

**ANALYSIS OF CORRELATIONS BETWEEN BURNOUT AND CENTRALITY IN
SOCIAL NETWORKS: A STUDY OF AN EMERGENCY DEPARTMENT**

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Abstract: Healthcare environments are known to be intense in knowledge and constant stress. Exchanging information through social interactions in the work environment was addressed in this study of an emergency department in order to answer the following research question: “Regarding knowledge management, what are the relationships between resilient performance and burnout?”. To do so, we used the resilience social network questionnaire and the Maslach Burnout Inventory. Results showed that resilience is positively correlated to burnout. Nurses are the most resilient actors. In addition, professional experience and participating in huddles relate to a greater contribution to the organisation's resilience performance. Therefore, the constant use of resilient capacity takes a toll on health care professionals. Knowledge sharing also promotes informal leadership, providing more skilled professionals and highly qualified human capital.

Keywords: Social Network Analysis; Resilient performance; Knowledge management; Burnout; Emergency Department.

Resumo: Sistemas de saúde são conhecidos por serem intensos em conhecimento e estresse. A troca de informações por meio de interações sociais no ambiente de trabalho foi abordada no estudo de caso de um serviço de emergência a fim de responder à seguinte questão de pesquisa: “Em relação à gestão do conhecimento, quais são as relações entre desempenho resiliente e burnout?”. Para tanto, utilizou-se o questionário de redes sociais de resiliência e o Maslach Burnout Inventory. Os resultados mostraram que a resiliência está positivamente correlacionada com o burnout. Os enfermeiros são os atores mais resilientes. Além disso, a experiência profissional e a participação em huddles relacionam-se a uma maior contribuição para o desempenho resiliente da organização. Portanto, o uso constante da capacidade resiliente prejudica os profissionais de saúde. O compartilhamento de conhecimento também promove a liderança informal, proporcionando profissionais mais qualificados e capital humano altamente qualificado.

Palavras-chave: Análise de Redes Sociais; Desempenho resiliente; Gestão do Conhecimento; Burnout; Serviço de Emergência.

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1. INTRODUCTION

Knowledge Management (KM) plays an essential role in the healthcare domain, known for its knowledge intensity (Pflugfelder, 2020), contributing to an outstanding pattern of healthcare systems operations (Almansoori, AlShamsi, Salloum, & Shaalan, 2021). KM originated from strategic management literature and focuses on knowledge flows (Nonaka & Takeuchi, 1995). Thereby, KM is deemed as the “dynamic” side of Intellectual Capital (IC), which comprises human capital, structural capital, and relational capital (Paoloni, Mattei, Dello Strologo, & Celli, 2020). Paoloni et al. (2020), through a systematic literature review, concluded that within the three IC components, the least studied is the human capital, which refers to the skills, qualifications, and experience of the employees in such complex sociotechnical systems as the healthcare sector. According to the same authors, human capital influences the quality of healthcare services provided by an organisation. It also implies a downside to improving patient safety (Singh, 2021).

Furthermore, human capital in the healthcare sector is affected by the high turnover rates (Islam, Ali, & Ahmed, 2018), and human resources shortages (WHO, 2019). These factors have proven to be barriers to improving healthcare professionals' well-being, who often exert extra effort to care for their patients in adverse conditions, thus contributing to the system's resilience (Smaggus, 2019). At the same time, it goes unnoticed due to the successful outcomes that most often occur. This extra and excessive effort from health workers, as a result of a flawed design of the work system, lack of basic resources, and ineffective management, is studied by the Resilient Health Care field (Wears, Hollnagel, & Braithwaite, 2015).

Beyond that, well-being at work may be correlated to the organisation's resilient performance aside from being encompassed in human capital, as they foster the retention of employees (Senik, 2021). In this view and from a Resilient Health Care perspective, the exchange of information through social interactions in the work environment was addressed in this study of an adult emergency department of a large university hospital using social network analysis and the Maslach Burnout Inventory (MBI) to answer the following research question: regarding knowledge management, what are the relationships between resilient performance and burnout?

