

INCIDENCES OF VARIABLES IN LABOR ABSENTEEISM: AN ANALYSIS OF NEURAL NETWORKS

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ABSTRACT

Labor absenteeism is a factor that affects the good performance of organizations in any part of the world, from the instability that is generated in the functioning of the system. This is evident in the effects on quality, productivity, reaction time, among other aspects. The direct causes by which it occurs are generally known and with greater reinforcement the diseases are located, without distinguishing possible classifications. However, behind these or other causes can be found other possible factors of incidence, such as age or sex. This research seeks to explore, through the application of neural networks, the possible relationship between different variables and their incidence in the levels of absenteeism. To this end, a neural networks model is constructed from the use of a population of more than 12,000 employees, representative of various classification categories. The study allowed the characterization of the influence of the different variables studied, supported in addition to the performance of an ANOVA analysis that allowed to corroborate and clarify the results of the neural network analysis.

KEYWORDS

Labor absenteeism, neural networks model, human resource management, ANOVA analysis.

Introduction

Labor absenteeism is one of the main difficulties facing Human Resource Management worldwide, proof of this is the geographic dispersion of research associated with the subject. Research is reported on the subject in Brazil [1], Canada [2], Nordic countries [3], India [4] and Japan, just to mention some.

The foregoing is not strange if one considers the great accumulation of affectations that originates the labor absenteeism to the final results of an organization. According to published research, this phenomenon causes productivity impairments [5], the income of the organization [6], or costs [7], among other type of affectations that it causes indirectly in the rest of the employees of the organization.

The manifestations of absenteeism also vary between the different productive sectors regardless of the propensity, of one or the other, to certain con-

ditioning characteristics of this phenomenon that affects business management. In the literature consulted, the greatest amount of research on the subject is found in the areas related to health [8]. This is motivated, above all, by the existence of a wider field of publications for these areas of knowledge. But the variety of productive sectors related to the object of study is extensive, from sectors that demand high physical effort such as construction [9] or agriculture [10], up to office work with less demand for physical effort [11, 12].

Similarly, the variety of causes recognized as generating absenteeism is vast, and they go from the most recognized as diseases [13] even though the type of disease that is analyzed as influential varies, to other more individuals such as age [14, 15], gender [16], motherhood [17]. Also, organizational variables such as working conditions [18], reward systems [19], leadership exercised within the organization [20] are

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considered; or the incidences of variables external to the organization such as the economic situation of the territory [21].

Perhaps, as a consequence of all the above, in equal measure there are different mathematical approaches to the analysis of absenteeism, ranging from the analysis of descriptive statistics to the application of more advanced techniques such as the analysis of structural equations [22] or the application of genetic algorithms [23].

In general, the purpose and objective of this research is to identify, through an analysis of neural networks, the degree of incidence that a group of objective variables have on the behavior of absenteeism. In this case variables of a subjective nature such as leadership style or job satisfaction are not considered.

The selection of neural networks as a tool for mathematical analysis is based on the potential that has to identify intrinsic relationships between multiple variables, regardless of quantity, and in the presence of a variety of individuals. Its use should allow employers to find the possible influence of objective variables available in the databases of organizations, which may determine the rate of absenteeism. In correspondence with the results, the businessmen will be more acts to design strategies aimed at reducing the indicator of absenteeism, as well as its negative effects.

To this end, we initially start reviewing the literature on the subject by identifying the possible causes that are evaluated, in correspondence with the theoretical framework. Subsequently, the design of the methodology prepared for the research is presented, based on the knowledge found during the review of the state of the art. Finally, the results achieved in the research are explained and the main theoretical and practical conclusions reached with the development of the research are presented.

Review of the literature

The review of the literature focused mainly on the publications on the subject that are indexed in the Scopus database, according to which there are 4,224 documents registered. Publications on the subject show a growing trend of interest since the 70s of the last century and the tendency to grow continues, although since 2014 there has been a tendency to maintain the number of publications per year (see Fig. 1).

Similarly, Figs 2 and 3 reflect the countries where most research is conducted on the subject and the different areas of knowledge from which the problem is addressed. As it is observed, the absenteeism analyzes are not alien to the problematic of the de-

veloped countries and they are the subject of studies by a great variety of knowledge areas, where, among others, the organizational management is found.

