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Artículos científicos

Los ciclos circadianos y su influencia en la ocurrencia de accidentes en las organizaciones de Estado de México

Circadian Cycles and Their Influence on the Occurrence of Accidents in Organizations from the East of the Estado de México

Ciclos circadianos e sua influência na ocorrência de acidentes em organizações no Estado do México

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Resumen

Las organizaciones industriales o de transformación aspiran a contratar trabajadores para realizar actividades en los procesos de producción bajo condiciones óptimas. Sin embargo, los diferentes contextos pueden cambiar las condiciones y afectar su estado de biorritmo. Al alterarse estos factores se propicia la ocurrencia de un accidente de trabajo. El objetivo del presente trabajo es investigar la existencia de una relación entre los ciclos circadianos con las incidencias en los accidentes de trabajo en los sistemas de producción de las entidades industriales o de transformación. En este estudio longitudinal, se utilizaron las bases de datos proporcionadas por la subdelegación del Instituto Mexicano del Seguro Social (IMSS) de la zona oriente del Estado de México de los años 2013, 2014 y 2015. En el procesamiento y análisis de datos se utilizó estadística descriptiva, a fin de conocer el comportamiento de las variables en la muestra. Los resultados sugieren que los ciclos circadianos conformados por el estado físico, emocional e intelectual influyen significativamente en la ocurrencia de los accidentes de trabajo al interior de la empresa. Lo anterior permite inferir que conocer el estado biorrímico es relevante porque, principalmente, permite ubicar y reubicar a trabajadores en periodos expuestos a riesgos y, en segunda instancia, evitar el aumento en el seguro de prima de riesgo de trabajo.

Palabras clave: accidente de trabajo, biorritmos, ciclos circadianos, riesgos laborales.

Abstract

Industrial or transformation organizations aspire to hire workers to carry out activities in the production processes under optimal conditions. However, different contexts can change conditions and affect their biorhythmic status. When these factors are altered, the occurrence of an accident at work occurs. The aim of this work is to investigate the existence of a relationship between circadian cycles with the incidence of accidents at work in the production systems of industrial or transformation entities. In this longitudinal study, the databases provided by the sub-delegation of the Instituto Mexicano del Seguro Social (IMSS) of the eastern part of the Estado de México for the years 2013, 2014 and 2015 were used.. In the data analysis, descriptive statistics of variables were applied, in order to know the behavior of the variables in the sample. The results suggest that the circadian cycles made up of the physical, emotional and intellectual state significantly influence the occurrence of workplace accidents within the company. The foregoing allows us to infer that knowing the

biorhythmic state is relevant because, mainly, it allows locating and relocating workers in periods exposed to risks and, secondly, avoiding the increase in the insurance of the occupational risk premium.

Keywords: accidents at work, biorhythms, circadian cycles, occupational hazards.

Resumo

As organizações industriais ou de transformação aspiram a contratar trabalhadores para realizar atividades nos processos de produção em condições ideais. No entanto, contextos diferentes podem alterar as condições e afetar seu status de biorritmo. Ao alterar esses fatores, favorece-se a ocorrência de acidente de trabalho. O objetivo deste trabalho é investigar a existência de uma relação entre ciclos circadianos com incidências de acidentes de trabalho nos sistemas de produção de entidades industriais ou de transformação. Neste estudo longitudinal, foram utilizadas as bases de dados fornecidas pela subdelegação do Instituto Mexicano del Seguro Social (IMSS) da zona leste do Estado do México nos anos de 2013, 2014 e 2015. estatística descritiva, a fim de saber o comportamento das variáveis da amostra. Os resultados sugerem que os ciclos circadianos compostos pelo estado físico, emocional e intelectual influenciam significativamente na ocorrência de acidentes de trabalho dentro da empresa. O exposto permite inferir que conhecer o estado biorrímico é relevante porque, principalmente, permite localizar e recolocar trabalhadores em períodos de exposição a riscos e, em segundo lugar, evitar o aumento do seguro do prêmio de risco do trabalho.

Palavras-chave: acidente de trabalho, biorritmos, ciclos circadianos, riscos ocupacionais.

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Introduction

In the 19th century, the first studies on circadian cycles were conducted on certain "rhythms" or "cycles" of life that were later called biorhythms. The word biorhythm is made up of two Greek terms, bios and rhythmos, which mean 'life' and a constant or periodic 'rhythm'. The biorhythm theory defines and measures three fundamental and important cycles of the human race: the physical, emotional and intellectual cycles.

Wilhelm Fliess, a respected and well-known Berlin doctor, became interested in biorhythms in the year 1890. Fliess, who had observed 23- and 28-day cycles in many of his patients, began collecting statistics on the periodic frequencies of the biorhythms. fever,

childhood illness and predisposition to illness and death. With these statistics, Fliess believed he had discovered fundamental "periods" of human life.