2. BACKGROUND

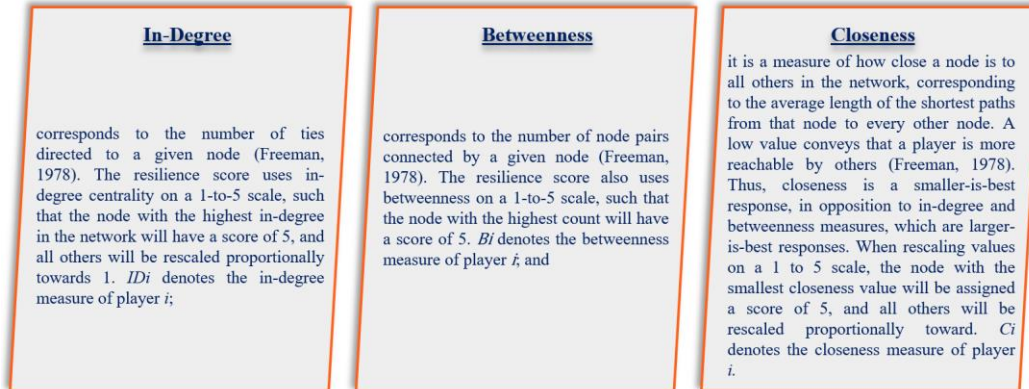
Health systems are responsible for providing services that improve, maintain or restore the health of individuals and their communities (WHO, 2021). Health systems differ from industries for being non-trivial and multifaceted (Hollnagel, Braithwaite, & Wears, 2013). These and other characteristics of health systems come from the theory of complex systems, framed explicitly as complex sociotechnical systems, which are characterised by the large number of elements interacting dynamically, non-linear interactions, a wide variety of elements, emergence, unexpected variability, uncertainty, path dependence, and the ability to adjust and adapt, better known as resilience (Saurin & Gonzalez, 2013).

In this context, the concept of systems with resilient performance has evolved since its inception at the roots of Resilience Engineering. The current definition for resilient functioning is “*the ability to succeed in varied conditions so that the number of intended and acceptable outcomes (in other words, everyday activities) is as high as possible.*” (Nemeth & Hollnagel, 2022). Thus, according to Nemeth and Hollnagel (2022), the focus is on the ability to respond appropriately to both disturbances and opportunities. In turn, the way that people work responding to disturbances or opportunities in the healthcare sector can be analysed by social interactions.

Indeed, socialisation does comprise a process of knowledge management. Even Nonaka and Takeuchi’s (1995) widely cited knowledge creation and dissemination model attributed the information sharing process as one of its processes derived from their knowledge creation spiral. In addition, communication is critical to an effective organisational learning strategy that supports patient safety (Guttman et al., 2018). Nursing professionals are information-dependent knowledge workers (McGonigle & Mastrian, 2022).

In order to assess the contribution of healthcare professionals to the resilient performance of the system, Bertoni et al. (2022) created the resilience score, which encompasses three social network metrics and two non-network attributes. These three metrics are rooted in social network analysis (i.e., in-degree, betweenness, and closeness) and are explained in Figure 1.

Figure 1 – Social metrics of the resilience score



Source: Authors

Moreover, the two non-network attributes composing the resilience score, which are the availability and reliability of each actor, respectively designated by A_i and R_i account for the variability in social interactions once Resilience Engineering grasps the performance adjustment and the gap between work-as-done and work-as-imagined (Hollnagel, Dekker, Nemeth, & Fujita, 2014). Therefore, availability (time) and reliability (accuracy) compose Equation (1) because actors with reduced availability can delay the transmission of information, as well as actors with little reliability can compromise actions and decision-making through incomplete and inaccurate information. In line with this postulation, the resilience score RS_i of actor i is calculated based on the following Equation 1 and evaluated using a 5-point scale where 1 indicates an actor with a low score and 5 indicates the opposite:

$$RS_i = ID_i \times C_i \times B_i \times A_i \times R_i \quad (1)$$

Anderson (2021) argues that exploratory research should be carried out to analyse complex patterns of social interactions inherent to health care workers and build a theoretical understanding of health teams and their work. As aforementioned, it is a setting known for being knowledge intense. Besides considering communication as the leading cause of unsuccessful events for patient safety, social network analysis through its social metrics would enlighten the relevance of resilient interactions in the healthcare domain.