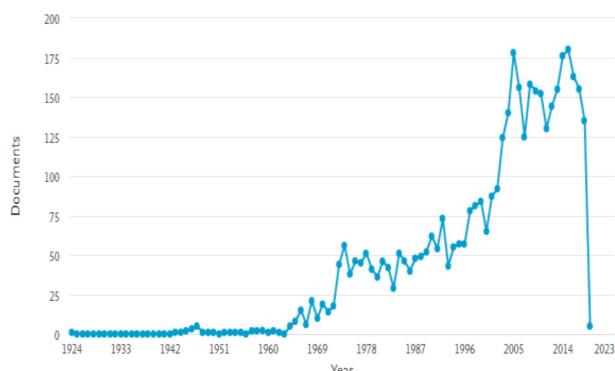


Fig. 1. Publications in Scopus per year on absenteeism.

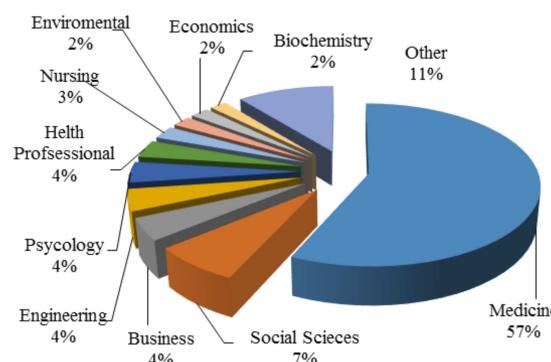


Fig. 2. Publications by areas of knowledge.

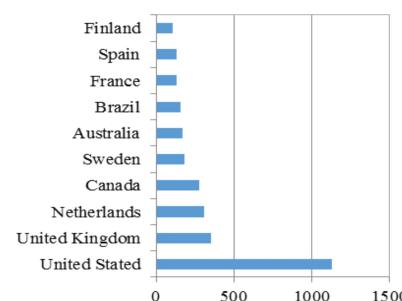


Fig. 3. Publications by country.

As already mentioned, the main cause recognized in the scientific literature or at least the most studied one is diseases. Perhaps because it is usually associated with a system that may involve wage payment, health insurance payments and has major component of legal regulation. The variety of diseases reported to be influential in absenteeism is scattered, although there is a certain predominance of musculoskeletal disorders [24, 25], cardiac disorders [26] or certain epidemics [27]. There is also a tendency to analyze absenteeism due to mental illnesses, generally associated with the stress that is generated as part of the work content [28, 29].

A separate analysis is presented when the impact on health corresponds to the existence of unfavorable working conditions [18, 30] and the occurrence of occupational accidents [31, 32]. In the analysis of diseases, the incidence of drugs and alcoholism is also explored [33].

Similarly, absenteeism is investigated from the point of view of the incidences of organizational variables, such as: workload in hours [34]; ways to organize working hours [35]; the influence of the absenteeism of some members of the organization on the rest of the members [36, 37]; and the form of contracting [38]. In addition, job satisfaction [39], leadership [20], differences between occupational categories [40], manifestations of harassment at work [41], and stimulation systems [19, 42]. On the other hand, there are other studies that analyze absenteeism based on gender differences [16, 43], the influence of age [15, 44], and the effects of pregnancy on absenteeism [17].

Figure 4 shows a summary of the most discussed topics in the publications in Scopus, made with the VosViewer Program, according to which the themes revolve around diseases and their most common manifestations: back pain, accidents, epidemics, mental affectations; the economic effects they generate in terms of productivity, costs, satisfaction; and the influence of other variables such as age and sex.

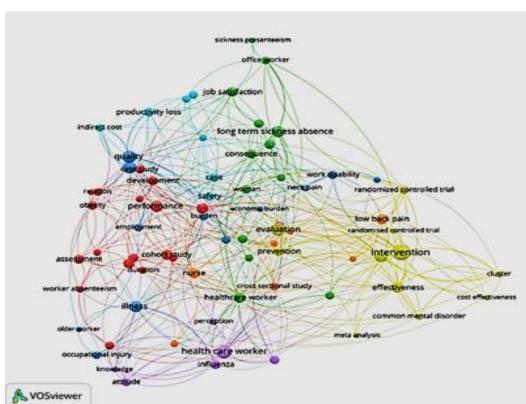


Fig. 4. Evaluation of the representativeness of topics related to labor absenteeism (source: VosViewer).