Subsequently, Dr. Fliess developed two of the most important theories about biorhythms: the first holds that nature grants man "internal clocks" that measure time throughout his life; The second theory affirms that one of these clocks, the one regulated by 23-day cycles, influences the physical condition and the other, the one regulated by a 28-day cycle, influences the emotional part of the human being and the level of sensitivity of him.

Unfortunately, the biorhythm theory fell into a tremendous commercialism that detracted from the serious studies that had been done to try to determine the existence of a scientific basis.

However, these studies have been somewhat limited in both the number of cases and the companies analyzed. As will be seen later, several studies have currently been developed that investigate the relationship between circadian cycles and various medical aspects, however, few studies have been found that seek to relate the biorhythmic state of the individual with the incidence of occupational accidents.

The objective of this work is to investigate the existence of a relationship between circadian cycles with incidences in work accidents in the production systems of industrial or transformation entities. In this longitudinal study, the databases provided by the sub-delegation of the Mexican Social Security Institute (IMSS) of the eastern part of the State of Mexico for the years 2013, 2014 and 2015 were used. In the data analysis, statistics were used descriptive of the variables in order to know their behavior in the sample. The results indicate that the circadian cycles made up of the physical, emotional and intellectual state significantly influence the occurrence of workplace accidents within the company. The foregoing allows us to infer that knowing the biorhythmic state is relevant because, mainly, it allows locating and relocating workers in periods exposed to risks and, secondly, avoiding the increase in the insurance of the occupational risk premium.

Theoretical framework

The National Institute of General Medical Sciences [Nigms] (2017) defines circadian rhythms as physical, mental and behavioral changes that follow a daily cycle, and that respond mainly to the light and darkness of the environment of an organism. Sleeping at night and being awake during the day is an example of a light-related circadian rhythm. Circadian

rhythms are found in most living things, including animals, plants, and many tiny microbes. The study of circadian rhythms is called chronobiology.

Arreaza and Arreaza (2001) specify the following:

In all living organisms, from bacteria to humans, a biological clock synchronized to 24 hours / day operates. This internal clock controls a wide variety of biochemical functions called cycle fluctuations, including behavior, sleep and activity, which are collectively called circadian rhythms (from Latin: circadia = around the day). (p. 31).

For his part, Silva (1984) points out that the history of biorhythms dates back to the year 1729, when Jean Jacques d'Ortous de Mairan observed that a plant called *mimosa pudica* opened its leaves during the day and closed them at night. It seemed clear that that plant "reacted to light" with some kind of reflex movement, but Mairan thought of locking that plant in a dark closet and was able to verify that it continued to open and close its leaves without any kind of light stimulus. . From there, the possibility of supposing that living beings could possess some kind of endogenous "biological clocks" was opened.

Fliess (1906) observed that children could be exposed to the same diseases and yet remain immune for days on end. After considering the onset of the disease and its evolution, he came to the conclusion that not all patients had similar symptoms at the same time. Thus, he founds his theory on biological rhythms. Fliess (1906) found that the physical rhythm (male) lasted 23 days and the emotional rhythm (female) 28 days, that both were present in every cell of the human organism and that they were related to the date of birth, marking highs and lows. Sigmund Freud (1986) believed in Fliess's theory, argued that it would be an opening in biological matters and sent him information about the cycles of his own life and that of his family, from which he had verified fluctuating health alterations according to cycles. Swoboda (1897, cited in Tomen, 2001) took up the revolutionary theory, deepened the research, defended it, and wrote about its application. Swoboda confirmed the existence of the aforementioned cycles and gave importance to the critical days that originate when the rhythm goes from high to low or vice versa.

Winstead, Schwartz and Bertrand (1981) point out that it was Alfred Teltcher who added a third cycle of 33 days after having detected that the intellectual capacity of his students (comprehension, creativity, concentration, etc.) varied clinically during this period. Unfortunately, he did not leave any published materials. Years later, the biorhythm began to be used in Germany, Japan, the United States, Canada, France and Latin America. Now,