In terms of human communication, the degree centrality measure means a person is in a position that allows direct contact with many other people, he/she can be considered a great channel of information and is subject to the feeling of being in the main flow of information on the network. At the opposite extreme, a low-grade actor is identified and can be seen as a peripheral actor. This position disfavors direct involvement with most others in the network and isolates him/her from active participation in the ongoing communication process (Freeman, 1978). Freeman (1978) summarises that the degree measure can be seen as an index of potential communication activity and that it emphasises (direct) connectivity.

The second measure of centrality proposed was betweenness (Freeman, 1978). This measurement is based on how often a point (p_i) is considered geodesic (the shortest path between two points). According to Freeman (1978), in terms of the communication process, the central position of this measure is strategic because the actor that intermediates groups/actors can withhold and/or distort when transmitting the information. This actor is also responsible for maintaining communication and is in the position of coordinating group processes (Freeman, 1978). Freeman (1978) states that this measure emphasises communication control.

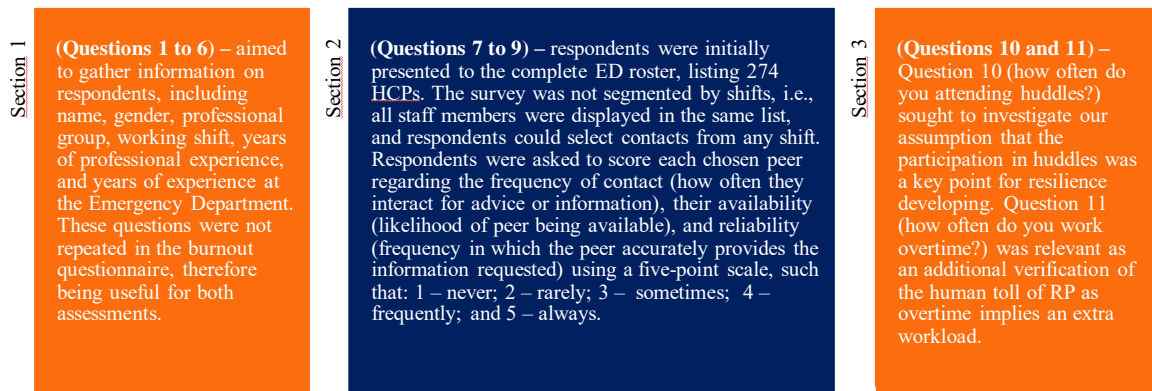
According to Freeman (1978), the third centrality measure emphasises independence. The author defines that the independence of an actor in the network, in this sense, is seen as his proximity to all other actors in the network. Thus, the concept of proximity in a network was established as the geodesic distances from the observed actor to all other actors in the network, which makes it a view of decentrality, as it grows as the points are distant, and centrality in this context means closeness (Freeman, 1978). A thorough social network analysis can demonstrate problems with the way information travels, revealing links between information networks or process performance.

3. METHOD

We conducted a case study in an Emergency Department formed by a team with 274 members. This population comprises nurse technicians, nurses, physicians, healthcare allied professionals and administrative assistants. In this research, we carried out a quantitative approach by applying two questionnaires as aforementioned. On one side, the social network analysis was

possible through a questionnaire, in which involved three sections totalising 11 questions, as follows (Figure 2):

Figure 2 – Resilience social networks questionnaire



Source: Authors

On the other side, a burnout assessment was performed by carrying out the MBI, which is composed of 22 items that capture the perceptions of occupational stress issues related to burnout of each respondent (Maslach & Jackson, 1981). Thus, the scores of each respondent were calculated by adding the scores assigned to each item to the dimension to which they belonged. As for criticality, the parameters were separated into three levels calculated from tertiles, the lower being good, the medium moderate, and the upper critical. The upshot of the tertiles is shown in Table 1. According to Maslach and Leiter (2020) a person is considered burnt out when all three dimensions, henceforth the burnout triad, are at the critical level. In order to engage the respondents to participate, the researchers made personal invitations during their visit to the Emergency Department and send emails to everyone.

