Title: NURSING WORKLOAD ASSESSMENT IN AN INTENSIVE CARE UNIT: A 5-YEAR RETROSPECTIVE ANALYSIS

Running head: Nursing Workload Assessment in Intensive Care


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**Contributions**

JLS, CM and MM contributed to study design. JLS, CJS, CO, NMS and JM contributed to data collection. JLS and PSC contributed to data analyses. JLS, PSC, CM and MM contributed to manuscript preparation and correction.


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**Conflict of interest statement**

The authors declare no conflict of interest.

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# Title: NURSING WORKLOAD ASSESSMENT IN AN INTENSIVE CARE UNIT: A 5-YEAR RETROSPECTIVE ANALYSIS


## ABSTRACT

**Aims:** To study the correlation between the workload of intensive care nursing teams and the sociodemographic, anthropometric and clinical characteristics of patients in critical condition in a Portuguese Intensive Care Unit (ICU) during a 5-year period.

**Background:** Currently, indices of nursing workload quantification are one of the resources used for planning and evaluating ICUs. Evidence shows that there are several factors related to critical patients and their hospitalisation which potentially influence the nursing workload.

**Design:** Retrospective cohort analysis of a health record database from adult patients admitted to a Portuguese ICU between January 1, 2015, and December 31, 2019.

**Methods:** *Simplified Therapeutic Intervention Scoring System* (TISS-28) scores of 730 adult patients. Three TISS-28 assessments were considered: first assessment, last assessment and average. The STROBE guidelines were used in reporting this study.

**Results:** The TISS-28 has an average of 34.2 ± 6.9 points at admission, which is considered a high nursing workload. A somewhat lower result was found for the discharge and average assessments. It shows that basic activities accounted for the highest percentage of time spent (38.0%), followed by the cardiovascular support category (26.5%). The TISS-28 shows consistent results throughout the study period, despite a small trend reduction in the last 2 years.

**Conclusions:** Lower workloads were found for age ≤ 44 years and with a shorter length of stay. Higher workload was more probable in patients classified in Cullen Class IV (OR = 2.5) and with a normal to higher weight percentile (OR = 1.9 and 1.5, respectively).

**Relevance to clinical practice:** Knowledge of the factors influencing the nursing workload facilitates the implementation of rules to improve performance in nursing interventions, based on the redefinition of care priorities, increased productivity, human resources management and reduction of additional costs to the organisation, related to possible adverse events, among others.

**Keywords:** Nursing; Intensive Care; Work Organisation; Patient-Centred Care; Nurse Manager

**What does this paper contribute to the wider global clinical community?**

- In intensive care environments, factors associated with the patients can influence nurses' care behaviours and the nursing workload;
- At a time when discussing the need for a response in terms of intensive care, it seemed important to know the characteristics of patients hospitalised in these units and the influence of these characteristics on the nurses' workload;
- Male patients, with older age and longer hospital stay, patients with more weight at admission and less weight at the end of hospitalisation and most severely ill patients on admission are more likely to cause greater nursing workload;
- Applying an adequate management of the nursing workload and good safety practices will contribute to the reduction of adverse events and of the risk associated with health care by nurses.

## Introduction

Working in an Intensive Care Unit is a considerable source of pressure and psycho-social stress because of the lack of natural lighting, excessive noise, the large number of professionals and clinical equipment, high patient mortality, the lack of tangible results of the care provided by nurses and the constant need for adequate decision making (Bahadori et al., 2014). These factors, associated with the characteristics of patients in critical condition and the workload, can negatively impact nurses (Despins, Kim, Deroche, & Song, 2019; Myny et al., 2011; Towell, Nel, & Muller, 2015).