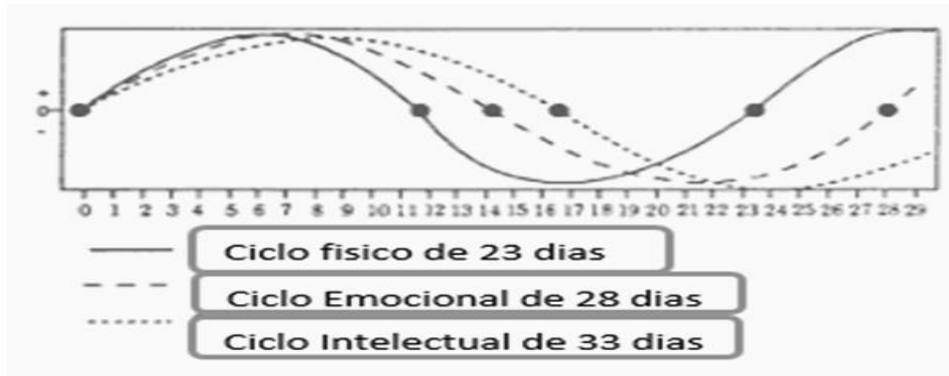
thanks to technological advances, it is possible to know the state of the energy flow in the physical, emotional and mental order at any time, to know how to channel the energies, to understand why certain situations arise, respecting our biological clock. Also, you may know that the duration of the three circadian rhythms is as follows:

- Physical rhythm = 23 days, 11 ½ positive days, 11 ½ days low.
- Emotional rhythm = 28 days, 14 days positive, 14 days low.
- Intellectual rhythm = 33 days, 16 ½ days positive, 16 ½ days low.

The biorhythm refers to three active biological cycles in all human beings: physical, emotional and intellectual. These cycles determine in people certain favorable or unfavorable states that can be anticipated and thus be able to plan and guide activities in all aspects of life in a more convenient and effective way.

Each of the biological cycles is calculated using equations of sinusoidal curves, where t indicates the number of days that have elapsed since the person's date of birth (see figure 1).

Figura 1. Curva sinusoidal



Fuente: Cardinali (1994)

- Physical cycle: $\text{sen}(2\pi t / 23)$,
- Emotional cycle: $\text{sen}(2\pi t / 28)$
- Intellectual cycle: $\text{sen}(2\pi t / 33)$,

Researchers Swoboda, Fliess and Teltscher, promoters of the biorhythm theory, indicate that through these equations it is possible to know the energy state both in the physical, emotional and intellectual order of any individual on a given date.

Feldman (1995) defines circadian rhythms as biological processes that repeat themselves in cycles of approximately 24 hours. Sleep and wakefulness, for example, occur

naturally at the rate of internal pacemakers. The circadian rhythm is observed mainly in the alternation between sleep and wakefulness, but it is also possible to observe it in other biological variables, such as body temperature, hormone secretion, cognitive functions and even emotions (Silva, 2010). Various other bodily functions, such as body temperature, also function based on circadian rhythms. Circadian rhythms are very strong states.

Taking into account all of the above, we consider that the circadian cycle is an important element that must be reflected on in order to prevent an accident at work, because each cycle of the biorhythm is made up of two semi-cycles, one positive and one negative, both of the same duration. The cycles are divided into two sectors: a positive part that starts at zero and increases its positive value until it reaches a maximum peak of one, and from there it descends again to zero, where the critical point of change takes place and where the change begins. second sector, contrary to the previous one, a decrease that starts from zero until it reaches a value of minus one, its maximum point, and again grows until it reaches a value of zero, thus completing a complete period of this cycle.

Even though this concept of circadian cycles had its great impact in the 80s, with the passage of time it was forgotten and, unfortunately, it ended up mixed between esoteric situations and popular magic, so much seriousness was lost in its treatment and application. However, according to Rutter, Martin and McKnight (2002), the study of circadian cycles and rhythms has taken on great importance in the areas of human behavior, for example, from the study of the mechanism of the “biorrhythmic apparatus” and how it regulates the physiological state of the individual according to its surrounding environment. This biorrhythmic apparatus is currently being studied, even at the molecular level. In fact, some authors define it as the circadian oscillatory apparatus, which is sought to model by integrating biochemical, cellular and psychological information.

Regarding the previous approach, the work of Cermakian and Boivin (2003) can be reviewed, who affirm that a large number of psychosocial variables present circadian or 24-hour rhythms. They also state that genes dedicated to the regulation and generation of these psychosocial rhythms have now been identified and that some mutations in these genes lead to sleep and mood disturbances.

On the other hand, Refinetti and Menaker (1992) have worked on the relationships between the circadian rhythm of body temperature (CRT) and defined oscillatory patterns of the ultradian and infradian type of this CRT. Additionally, they studied the relationship

between this CRT and the circadian rhythm of the locomotor activity system, including its relationship with nervous control.

Another important finding related to the study of these biorhythms is that of Guo and Stein (2003), who, after a systematic review of 300 scientific articles, found equivalent conclusions in 52 of them. Thus, Guo and Stein (2003) document a significant relationship between circadian rhythms and heart rate and blood pressure, as well as with psychosocial pathological events such as myocardial ischemia and sudden cardiac death. Finally, they recommend the study of circadian rhythms and their relationship with the cardiovascular system as a means of managing the patient's health.