Table 1 – Classification of burnout dimensions

Dimension / Condition	Critical	Moderate	Good
Emotional Exhaustion (EE)	≥ 26	19 to 25	≤ 18
Depersonalisation (DP)	≥ 11	8 to 10	≤ 7
Personal Accomplishment (PA)	≤ 17	18 to 19	≥ 20

Source: Authors

4. RESULTS

The response rate was 81%, of which 64% were female workers. Table 2 illustrates the sample distribution, indicating the preponderance of nursing technicians (45% of respondents) and nurses (23% of respondents). Similarly, in terms of response rate considering the total population of each category, nurses and nursing technicians also stood out, with 96% and 85% participation among professionals in each category respectively.

Table 2 – Population and sample respondents

	<i>N</i>	<i>n</i>	(<i>N</i>)%	(<i>n</i>)%
Nurse Technicians	117	99	85%	45%
Nurses	53	51	96%	23%
Physicians	51	34	67%	15%
Administrative Assistants	31	24	77%	11%
Healthcare Allied Professionals	22	13	59%	6%
TOTAL	274	221	81%	

Source: Authors

Interactions between and within professional categories are presented in Table 3. Except for healthcare allied professionals, in each category, most interactions occurred among peers. Following fellow physicians, physicians were the ones who interacted the most of their working time with nurses and nurse technicians. Although nurses interacted firstly with other nurses, secondly with nurse technicians, and then with physicians, most of these interactions occurred within the greatest patient care teams from this sample (*i.e.*, nurses, nurse technicians, and physicians). Also, administrative assistants were more relevant to healthcare allied professionals and physicians in work dynamics than nurses and nurse technicians. One possible reason is that physicians and healthcare allied professionals have greater autonomy in decision-making, which could explain the need for administrative appeal more often.

Table 3 – Frequency of interactions between and within professional's categories

	Cited				
	Adm. Assist.	Nurses	Physicians	N. Technicians	HC. A. Professionals
Respondents Administrative Assistants	35%	18%	23%	21%	3%
Nurses	4%	50%	12%	31%	3%
Physicians	8%	21%	47%	18%	7%
Nurse Technicians	3%	29%	9%	55%	4%
Healthcare Allied Professionals	10%	16%	19%	39%	16%

Source: Authors

Regarding shifts, most interactions were with co-workers from the same shift, followed by the ones with the prior shift. As can be seen in Table 4, the night shift was the most secluded one (75% of interactions). Reasonable explanations would be the existence of the three different night shifts and the long working hours (12x36). On the other hand, the shift that had the most distributed interactions (among different shifts) was the morning one.

Table 4 – Frequency of interactions between and within shifts

Respondents	(n)	Cited		
		Morning	Afternoon	Night
Morning (26%)		48%	24%	28%
Afternoon (26%)		32%	49%	19%
Night (48%)		15%	10%	75%

Source: Authors

Table 5 shows the top 10 actors of social metrics for resilience score. In the top ten actors of the in-degree metric, six nurses ranked as the most contributors to the resilient performance of the system, showing how the emergency department team preeminently consulted them. In this case, it can be inferred that the nurses in this network are extremely interactive with the other actors, as their role is to be responsible for the nursing technician team and they are also those who will implement the treatment suggested by the doctor to the patient, in addition to receiving updated information on patient transfers and medical discharges from the administrative staff. In the top ten actors of the closeness metric, it can be seen that 9 out of 10 actors were also in the in-degree top ten. Such a result can be analysed as the closer an actor is to all other actors in the network, the more likely they will be a highly requested actor by their close co-workers and vice versa. The administrative staff appeared as 2 out 10 top betweenness metric actors, emphasising its intermediate role among the ED team. This metric of betweenness implies a position of gatekeeper of information to those actors with highly ranked, as it means they bridge the knowledge from diverse actors and convey a unique perspective. Moreover, the PH34 and NU51 actors were heads of their respective professional categories, which made them highly requested to interact in the system. As three heads of the ED appeared in the top ten of the three social metrics, it can be inferred that they were close to most actors in the resilience network.