In general terms, it can be concluded that until now the studies on absenteeism have been carried out with a fragmented vision, evaluating the incidence of one or the other variable on this phenomenon. But those studies that deepen the possible degree of relationship between the variables recognized as potential causes are not abundant. On the other hand, it must be recognized that in the analysis of absenteeism there are variables that are as objective and easy to measure as: age, sex or other subjective factors; as satisfaction, leadership, which usually must

be evaluated through questionnaires designed for these purposes. Also, it should be noted that it calls the attention of researchers that variables such as the number of economic dependents of workers have not been considered, this being a possible cause of absenteeism, either by having children or parents to take care of.

Methodology

For the development of this research, the steps described below were performed.

Selection of study variables: To this end, the review and classification of the variables analyzed in the literature was initiated, of which only those that could be measured without resorting to additional instruments were selected. These variables were valued by a group of experts: 13 university professors with PhD degrees and at least ten years of experience, with research or training activities in the area of administrative sciences. Of the selected experts, six of them have experience in business management as managers or functions related to the subject under study, in different sectors of production or services. All the experts were selected in correspondence with their coefficient of skills, calculated from a test that takes into account the experience and relevance of knowledge with the topics to be addressed by the experts. In this case, everyone scored above 0.85.

The review of the literature initially allowed the identification of six variables presumably related to absenteeism, and consultation with the experts extended the list to five other variables, being selected by at least 80% of them. Of the variables initially selected, the variable *marital status* was eliminated, considering that it was related to the number of people in their charge (dependents). The variable *another household incomes* were added, considering that it could influence the absenteeism, as well as the *position* in the organization and the *seniority* in the organization, in addition it was proposed to divide the number of dependents in *children* and *elderly dependents*. The variables under investigation were:

- 1) age,
- 2) sex,
- 3) educational level,
- 4) children,
- 5) elderly dependents,
- 6) average income,
- 7) another household incomes,
- 8) sector to which the organization belongs,
- 9) position,
- 10) seniority,
- 11) health condition.

It is necessary to clarify that, in addition to the previous variables, the variables absenteeism and possible causes of absence were considered. Among the possible causes of absence were recognized the following: Sporadic diseases (viral or non-repetitive) and repetitive diseases, absences for caring for children or elderly dependents, among other possible causes.

Design of measurement method of variables: The information of the variables in each of the workers of the different organizations studied was obtained from the computer systems established for the control of the human resources existing in the company. Except in four organizations that did not have this information in an automated way, and it was necessary to review labor files and (or) interviews with workers.

Definition of sample: The information was collected in 31 organizations of Holguin province, Cuba, characterized by making an important contribution to the country's economy and having a wide variety of economic sectors. The selection of organizations to study was the result of applying a non-probabilistic sampling for convenience, based on access to information offered by the entities. The organizations had between five and ten years of founded. The number of employees per company was very diverse, ranging from five to 1,123 employees. Table 1 shows a characterization of the sample by company.

Table 1

Characterization of the sample by company.

Composition of the selection criteria of sample		
Criteria	Ranks	Percent
Years of creation	Less than 10	51
	10–20	26
	21–30	13
	More than 30	10
Employees	Less than 10	6
	11–50	20
	50–100	3
	101–500	42
	More than 500	29
Sector	Tourism	10
	Transport	7
	Communication	7
	Building	3
	Computing	6
	Health	10
	Education	6
	Finance	3
	Energy	6
	Farming	6
	Mining	10
	Services	13
	Mechanical industry	13

The composition of sample guarantees a high representative level by size and age of the organization, as well as the presence of multiple socio – productive sectors. Within the organizations, we worked with all the employees registered in their human resources databases. Table 2 reflects the characterization of sample by employees, according to this information it can be stated that it is representative and diverse in each of the variables analyzed.

Table 2

Characterization of sample by employees considered in the study.