One more investigation is carried out by Hofstra and Weerd (2008). Knowing that epileptic seizures have certain patterns, they studied the pathology of epilepsy and correlated these patterns with circadian cycles. In their research they found mechanisms to measure the phase of the circadian state, such as light, melatonin, body temperature and cortisol. In other words, they have managed to asynchronize-synchronize the circadian rhythm through these biological markers. They also sought to correlate the biorhythmic state of the individual at the time of an accident, and an indirect way they found is to estimate the level of the state in each of the elements considered, physical, emotional, and intellectual. But, according to these researchers, it is actually the level of these biochemical elements (light, melatonin, body temperature and cortisol) that generates a state of drowsiness, inattention, deconcentration, fatigue; in general, a high-risk psycho-emotional state for tasks that involve any aggressor agent (machinery, equipment, instruments).

Even the study of these circadian rhythms has been linked to the development of cancer, as an example you can see the research of Savvidis and Koutsilieris (2012) and Zee, Attarian and Videnovic (2013).

Currently, there is a considerable and diverse amount on the study and application of circadian cycles, which allows us to conclude that:

- Biorhythms are not an esoteric question without scientific foundation.
- There are very few studies that seek to correlate these biorhythmic states with industrial accidents.
- Currently available applications only indicate the level of biorhythmic status, they do not correlate these indicators with other variables.

From what has been mentioned so far, it is possible to understand that an extensive correlational study between these states and the moment of an industrial accident is more than necessary. Likewise, the availability of an extensive database allows to support an exhaustive exploratory study. This is, among others, the main objective of this research.

On the other hand, circadian cycles are a factor that enables the physical care and protection of the worker in the performance of their work. In addition, it contributes to the prevention of workplace accidents and, consequently, promotes compliance with the provisions specified in the Mexican Federal Labor Law.

Labor regulations specify that work accidents are injuries that make the worker's well-being impossible and that limit the performance of their activities within the organization. Diseases are causes that cause physical or psychological discomfort derived from daily activities directly related to his work in the organization. Risks are all those events that make the worker susceptible to suffering an injury or illness and that harm his well-being. The safety and hygiene conditions are those scenarios that benefit the worker to comply without risk of suffering an alteration to his physical, emotional or intellectual state. All of the above is regulated in the ninth title, "Work Risks", of the Federal Labor Law (Presidencia de la República, 2019) (table 1).

Tabla 1. Conceptos básicos de riesgo de trabajo

Artículos	Ley Federal de Trabajo
Artículo 473	Riesgos de trabajos son los accidentes y enfermedades a que están expuestos los trabajadores en ejercicio o con motivo del trabajo
Artículo 474	Accidente de trabajo es toda lesión orgánica o perturbación funcional, inmediata o posterior, la muerte o la desaparición derivada de un acto delincencial, producida repentinamente en ejercicio o con motivo del trabajo, cualesquiera que sean el lugar y el tiempo en que se preste. Quedan incluidos los accidentes que se produzcan al trasladarse el trabajador directamente de su domicilio al lugar del trabajo y de éste a aquél.
Artículo 475	Enfermedad de trabajo es todo estado patológico que tenga su origen o motivo en el trabajo o al prestar sus servicios.
Artículo 475 Bis	El patrón es responsable de la seguridad e higiene y de la prevención de los riesgos en el trabajo

Fuente: Presidencia de la República (2019)

Objective

Industrial or transformation organizations require the hiring of personnel to carry out the tasks in the various processes. For workers, it is necessary for the entity to have optimal security conditions that guarantee their physical, emotional and intellectual health. The increasing occurrence of occupational hazards, derived from the scenarios in which workers are immersed, limits compliance with worker safety. The objective of this work is to investigate the relationship between circadian cycles and occupational accidents in industrial or transformation entities.

Method description

This document reports the first phase of an extensive investigation that is being developed on the relationship / characterization of circadian cycles with accidents in industry, as well as with the levels of achievement of higher-level students.

As a first approximation, we sought to find a pattern, through descriptive statistics, between these accidents and the biorhythmic state of the worker, so that the results serve as the basis for a more extensive study, including more rigorous statistical analyzes.

The sub-delegation of the IMSS of the eastern zone of the State of Mexico was requested, by means of official letter, to provide a database. This database received contains information about the date of birth of the workers, the date the accidents were incurred and the type of work accident. With this information, a descriptive statistical analysis was carried out on the occurrence of work accidents and the state of their circadian cycle.