Several studies have analysed the workload of the nursing staff in intensive care environments, but studies on the influence of factors related to patients in critical condition in this workload are less frequent. Some of the variables referred to in the literature include gender (Samuelsson, Sjöberg, Karlström, Nolin, & Walther, 2015), age (Ferretti-Rebustini et al., 2017), weight (Goulart, Carrara, Zanei, & Whitaker, 2017), length of stay and clinical status (Gonçalves Menegueti, Ricci de Araújo, do Altíssimo Nogueira, Sanchez Gulin, &

Laus, 2017) as well as adverse events (Oliveira, Garcia, & Nogueira, 2016) of the intensive care hospitalised patients as potential influencers of the workload of nursing teams.

Thus, since the workload is of considerable significance for the biopsychosocial well-being of nurses, an increase in the workload not only leads to an increase in work absence, but is also one of the main factors that determine the decision to abandon this work field (Kwiecień, Wujtewicz, & Mędrzycka-Dąbrowska, 2012).

**Background**

According to Oliveira, Garcia and Nogueira (2016, p. 684) the nursing workload can be defined as "elements of the work process that dynamically interact with each other and with the worker's body, generating an adaptation process that translates to wear and tear".

In an intensive care context, the performance of the nursing team stands out, which, in most situations, implements established protocols, leading to the reduction of mortality, time on mechanical ventilation (invasive or non-invasive) and hospitalisation (Poncette et al., 2019; Rivera-Fernández, Nap, Vázquez-Mata, & Miranda, 2007).

According to Shalaby, Janbi, Mohammed and Al-harthi (2018), in intensive care environments, factors associated to the patients can influence nurses' care behaviours, since they establish contact with patients with serious health problems, health- and life-threatening conditions, dependency on means to constantly support vital functions and, additionally, with specific physical and clinical characteristics of each patient in critical condition. All these issues impact the nursing workload.

Stress factors experienced by nurses in ICUs can lead to the development of stress-related illnesses, emotional exhaustion at work, depersonalisation, feelings of failure, demotivation, conflicts with other team members and even to a decrease in the quality of care provided to the patient in a critical condition (Preto & Pedrão, 2009; Towell et al., 2015). All these factors lead the nurses to experience functional and emotional changes.

In the literature, several factors are described as potential influencers of nursing workload in an intensive care environment, namely those that are mentioned in Gonçalves, Menegueti, Ricci de Araújo, Altíssimo Nogueira, Sanchez Gulin and Laus (2017). In their analysis, the variables most cited as predictors of higher nursing workload were length of stay, clinical

severity and death. Thus, patients who died and those who remained hospitalised longer, probably because they had a more unstable condition, with the need for more rigorous monitoring and multiple therapeutic interventions, presented a higher workload.

Regarding the length of stay, Macedo (2017) found a statistically significant influence on the nursing workload, which increased with a shorter length of stay.

The gender of the patient in critical condition also influences the workload. According to Samuelsson, Sjöberg, Karlström, Nolin and Walther (2015), there are substantial preclinical data on how male and female sexual hormones play a role in the pathophysiology and recovery from critical illnesses. The authors refer to the example of estrogen as a potent antioxidant that appears to have a protective effect in situations of trauma and haemorrhage, but high levels of testosterone in critical conditions are associated with the suppression of cardiac function and immune response. These authors found that male individuals were independently associated with receiving more care at the ICU by admission.

Another factor that can influence the nursing workload in ICUs is the age of the patients. There is a substantial increase in the number of elderly patients admitted to ICUs, due to an aging population worldwide (Walker, Spivak, & Sebastian, 2014), which increases the average age of patients. Differentiated care for the elderly in the ICU requires qualified nurses who are aware of the specificities inherent to senescence and senility, being one of the most important determinants of the quality associated with the care and safety of these patients (Ferretti-Rebustini et al., 2017).

There is evidence that the weight of the patients can influence the workload of nurses in intensive care. According to Shea and Gagnon (2015), nurses who care for obese patients generally experience discomfort and physical exhaustion, classifying the experience as more challenging, difficult and demanding. Also, Robstad et al. (2018) found that intensive care nurses understand the care of obese patients as emotionally demanding due to the vulnerability and physical challenges of these patients compared to patients with normal weight, with repercussions on their workload.