Variable	Categories of the variables	Quantity	Percent
Age	Less than 30	3,501	28.02
	30–50	7,206	57.67
	50–60	1,354	10.84
	More than 60	434	3.47
Sex	Male	6,193	49.56
	Female	6,302	50.44
Educational level	Basic	550	4.40
	Secondary	6,988	55.93
	University	4,957	39.67
Children	Any	4,741	37.94
	One	4,777	38.23
	Two or more	2,977	23.83
Elderly dependents	Any	11,194	89.59
	One	745	5.96
	Two or more	556	4.45
Average income	High	3,736	29.90
	Medium	6,224	49.81
	Low	2,535	20.29
Another household incomes	High	4,492	35.95
	Medium	5,766	46.15
	Low	2,237	17.90
Seniority	Less than 10	4,040	32.33
	10–20	5,376	43.03
	More than 20	3,079	24.65
Position	Operative	4,988	39.92
	Technique	6,190	49.54
	Strategic	1,317	10.54

Analysis of the results: for the processing of the results, the use of neural networks was proposed. For these purposes, the Statistical Package (IBM SPSS, 23) was used, defining the dependent variable as absenteeism and the remaining as independent variables. The option of automatic architecture selection was chosen. The percentages for training and validation of the network are set based on the values implicit in the Software, and the use of equal percentages by other researchers [45–47]. It was decided to accept only one step after the error increase, and 0.0001 of the minimum change relative to the training error, as a criterion for stopping the training.

Results

The research aims to identify the variables that characterize the propensity of workers to influence absenteeism. We work with the information of 12,495 employees characterized in the sample. From the sample taken, a total of 1,834 employees presented at least one absence in the period under analysis. Figure 5 summarizes the fundamental causes that affected absenteeism.

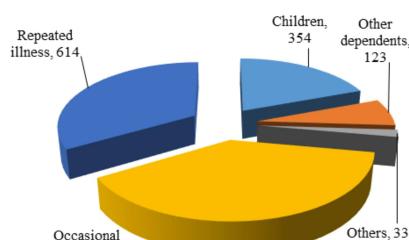


Fig. 5. Cause of absenteeism.

For the analysis a random sample of these 11,370 employees is used, with the objective of configuring a multilayer perceptron, using the rest of the sample (1,125) to evaluate the validity of the analysis.

Table 3 summarizes the processing of cases. It shows that 8,186 cases were assigned to the training sample and 3,184 to the retention sample. The 1,125 cases excluded from the analysis are the possible ones to be absent.

Table 3
Case processing summary.

	N	Percent
Sample	Training	8,186
	Holdout	3,184
Valid	11,370	91.0%
Excluded	1,125	9.0%
Total	12,495	100.0%

Table 4 summarizes the information about the neural network and corroborates that the research specifications are correct:

- A separate unit is created for each Sector category and none of the categories are considered “redundant” units.
- In the same way, a separate output unit is created for each category of absenteeism for a total of two units in the output layer.
- The automatic selection of the architecture by the IBM SPSS 23 has chosen three units in the hidden layer.

The summary of the model is presented in Table 5. This contains information on the results of the training and the application of the final network to the holdout sample.

Table 4
Network information.

	Factors	1	Sector
Input layer	1	Age	
	2	Sex	
	3	Educational level	
	4	Children	
	5	Elderly dependents	
	6	Average income	
	7	Another household incomes	
	8	Seniority	
	9	Position	
	10	Health condition	
Covariates	Number of units		22
	Rescaling method for covariates		Standardized
Hidden layer(s)	Number of hidden layers		1
	Number of units in hidden layer 1 ^a		3
	Activation function		Hyperbolic tangent
Output layer	Dependent variables	1	Absenteeism
	Number of units		2
	Activation function		Softmax
	Error function		Cross-entropy

Table 5
Summary of the model.

Training	Cross Entropy Error	1524.180
	Percent Incorrect Predictions	8.1%
	Stopping Rule Used	Relative change in training error criterion (0.0001) achieved
Holdout	Training Time	0:00:11.56
	Percent Incorrect Predictions	9.3%

Classification Table 6 summarizes the results of use of the network and is constructed from the combined training and test samples. For each case, the predicted answer is Yes if the predicted probability pseudo-probability is greater than 0.5. For each sample, the cells in the diagonal of the cross-classification of the cases are correct predictions and the cells of

Table 6
Percentage of classification of the test sample and holdout.

Sample	Observed	Predicted		
		No	Yes	Percent Correct
Training	No	6677	1183	96.2%
	Si	515	309	37.6%
	Overall Percent	81.76%	18.23%	90.7%
Holdout	No	2786	91	96.8%
	Si	198	111	33.8
	Overall Percent	93.66%	6.34%	90.2%

the diagonal of the cross-classification of the cases are incorrect predictions.