Subsequently, the calculation was made to determine his biorhythm cycle in that period and to know if it was directly related to the accident. Likewise, the type of state that presented vulnerability was identified. In this study, vulnerability is considered as the point at which the cycle crosses zero, that is, the positive cycle decreases before moving to the negative phase and also increases before moving to the positive phase. The point between the negative and positive phase is considered critical, that is, the theory says that at that point the person is more vulnerable.

With the data of the worker's date of birth and the date of the accident, a comparison was made, considering the occurrence as "successful" when the date of the accident is +/- 1 day from the critical point (zero), in any of the three biorhythms, physical, intellectual and emotional.

The final results show the coincidence proportions of these occurrences considered successful for the purposes of this study.

Results

When reviewing the statistical data on the work risks caused by the employment relationship, we can identify that there is a high rate of accidents derived from the poor performance of their activities, either for physical, emotional or intellectual reasons, hence the possibility of relate them to the circadian cycles and in this way be able to determine when is the best time for the worker to carry out their activities and vice versa, since the statistical data affirm the high index of risks caused, as indicated in Table 2.

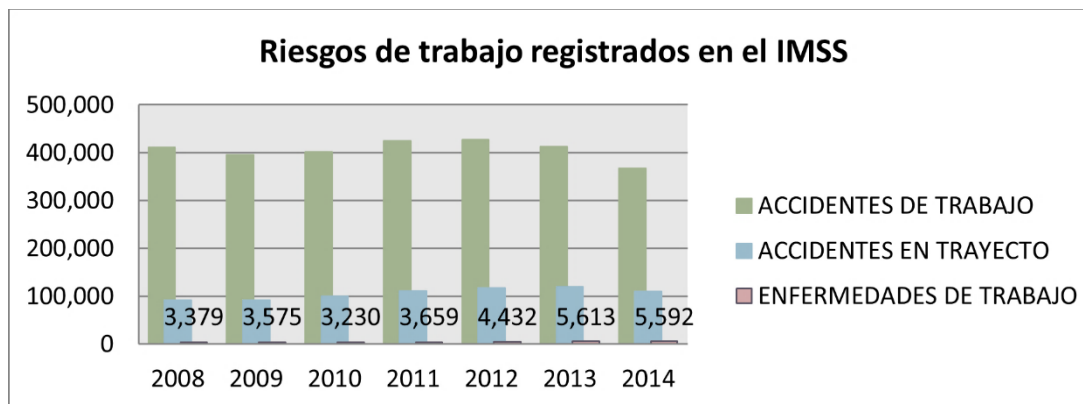
Tabla 2. Riesgos de trabajo terminados registrados en el IMSS por año de ocurrencia, según tipo de riesgo

Periodo	Total	Accidentes de trabajo	Accidentes en trayecto	Enfermedades de trabajo	No especificado
2011	539 418	424 624	111 135	3659	0
2012	549 595	427 811	117 352	4432	0
2013	537 435	412 523	119 299	5613	0
2014	482 408	366 942	109 874	5592	0

Fuente: Secretaría del Trabajo y Previsión Social, con información de la Coordinación de Salud en el Trabajo, IMSS

Figure 2 specifies the IMSS statistics that show the classification of occupational hazards and the degree of incidence of each of them from 2014 to 2015, and it is observed that the risk that occurs most frequently is that of occupational accidents job.

Figura 2. Riesgos de trabajo registrados en el IMSS



Fuente: Secretaría del Trabajo y Previsión Social con información de la Coordinación de Salud en el Trabajo, IMSS.

The data provided by the IMSS delegation of Ecatepec de Morelos on workers who have had work accidents in 2013, 2014 and 2015 make up 100% (n = 34,443) of the registered cases, of which 22% (n = 7,485) correspond to the year 2013, 49% (n = 16,826) to the year 2014 and 29% (n = 10,132) of the cases were registered in 2015 (Table 3).

Tabla 3 Número de casos de accidentes de trabajo

Años	Núm. de casos	% por escala
2013	7485	22 %
2014	16 826	49 %
2015	10 132	29%
Total	34 443	100 %

Fuente: Elaboración propia

When cleaning workers related to industrial activity, it was determined that 11% (n = 3820) of cases considered for this research occurred in 2013, 12% (n = 4238) were in 2014 and 10% (n = 3378) in 2015 (table 4). Here we observe a variation in the increase and decrease of the accidents registered during the reference years, therefore the trend of work accidents in subsequent years cannot be predicted.

Tabla 4. Depuración de trabajadores relacionados con el área industrial

Años	Núm. de casos	% por escala
2013	3820	11 %
2014	4238	12 %
2015	3378	10 %
Total	11 436	33 %

Fuente: Elaboración propia

Regarding the emotional, physical and intellectual biorrhythmic states at the time of the accident, the following was found.

