance and on the general health of individuals and on the relationship with metabolic diseases has been investigated. However, further studies are needed to establish the specific relationship between chronotype, physical activity and depression. In our review, we found that many studies indicate that higher depression scores and lower levels of physical activity are found mainly in evening or intermediate types. What makes it difficult to compare is the fact that researches do not distinguish whether this relationship can be influenced by the depression classification of the investigated subjects, or by the characteristics of the physical exercise [intensity, volume and physical exercise] performed. Other factors that were not considered in the studies are sleeping, eating, working and the time of physical activity.

Understand the pattern of preferences [morning or evening] of the subjects and the current routine of life [hours at work / study] can be important mechanisms to start a physical activity program, promoting improvement in general health. Furthermore, the importance of physical activity in combating depression is quite evident and suggested by the literature. However, the explanations of the possible physiological and psychological mechanisms that influence this relationship are still under investigation.

Simple strategies to improve mental wellbeing by targeting circadian disruption without the need for pharmacological agents can be used in the treatment of depression. Identifying the chronotype in individuals with depression can be the first step to start a chronobiological intervention including the time of physical activity, meal time, sleep/awake cycles that will improve mental wellbeing. Despite the need for further research, this remains an exciting prospect for a large number of people that suffer from reduced mental well-being.
References


90 Facer-Childs ER, Middleton B, Skene DJ, Bagshaw AP (2019) Resetting the late timing of ‘night owls’ has a positive impact on mental health and performance. Sleep medicine 60:236-247.