Within the cases used to create the model, 309 of 515 employees who previously affected absenteeism are classified correctly. This is motivated by the fact that workers who are not absent compared to those who do are relatively low, and the network could not discriminate against them. However, 6677 employees who are not absent are classified correctly, in this case the network was able to classify more than 96.2% correctly.

In general, 90.2% of the training cases are classified correctly (see Table 6), which corresponds to the incorrect 9.3%, as shown in the model's summary (see Table 5). This is considered evidence that the model was able to correctly identify a high percentage of cases for employees that do not affect absenteeism. The retention sample helps validate the aforementioned; 90.2% of these cases were correctly classified by the model.

The Receiver Operative Characteristics (ROC) curve (shown in Fig. 6) shows the sensitivity and specificity of all the possible cut points in a single plot. In this way, the ratio of true positives in relation to false positives is represented, as the threshold of discrimination is modified (value from which it is possible to discern that a case is a positive one or that it affected absenteeism). The graph contains two curves, one for the category "Absent" and another one for the category "Not absent". Since there are only two categories, the curves are symmetric around a 45 degree line from the upper left corner of the table to the lower right.

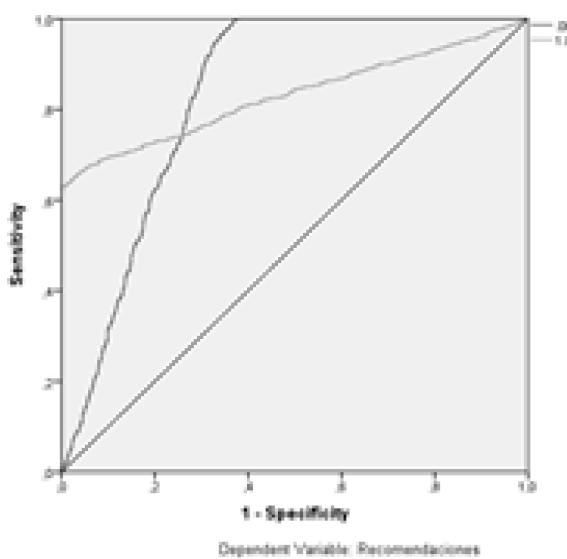


Fig. 6. ROC curve.

The area under the curve is proportional, for both categories: Absent and Not absent, is 0.811. These probabilities can be interpreted as follows, for a person who is absent and another who is not, selected randomly, there is a probability 0.811 that the pseudo probability predicted by the model is greater for the absent than for the that does not

The importance of an independent variable (see Table 7) expresses the degree to which the predictive value of the network model changes for different values of the independent variable. The normalized importance is determined by dividing the values of importance by the values of greatest importance and expressed as percentages.

Table 7
Independent variable importance.

Variables	Importance	Normalized importance [%]
1. Health condition	0.210	100.0
2. Age	0.158	70.0
3. Sex	0.115	67.0
4. Children	0.106	63.0
5. Elderly dependents	0.091	56.0
6. Average income	0.074	41.0
7. Position	0.073	26.0
8. Another household incomes	0.072	19.0
9. Educational level	0.041	7.0
10. Seniority	0.020	4.0
11. Sector	0.011	2.0

From the above it follows that the variables related to: health condition, age, sex, children or elderly dependents and average income have the greatest effect on how the network classifies workers. The behavior of the summary variables in Table 8 excludes the sector to which they belong because they are very diverse and show little influence according to the results of the network.

The first observation that can be extracted from the analysis of the information in Table 8, and that corresponds to the previous results, is the high relationship between repetitive or sporadic diseases and absences, which is obvious. However, for this same reason, from the high influence that diseases have on the level of absenteeism, it becomes difficult to discern to what extent the other variables under study can influence absenteeism. For this reason it is decided to carry out other complementary studies, based on which an ANOVA analysis is performed to evaluate the incidence of the other factors in the absences. The results of these three analyzes are shown in Table 9.

Table 8
The most influential variables and their relationship with absenteeism.