Macedo (2017) identified several instruments referred to in the literature for the assessment of nursing workload, such as the Therapeutic Intervention Scoring System (TISS), TISS-28, the Nursing Activities Score (NAS) , the Nine Equivalents of Nursing Manpower (NEMS), the Omega Scoring System (OMEGA), the Project of Research of Nursing (PRN), the Time

Oriented Score System (TOSS), the Comprehensive Nursing Intervention Score (CNIS), the Nursing Care Recording System (NCR11) and the Clinical Activity Monitoring System (CATS).

Of these instruments, the one most used in Portugal are the TISS-28 and the NAS, as they are part of the three instruments that are validated for this country (TISS, TISS-28 and NAS).

Ferreira, Machado, Vitor, Lira and Martins (2014) state that although the importance of TISS-28 is recognised, its use has highlighted some structural gaps for the total measurement of nursing workload, as activities indirectly related to patients in critical condition care, such as organisational, family support and administrative tasks, are not considered. Also, Wysokiński, Ksykiewicz-Dorota and Fidecki (2013) mention that the interventions considered in the TISS-28 are mainly focused on diagnostic-treatment procedures in the scope of intensive care, generally omitting the autonomous nursing interventions associated with nursing in intensive care. In this regard, Queijo and Padilha (2009) state that the TISS-28 covers only about 43.3% of nursing activities.

In Portugal, despite these weaknesses, the TISS-28 scale is an instrument widely available and applied in ICUs. Queijo (2002) classifies it as a reliable workload assessment method as it considers the specificity of each patient in relation to severity and allows a comparison of the workload between each patient or group of patients. Pirret (2002) also considers it adequate for the nursing workload assessment as it can easily and rapidly be applied, with few resources.

In this context, the main objectives of this study were: (1) to analyse the workload of the nursing team of one ICU of one hospital in the central region of Portugal during a 5-year period (2015-2019) and (2) to evaluate the influences of sociodemographic, anthropometric and clinical factors of patients in critical condition over that period.

## Methods

### Experimental design

The present study is a quantitative, observational, analytical and longitudinal approach, based on retrospective analysis of electronic data, recorded in the software PICIS® (Patient Management Software), of adults and elderly patients in critical condition admitted to one

ICU (level 3 – patients requiring advanced respiratory support alone or monitoring and support for two or more organ systems; this level includes all complex patients requiring support for multi-organ failure) of one hospital in the central region of Portugal from January 1, 2015, to December 31, 2019 (5 years). This study was executed and reported in accordance with Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies (Supplementary File 1).

**Sample/participants**

The inclusion criteria were as follows: (1) patients in critical condition of both genders and ≥ 18 years old at the time of admission, (2) hospitalised patients, admitted between January 1, 2015, and December 31, 2019, and (3) patients with at least one complete assessment of the Simplified Therapeutic Intervention Scoring System (TISS-28).

The exclusion criteria were as follows: (1) patients with a length of stay of less than 24 hours and (2) patients with incomplete assessment of the TISS-28.

Applying the inclusion and exclusion criteria described above, we obtained a total sample of 730 patients in critical condition.

**Ethical considerations**

The study was approved by the Hospital Council Board and Ethics Committee approval. Confidentiality of the data and anonymity of the participants in the study were always guaranteed, as well as their treatment with respect and professional secrecy. Each patient was coded numerically in chronological order, making it possible to guarantee and maintain the anonymity of the participants throughout the study. All data were stored in a digital database, protected by a password, to ensure that only the investigators had access.

**Data collection**

All TISS-28 assessments for each patient included in the study were extracted from an electronic health record database. Other demographic and clinical data were extracted from the same electronic health record database and included the following variables: gender, age and admission weight.