Table 5 – Top 10 actors of social metrics for resilience score (and their shift)

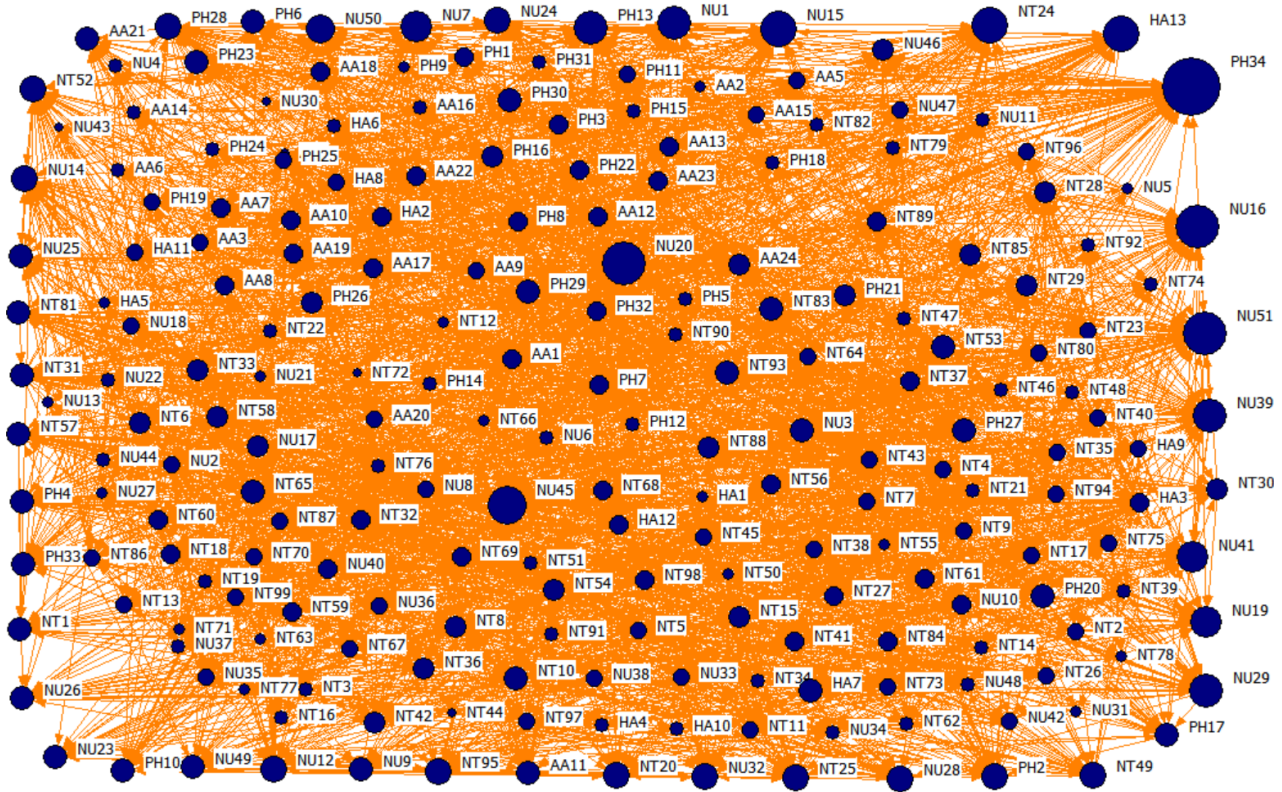
Top 10		
<i>In-Degree</i>	<i>Closeness</i>	<i>Betweenness</i>
*PH34 (morning)	*PH34 (morning)	NT32 (morning)
NU20 (afternoon)	NU20 (afternoon)	PH7 (morning)
*NU51 (morning)	*NU51 (morning)	AA1 (morning)
NU16 (night)	NU45 (night)	NU39 (night)
NU45 (night)	NU16 (night)	PH32 (afternoon)
NU15 (morning)	NT24 (morning)	AA24 (night)
NT24 (morning)	NU39 (night)	HA3 (night)
HA13 (morning)	PH13 (afternoon)	*NU51 (morning)
NU39 (night)	HA13 (morning)	NU7 (afternoon)
PH13 (afternoon)	*NU50 (morning)	NU17 (afternoon)