Emotional factor

Emotional biorhythms refer to the state of our emotions, mental vitality, feelings that vary according to mood and mood. In high phase we are happier; in low phase, more apathetic; the critical phase is the most prone to arguments.

In this case, the data indicate that in 2013, 77.51% (n = 2961) represents the male gender, and the critical point is in the negative phase in the range of -0.1 to -1 with a cumulative percentage of 37.67% (n = 1439); while for the year 2014, 74.40% (n = 3153) of the male gender, and the critical point in a positive interval from 0.1 to 1, representing a percentage of 44.88% (n = 1902), and for the year 2015, 76.58 % (n = 2587) made up of the

male gender, and a negative critical point of 37.03% (n = 1251), comprising, as in 2013, from -0.1 to -1 (table 5).

Regarding female workers for 2013, it represents 22.49% (n = 859), of which the critical point is positive, because 10.79% (n = 412) in a range of 0.1 to 1, for the 2014 25.60% (n = 1,085) of women, the critical point is in an interval from -0.1 to -1, represented by 14.70% (n = 623), and for 2015, with a total of women of 23.42% (n = 791), the critical point is negative with 11.34% (n = 383) in a range from -0.1 to -1 (table 5)

Tabla 5. Factor emocional

Género			2013	% por escala	2014	% por escala	2015	% por escala	2013	2014	2015
Masculino	0.6	1	106	2.77 %	777	18.33 %	792	23.45 %			
	0.1	0.5	1287	33.69 %	1125	26.55 %	431	12.46 %	36.47 %	44.88 %	36.20 %
	0		129	3.38 %	115	2.71 %	113	3.35 %			
	-0.1	-0.5	661	17.30 %	438	10.34 %	447	13.23 %			
	-0.6	-1	778	20.37 %	698	16.47 %	804	23.80 %	37.67 %	26.81 %	37.03 %
Total			2961	77.51 %	3153	74.40 %	2587	76.58 %			
Género			2013	% por escala	2014	% por escala	2015	% por escala	2013	2014	2015
Femenino	0.6	1	234	6.13 %	219	5.17 %	232	6.87 %			
	0.1	0.5	178	4.66 %	204	4.81 %	134	3.97 %	10.79 %	9.98 %	10.83 %

	0	36	0.94 %	39	0.92 %	42	1.24 %			
	- 0. 1	- 0. 5	37 0.97 %	125	2.95 %	138	4.09 %			
	- 0. 6	-1	374 9.79 %	498	11.75 %	245	7.25 %	10.76 %	14.70 %	11.34 %
Total		859	22.49 %	108 5	25.60 %	791	23.42 %			
Total		382 0	100 %	423 8	100 %	337 8	100 %			

Fuente: Elaboración Propia

Physical factor

The physical factor is an element that companies must consider important within the work areas, since workers in the operating areas can be seriously affected.

The data obtained show that the workers who had a work accident with respect to the physical factor in 2013, considering that of 100% (n = 3820) of workers, 77.51% (n = 2961) belong to the male gender, obtaining a positive accumulated sum of 33.53% (n = 1281) and establishing the critical point that ranges from 0.1 to 1 as a higher percentage, with 26.07% (n = 996) in a negative range from -0.6 to negative -1.

Of 100% (n = 4238), for 2014, 74.40% (n = 3153) belonged to the male gender, identifying the critical point in a negative range from -0.01 to -1, with 31.97% (n = 1355) of accumulated sum and 23.24% (n = 985) being the highest percentage in a positive interval of 0.6 to 1; While for the year 2015, of 100% (n = 3378) of workers, 76.58% (n = 2587) belong to the male gender, obtaining a negative critical point of 34.22% (n = 1156) of a cumulative sum in the range from -0.01 to -1, and 25.84% representing the critical point as the highest percentage in a positive range from 0.6 to 1 (table 6).

Considering female workers for the year 2013, they represent 22.49% (n = 859); they obtained a positive accumulated critical point of 10.10% (n = 336) in a range of 0.1 to 1 and as the highest percentage of the critical point 7.41% (n = 283) with a negative range of -0.6

to -1; For 2014, 25.60% (n = 1085) of women, the critical point is in an accumulated interval of -0.1 to -1, represented by 9.89% (n = 409), and with 8.45% (n = 358), representing the highest point in a range of 0.6 to 1 positive, and for 2015, with a total of women of 23.42% (n = 791), with a positive critical point of 10.54% (n = 356) in a range of 0.1 to 1 and the highest with 7.55% (n = 255) in an interval of 0.6 to 1 positive (table 6).