The age variable was dichotomised in the following categories: ≤ 44 years, 45-64 years, 65-84 years and ≥ 85 years, considering the ranges suggested by the World Health Organization (Ahmad et al., 2001). The weight variable was dichotomised in the following categories: Percentile ≤ 25, Percentile 26-75 and Percentile > 75, considering the anthropometric values of reference for the Portuguese adult and elderly population, suggested by Nogueira (2016). This categorisation takes into account the different suggested values for men and women and for each age group. The length of stay was categorised as follows: 1 day, 2-7 days, 8-14 days and ≥ 15 days. We chose this categorisation considering the first cut-off point of 1 day to define the group of patients with a hospital stay of less than 48 hours and therefore with only one evaluation of the TISS-28. The TISS-28 score variable was categorized into Cullen Class I [up to 9 points], Cullen Class II [from 10 to 19 points], Cullen Class III [from 20 to 39 points] and Cullen Class IV [above 40 points] (Cullen, Civetta, Briggs, & Ferrara, 1974).

**Validity and reliability/rigour**

The TISS-28 is a reduced version of the original TISS scale, created by Cullen (Cullen et al., 1974) and later updated by Keene and Cullen (1983). It consists of a system to measure the severity and nursing workload in intensive care based on the quantification of interventions performed on hospitalised people, according to their complexity, degree of invasiveness and the time spent by nurses to perform certain procedures. Thus, this scale was initially made up of 57 therapeutic acts, scored from 1 to 4 according to the workload involved, with 76 therapeutic acts being measured with the reformulation that occurred in 1983.

The simplified version (TISS-28), with a reduction in the number of items and grouping of related items, in a total of 28 therapeutic acts, was adjusted by Miranda, De RijK and Schaufeli (1996) to make the index more reliable for measuring nursing workload and facilitating its practical application. Moreno and Morais (1997) translated and validated this system into the European Portuguese language, enabling its use in the context of Intensive Care in Portugal, being one of the three instruments for assessing the nursing workload validated in a multicentre way in Portugal (TISS, TISS-28 and NAS). In this study, with the objective to evaluate the performance of the TISS-28 in an independent database and to determine its relation with the TISS in the quantification of nursing workload in intensive care, the authors verified that the correlation between the two was good, with TISS-28 explaining 72.0% of the variation of TISS-76 ($r = 0.85$, $r^2 = 0.72$). The relation between the

two systems was TISS-28 = 6.22 + 0.85 TISS-76. In this cohort, reliability of data collection was high, with intraclass correlation coefficients greater than 0.90 for both systems.

This scale is composed of seven categories of therapeutic interventions: basic activities, ventilatory, cardiovascular, renal, neurological, metabolic support and specific interventions (Padilha et al., 2005). Each of these categories is composed of a variable number of items, corresponding to the nursing interventions provided to each patient in a critical situation. After scoring the categories, they are summed, and the final value is the TISS-28 score of that patient for the last 24 hours.

The application of TISS-28 in Intensive Care also allows the classification of patients into four classes of hierarchy by degree of severity (Cullen Classes) through the sum of the points attributed to Nursing interventions: Class I to IV (Padilha et al., 2005).

According to Cullen et al. (1974), the first degree (class I) identifies patients who do not need to be in an intensive care service. The second degree of severity (class II) identifies patients with an indication for admission to an intensive care service. The third degree of severity (class III) identifies patients who require intensive care due to haemodynamic instability. The fourth and highest degree of severity (class IV) refers to patients who have a compulsive indication for the use of intensive care because they have great haemodynamic instability. Thus, Cullen's classes help, indirectly, to understand the necessary degree of vigilance as well as the need for each patient in critical situation to stay in an intensive care service.

**Data analysis**

Data were analysed using the Statistical Package for the Social Sciences software (SPSS), version 23.0 (IBM Corp., New York, USA). All results with a $p < 0.05$ were considered significant. Descriptive statistics were calculated for the demographic and clinical variables and sample characterisation.