Source: Authors* *Chief*

In respect of Figure 3, it shows actors whose closeness scores were higher, therefore, the larger the node size, the closer to all the actors in the network. In the matter of the betweenness metric, there were only two actors that were also present in the top 10 of the other two social metrics (NU39 and NU51). This implies that an actor does not need to be high ranked on the path between two different actors to show a high in-degree metrics (*i.e.*, high direct connectivity) or to be close to all the actors in a network. Finally, it can also be verified that the nursing profession has the largest number of actors within the top 10 social metrics.

Table 6 presents the ten best-ranked actors based on the overall resilience score. The six best-ranked actors plus another one (in the eighth position) who ranked the highest scores, were nurses; only one of them held a management position (NU51). Additionally, the only two physicians in the top 10 resilience scores held no management positions, nor the healthcare allied professional (in the top 10 resilience), a physiotherapist. This infers the informal leadership role in knowledge sharing.

Figure 3 – Closeness node-sized network



Source: Authors

Table 6 – Ten best-ranked actors based on the resilience score

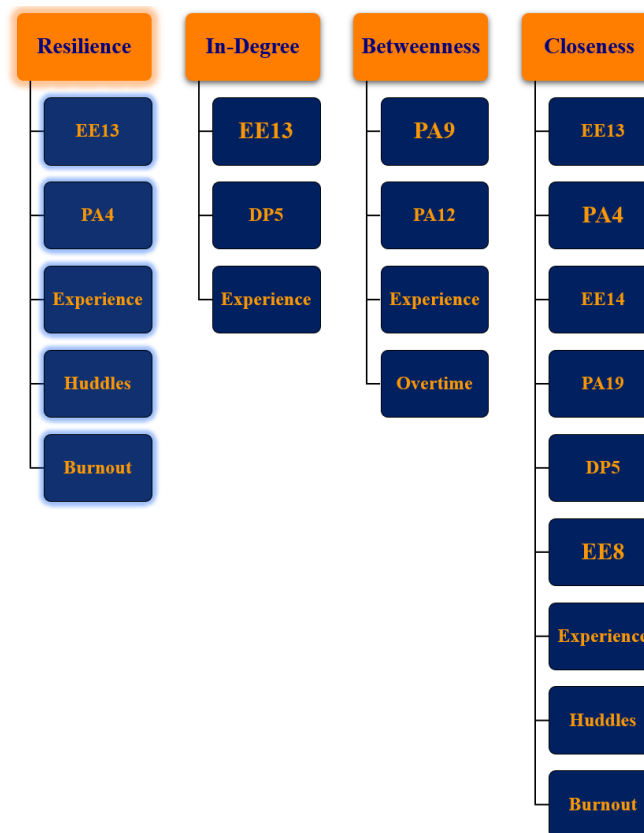
Actor	Network attributes			Non-network attributes		Resilience Score	Demographics		
	ID _i	C _i	B _i	Availability	Reliability	RS _i	Gender	Shift	ED Experience
NU39	3.05	3.90	4.52	4.63	4.58	1139.40	F	3	10
NU51*	3.84	4.43	3.08	4.30	4.30	966.99	F	1	12
NU45	3.42	4.27	2.43	4.70	4.56	761.64	F	3	22
NU20	3.90	4.46	2.03	4.08	4.51	650.71	F	2	2
NU16	3.74	4.24	2.03	4.47	4.45	640.64	F	3	13
NU7	2.79	3.67	3.08	4.38	4.65	639.77	F	2	13
PH13	3.05	3.89	2.35	4.55	4.59	583.13	F	2	8
NU29	2.95	3.49	2.76	4.38	4.45	554.20	M	3	24
PH7	1.89	3.14	4.76	4.33	4.50	552.01	M	1	13
HA13	3.10	3.87	2.27	4.31	4.53	533.26	M	1	7