It is possible to identify that in the years of study the critical point has been in a positive and negative range, so it is interpreted that the work accident can occur in any interval, and cause progressive damage to the health of workers and greater compensation for the companies.

Tabla 6. Factor físico

Género			2013	% por escala	2014	% por escala	2015	% por escala	2013	2014	2015
Masculino	0.6	1	901	23.59 %	985	23.24 %	873	25.84 %			
	0.1	0.5	380	9.95 %	424	10.00 %	363	10.75 %	33.53 %	33.25 %	36.59 %
	0		202	5.29 %	389	9.18 %	195	5.77 %			
	-0.1	-0.5	482	12.62 %	460	18.85 %	342	10.12 %			
	-0.6	-1	996	26.07 %	895	21.12 %	814	24.1 %	38.69 %	31.97 %	34.22 %
Total			2961	77.51 %	3153	74.40 %	2587	76.58 %			
Género			2013	% por escala	2014	% por escala	2015	% por escala	2013	2014	2015
Femenino	0.6	1	244	6.39 %	358	8.45 %	255	7.55 %			
	0.1	0.5	142	3.72 %	210	4.96 %	101	2.99 %	10.10 %	13.40 %	10.54 %
	0		54	1.41 %	98	2.31 %	61	1.81 %			
	-0.1	-0.5	136	3.56 %	207	4.88 %	120	3.55 %			
	-0.6	-1	283	7.41 %	212	5.00 %	254	7.52 %	10.97 %	9.89 %	11.07 %

Total	859	22.49 %	108 5	25.60 %	791	23.42 %	
Total	382 0	100%	423 8	100 %	337 8	100 %	

Fuente: Elaboración propia

Intellectual factor

This factor influences memory and ability to reason. It should be noted that in its positive phase of 16 and a half days, the capacity for studies and everything that requires attention and concentration increases; Unlike what happens during the negative phase, the next 16 and a half days, where there is a cognitive decline (mental fatigue).

Evaluating the workers who incurred an accident, the results reveal that in 2013 77.51% (n = 2961) represents the male gender, analyzing that the critical point is in the negative phase in the range of -0.1 to -1 with a cumulative percentage of 40.08% (n = 1531), placing the highest percentage 25.86% (n = 988) in a negative range from -0.6 to -1. For the year 2014, 74.40% (n = 3153) belonging to the male gender, acquiring a critical point in a negative interval from -0.1 to -1, representing a cumulative percentage of 37.14% (n = 1574) and 21.59% (n = 915) the highest in a range of negative -0.6 to -1.

For the year 2015, 76.58% (n = 2,587) was made up of the male gender, and obtained an accumulated negative critical point of 37.74% (n = 1275), with a higher percentage in a range of -0.6 to -1 negative of 23.33 % (n = 788) (table 7).

Considering female workers who incurred a work accident in 2013, they represent 22.49% (n = 859), with a positive critical point of 11.94% (n = 456) accumulated in a range of 0.1 to 1 and with 7.28% (n = 278) the highest in a range of 0.6 to 1 positive.

For 2014, 25.60% (n = 1085) of women registered the critical point in an interval from -0.1 to -1, represented by 12.77% (n = 541) accumulated and the highest with 9.11% (n = 386) negative in a negative range of -0.6 to -1, and for 2015, with a total of 23.42% women (n = 791) the critical point is negative, with 10.92% (n = 369) accumulated in a range of -0.1 to -1, identifying the highest with 7.02% (n = 245) of a range of 0.6 to 1 positive (table 7).

Tabla 7. Factor intelectual

Género			2013	% por escala	2014	% por escala	2015	% por escala	2013	2014	2015
Masculino	0.6	1	821	21.49 %	879	20.74 %	741	21.94 %			
	0.1	0.5	539	14.11 %	592	13.97 %	484	14.33 %	35.60 %	34.71 %	36.26 %
	0		70	1.83 %	106	2.55 %	87	2.58 %			
	-0.1	-0.5	543	14.21 %	659	15.55 %	487	14.42 %			
	-0.6	-1	988	25.86 %	915	21.59 %	788	23.33 %	40.08 %	37.14 %	37.74 %
Total			2961	77.51 %	3153	74.40 %	2587	76.58 %			
Género			2013	% por escala	2014	% por escala	2015	% por escala	2013	2014	2015
Femenino	0.6	1	278	7.28 %	368	8.68 %	237	7.02 %			
	0.1	0.5	178	4.66 %	110	2.60 %	157	4.65 %	11.94 %	11.28 %	11.66 %
	0		20	0.52 %	66	1.56 %	28	0.83 %			

	-	-	123	3.22	155	3.66	151	4.47			
	0.	0.		%		%		%			
	1	5									
	-	-1	260	6.81	386	9.11	218	6.45	10.03	12.77	10.92
	0.			%		%		%	%	%	
	6										
Total				22.4	108	25.60	791	23.42			
			859	9 %	5	%		%			
Total			382	100	423	100 %	337	100 %			
			0	%	8		8				

Fuente: Elaboración propia

Discussion

The theory specifies that, to have a stable emotional intelligence, it is necessary to be physically well, since the state of our emotions provides mental vitality. Feelings vary according to mood and mood, these elements are essential to harmonize these trends.