To evaluate the relationship between the variables under study and the TISS-28, we used the one-way between subjects analysis of variance (ANOVA) (with normality of the residuals and homogeneity of the verified variance) or the Kruskal-Wallis test (if the previous assumptions were not verified). Multiple comparisons (MC) were performed when the null hypothesis of the ANOVA was rejected, and the methods used were Tukey´s test (parametric) or Mann-Whitney test with Bonferroni correction (non-parametric).

In the logistic regression analysis, the TISS-28 scores on admission and discharge were dichotomised according to the Cullen Classes, with the construction of two groups: group 1 consisted of the Cullen Class classification I-II-III (associated with a lower nursing workload) and group 2 of Cullen Class IV (associated with a greater nursing workload and greater haemodynamic instability). This division was carried out also considering the low number of patients classified in classes I and II due to our ICU characteristics (level 3 unit). The presented models are only for the univariate case, and the results are presented in the form of the odds ratio (OR) and its 95% confidence interval.

The STROBE checklist was used in this report.

## Results

### Sample characterisation

This study included a sample of 730 patients in critical condition. Most of the patients were male (60.5%), with an average age of 62.6 ± 16.6 years, ranging from 18 to 96 years. Through the joint analysis of the last two age groups, we found that most of patients belonging to the sample were over 65 years old (52.2%) (Table 1).

Weight information was recorded for only 435 patients, considering anthropometric characterisation, with an average weight of 78.0 ± 18.4 kg and minimum and maximum values of 40 and 180 kg, respectively. For the weight categorisation, we found that the group most represented was Percentile > 75 (38.2%).

INSERT TABLE 1 HERE

Regarding the length of stay, it lasted an average of 7.7 ± 9.8 days, with a minimum duration of 1 day and a maximum of 188 days (Table 2). The most represented category was that of patients with a stay that lasted between 2 and 7 days, representing the majority of the total sample (53.1%).

The first TISS-28 evaluation, at 24 hours of hospitalisation, showed an average of 34.2 ± 6.9 points, oscillating between a minimum to a maximum of 14 to 54 points, respectively. On the other hand, the last TISS-28 evaluation, considering a sample of 643 patients (87 patients

were hospitalised for less than 48 hours, leading to the record of only one evaluation) had an average of 29.3 ± 5.7 points, with a minimum value of 11 points and a maximum of 52 points. During hospitalisation, the average value of the TISS-28 was 32.4 ± 5.3 points, with a minimum value of 14 and a maximum of 51 points.

INSERT TABLE 2 HERE

**Characterisation of the nursing workload**

Table 3 shows the characterisation of the nursing workload. In the category *Basic activities*, the intervention *Basic monitoring* was recorded in the entire sample (100%) during the hospitalisation period. Still in this category, we obtained values close to those of the total sample in the therapeutic interventions *Analysis* (98.9%), *Intravenous multiple medication* (97.9%) and *Drainages* (97.8%). Regarding the number of interventions, the therapeutic interventions, already mentioned, were those with the highest average value (from 7.4 to 7.7 interventions). Converting these interventions into minutes spent [according to Padilha et al. (2005), each TISS-28 point consumes 10.6 minutes of a nurse's working time in providing care to a critically ill patient, in an 8-hour shift], we see that this trend continues to increase, except for *Analysis*, which had a lower score than the others. Thus, we found that *Basic monitoring* occupied 14.8% of the total nursing care time and *Analysis* intervention only 2.9%, despite being one of the most prevalent interventions.

Regarding the category *Respiratory support*, we found that the most prevalent one was *Support measures for lung function* (95.2%), followed by *Artificial ventilation* (80.3%). This trend continues in relation to the average number of interventions. However, the values related to the time spent to carry out these interventions were higher for *Artificial ventilation*, representing 11.2%.

Analysing the *Cardiovascular support* category, the most prevalent therapeutic interventions were *Peripheral arterial line* (98.1%) and *Central venous catheter* (89.2%). This appreciation remains in relation to the average number of interventions performed. However, the time spent with the *Peripheral arterial line* was considerably higher (14.6%) than that with *Central venous catheter* (5.4%).