Gender: F = female, M = male; *ED Shift:* 1 = morning, 2 = afternoon, 3 = night; *ED experience* = years working at the studied ED. The Resilience Score (RS_i) is calculated using Equation. (1). * = leadership position

Source: Authors

The Cronbach's alpha estimate for the entire MBI questionnaire was 0.884, which proves sufficient internal consistency (Hair, Black, Babin, & Anderson, 2019). The results that stand out in Figure 4 are: a positive correlation ($r = 0.166$, $p = 0.013$) between resilience score and EE13 (*Feel frustrated by job*) at a 95% significance level, as well as PA4 (*Can easily understand patients' feelings – inverted*) ($r = 0.137$, $p = 0.042$). This means that those actors who contributed most to the system's resilient performance, also sharing knowledge, are those who felt most misunderstood or dissatisfied with the dynamics of work, whether due to the activities performed or feedback from patients regarding their work. In fact, resilience was correlated to burnout ($r = 0.117$, $p = 0.083$), which demonstrates the toll for human resilient capital. In addition, positive correlations between resilience and experience ($r = 0.285$, $p < 0.001$) corroborated human capital matter for the resilient performance of the system along with participation in huddles of the emergency department studied ($r = 0.149$, $p = 0.026$).

Figure 4 – Correlations between resilience score and burnout score



Burnout prevalence was slightly higher when considering the frequency of actors in the critical range in at least two dimensions (Maslach & Leiter, 2020). In this regard, 17% of the respondents were in the critical range for EE and DP, 7% for EE and PA, and 6% for DP and PA (Table 7). Regarding critical results at a singular dimension, they were pinpointed for PA in 43% of respondents, DP in 29%, and EE in 28%. According to Leiter and Maslach (2016), these results represent latent burnout profiles of Ineffective, Disengaged, and Overextended, respectively.

Table 7 – Ten best-ranked actors based on the resilience score

Range/ Triad items - n (%)	EE	DP	PA	EE & DP	EE & PA	DP & PA	EE & DP & PA
Critical	62 (28%)	64 (29%)	95 (43%)	37 (17%)	16 (7%)	13 (6%)	8 (4%)
Moderate	77 (35%)	69 (31%)	61 (28%)	29 (13%)	30 (14%)	23 (10%)	14 (6%)
Good	82 (37%)	88 (40%)	65 (29%)	52 (24%)	13 (6%)	18 (8%)	6 (3%)

Source: Authors

5. CONCLUSION

In our study, we posed the following research question: “regarding knowledge management, what are the relationships between resilient performance and burnout?”. It has been found that resilience and burnout were convincingly correlated, as well as positive correlations were found between resilience and experience, and resilience and huddles, corroborating intellectual capital matter for the system functioning resiliently. In addition, results also indicate for the top ten actors, that the closer an actor is to all other actors in the network (closeness), the greater probability that they are highly requested by their close co-workers (in-degree) and vice versa. However, we cannot say the same for a high-ranking actor on the path between two different actors (betweenness) will certainly have high direct connectivity (in-degree) or be close to all the actors in a network (closeness). In sum, the constant use of resilient capacity takes a toll on healthcare professionals, but also that knowledge sharing promotes informal leadership, more skilled professionals and, henceforth, bolstering highly qualified human capital.

ACKNOWLEDGMENTS

The authors thank the **FAPERGS** for making this research possible through financial support and **everyone who participated** directly or indirectly by landing some of their time to strengthen this work.

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