In 2013, a greater number of male workers suffered a work accident while in the negative phase. Regarding the female gender, the highest percentage of accidents is located in the positive phase. For 2014, the greatest relevance is located in the positive phase for men and in the negative phase for women. And in 2015, for the male and female gender, it was determined that the highest number of accidents incurred in a negative phase. In no case were the greatest number of injured workers at a critical zero point. This data analysis of the emotional factor can be mentioned that accidents do not fully comply with what is specified by the theory that the critical point is more prone at the time of being in the negative phase or at the time of being at zero.

Regarding physical factors, the theory points out that they are environmental factors that depend on the physical properties of bodies. The final statistical results of the analysis of the physical factor show that the highest number of accidents for 2013 in males is located in the negative phase, while for 2014 and 2015 the accidents were generated within the positive phase. The foregoing takes on relevance derived from the fact that in that period what the theory specifies is not complied with, because in this case workers suffer more accidents in a positive phase than in a negative one, in the case of men. For the female gender,

in 2013 the greatest risk in workers who incur an accident is located in the negative phase; in 2014 in the positive phase, and in 2015 in the negative phase. In no case were the largest number of injured workers at a zero critical point, so it is considered that this data analysis does not necessarily comply with the theory that the critical point is more prone at the time of being in a negative or negative phase. at the moment of being at zero.

Finally, the intellectual factor specifies that it is the one that influences our memory and ability to reason. In relation to the database, we obtained that in 2013 there was a greater number of accidents in the male gender, which was 40.08%, being in the negative part; for the female gender, the positive part was greater, obtaining a higher percentage of 11.94%, decreasing a little work accidents to 10.03%.

For the year 2014, in both genders there were more accidents because there were more workers in their negative phase: for the male gender it was 37.14% and the female one 12.77%. And in 2015, for the male gender it is in the negative phase, with 37.74%, and the female one the majority is for the positive one, 11.66%, reducing the number of accidents to 10.92%.

It should be noted that women are more prone to accidents at work in negative periods in two of the factors, since of the three years analyzed it is shown as a result that in two they had the accident in a negative period in the emotional and physical phases, while that the men only presented affectations in the negative period in these two phases in one year and their accidents were recurrent in positive periods. Compared with the intellectual factor, women were in a negative period for only one year and their accidents were in the positive period, while men in this phase all their accidents were in a negative period.

Conclusions

Industrial or transformation organizations, having workers who are susceptible to events that limit their performance, seek strategies to reduce risks. One of the most viable proposals in the face of this event is to measure the biorhythm cycle of operational and administrative workers to measure the behavior of the physical, emotional and intellectual cycles.

From the results obtained in this research, it was observed that women are more susceptible to occupational accidents in their negative physical and emotional cycle, while men are more susceptible in positive periods. As for the intellectual cycle, men are more

susceptible to accidents in their negative period, contrary to women, which occurs in their positive cycle. These data contrast with what is established by the theory that the critical point is zero or negative. Be that as it may, interesting data was found on how gender-derived cycles influence. The measurement of the biological cycle allows organizations to know the periods of possible risk within the entity in order to prevent risk. It is important that the managers of the companies and professionals of the areas study these factors to generate strategies that improve the performance of the worker and, consequently, the productivity of the organization, reducing the compensation of payment for accidents.

Continuing with this line of research, it is intended to investigate and analyze if there is a direct relationship between the type of circadian cycle, the period of occurrence and gender, as well as analyze the existing tools that develop the automated calculation of the cycles, propose an application that measure and evaluate biological cycles and know their usability within industrial companies, in order to carry out strategic planning as a preventive measure in the occurrence of work accidents.

Proposed lines of research

The results suggest an important correlation, however, it is necessary to consider other variables:

- The gender. Descriptive statistics suggest an important difference in the occurrences between men and women in the three biorrhythmic states studied.
- A correlation matrix must be included, so that the significance between these variables is studied mathematically.
- Apparently, the “zero critical point” theory is not enough. It is necessary to study other variables, such as the combination of the biorrhythmic states, the sense of the state at the time of the accident (increasing, decreasing, slope of the curve).

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