Variables	Levels	Absent	
		No	Yes
Age	Less than 30	67.35	32.65
	30–50	89.40	10.60
	51–60	33.83	66.17
	More than 60	18.20	81.80
Sex	Male	89.31	10.69
	Female	81.40	18.60
Educational level	Basic	81.14	18.86
	Medium	87.54	12.46
	Higher	84.27	15.73
Children	None	88.55	11.45
	One	86.94	13.06
	Two or more	77.59	22.41
Elderly dependents	None	89.04	10.96
	One	80.54	19.46
	Two or more	52.75	47.25
Average income	Low	79.84	20.16
	Medium	90.21	09.79
	High	82.86	17.14
Another household incomes	Low	79.82	20.18
	Medium	87.03	12.97
	High	84.07	15.93
Seniority	Less than 10	75.44	24.56
	10–20	87.03	12.97
	More than 20	89.56	11.44
Position	Operative	77.64	22.36
	Technical	88.95	11.05
	Strategic	83.06	16.94
Health condition	Healthy	95.43	04.57
	Occasional illness	0.00	100.00
	Repeated illness	0.00	100.00

Table 9
ANOVA analysis of the incidence of variables in absenteeism.

Variables	Significance					
	Factors					
Absenteeism	Absence due to repeated illness	Absence due to occasional illness	Absence for childcare	Absence for adult care	Absence for other reasons	
Sector	0.649	0.723	0.838	0.738	0.943	0.534
Age	0.002*	0.001*	0.537	0.041*	0.049*	0.217
Sex	0.011*	0.035*	0.648	0.004*	0.007*	0.079
Educational level	0.458	0.547	0.666	0.545	0.478	0.682
Average income	0.112	0.346	0.736	0.326	0.479	0.689
Another household incomes	0.256	0.678	0.702	0.707	0.823	0.785
Seniority	0.168	0.743	0.578	0.503	0.602	0.509
Position	0.735	0.888	0.836	0.689	0.812	0.901

According to the values of significance of the previous table, it is possible to affirm that age and sex are variables that influence absenteeism, although as

such the visible causes do not result. This is due to the fact that: on the one hand, the older the greater the probability of having a disease that shows a re-

peated affection to work; On the other hand, the affectations related to sex respond to a prevalence of a macho culture in society where the care of children and elderly dependents are the main responsibility of the female sex. It is logical, from the statistical point of view that the greater the number of children or dependents, the greater the probability of incidence in absenteeism in cases in which these dependents become ill.

These results corroborate those achieved through the analysis of the neural network. It should also be noted that in the case of other variables, no significance levels were observed that favored arriving at a definitive conclusion in this regard.

Discussion

Based on the previous results, regarding the incidence of diseases as the main cause of absenteeism, the results achieved corroborate the analyzes of other previous authors [28,29]. Similarly, the results related to the incidence of sex and age correspond to the investigations of Rabacow, Levy et al. [43], Baima, Lopes Barroso et al. [17], Kröger [16], Sumannen, Pietiläinen et al. [44] and Sundstrup, Hansen et al. [14].

There is another group of variables under analysis in the literature with which it was not possible to make comparisons, in correspondence with the objectives of the research, so that variables with some degree of subjectivity were not taken into consideration, such as: leadership, climate or organizational culture [19, 20, 39–42].

Limitations and future research

The results achieved in this research are limited since they do not exhaust all possible causes of absenteeism, do not delve into variables related to occupational safety and health, accidents and occupational diseases. They do not consider other variables such as the existence of Licenses for mobilizations for specific purposes, among other aspects.

On the other hand, the design of the research and the way of extracting the sample establish a bias on the results, since the absences due to diseases have a greater representativeness than the other remaining causes, which limits any attempt that is desired, to deepen the influence of other causes. Similarly, as described, the study presented a cross-sectional design and the analyzed sample is representative of a wide variety of sectors, it might be convenient that subsequent research analyze the possible differences between sectors.

Conclusions and management implications

In correspondence with the results obtained, it can be concluded that although diseases are the main cause of absenteeism, their behavior is not totally random but is conditioned by age. While another variable as important as sex that is a controlled variable also shows incidence in absenteeism. It seems that it is not possible from the point of view of the administration to design actions that counteract the influence of the variables: health conditions, sex and age without applying policies that are discriminatory or that attempt against gender equality, but it is not all real. Although it is difficult to mitigate the effect of these in absenteeism if you can design actions that from establishing redundancy of functions, polyvalence of staff to meet the functions, among others, it is possible to mitigate the effects of absenteeism, avoiding impacts on continuity and quality of production or service and gain stability in the operation of the system.

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