In the *Renal support* category, the most prevalent intervention was *Monitoring of urine output* (99.5%), maintaining its relevance both in the average number of interventions (7.6 interventions) and in the percentage of time (5.9%).

Regarding the *Metabolic support* category, the most registered intervention was *Nasogastric tube feeding* (53.2%), presenting, however, lower values than other interventions already highlighted in the other categories. In this category, this was also the intervention with the highest average number of interventions (4.6), as well as the highest percentage of time (3.5%).

For the category *Specific interventions*, *Unique specific intervention in the ICU* was the most prevalent therapeutic intervention (48.5%), keeping the emphasis on the remaining dimensions under analysis: number of interventions (0.8 interventions) and time spent (1.0%).

Regarding the total time of nursing care in the studied period, the interventions *Basic monitoring*, *Peripheral arterial line*, *Artificial ventilation*, *Intravenous multiple medication*, *Drainage*, *Urine output monitoring* and *Central venous catheter* occupied a greater percentage of time of care, representing in total almost 70.0% of all time spent.

INSERT TABLE 3 HERE

To conclude the characterisation of the nursing workload, Figure 1 shows the percentage of time spent in each TISS-28 category. Basic activities accounted for the highest percentage of time spent (38.0%), followed by the Cardiovascular Support category (26.5%). The categories with the least time spent were Specific Interventions (2.2%) and Metabolic Support (5.3%), in addition to the Neurological Support category, which does not apply in this context.

INSERT FIGURE 1 HERE

Figure 2 shows the mean and 95% CI for TISS-28 scores between 2015 and 2019. There appears to be a decrease in the TISS-28 first assessment on average values and variability from 2018. In the TISS-28 last assessment and in the TISS-28 average assessment, there was a reduction in the average only for the year 2018. In both cases, the variability remained constant in the period under analysis.

INSERT FIGURE 2 HERE

**Influences of sociodemographic, anthropometric and clinical variables on the nursing workload**

Regarding the first TISS-28 assessment (Table 4), we only obtained statistically significant differences in age and length of stay ($p < 0.001$). In the first assessment, from multiple comparisons for age, two groups of different statistical effects emerged: a first for age ≤ 44 years and a second effect for the remaining age groups. These results indicate the existence of differences between younger adults and the remaining age groups. Regarding the length of hospital stay, multiple comparisons showed no differences between the groups of 1 day and 2-7 days of hospitalisation and the groups of 8-14 days and ≥ 15 days. However, they indicate differences between patients with a shorter hospital stay when compared to longer hospital stays.

For the last evaluation of TISS 28, only age was statistically significant ($p < 0.001$). However, we found values close to statistical significance in the gender ($p = 0.058$) and length of stay ($p = 0.051$). In this last evaluation, from multiple comparisons for age, two groups of two different statistical effects emerged: a first for age ≤ 44 years and a second for the remaining groups, similar to the previous evaluation.

Regarding the TISS-28 average differences, statistically significant differences were found for sex ($p = 0.036$), age ($p < 0.001$) and length of stay ($p < 0.001$). Multiple comparison analysis for age and length of hospital stay revealed results identical to those found in the first assessment.

INSERT TABLE 4 HERE

Table 5 shows the results of the logistic regression models for TISS-28 at admission and at discharge. For the gender variable, we found that, in both assessments of the TISS-28, men had a greater chance of presenting higher values in the nursing workload when compared to females, being even higher in the last evaluation (OR = 1.6) than in the first one (OR = 1.2). We also found that the increase in age was directly proportional to the nursing workload, with a greater possibility for older patients to have higher TISS-28 values when compared to the younger group. This probability was greater in the last assessment (OR 45-64 years = 1.9; OR 65-84 years = 2.1, respectively) than in the first one (OR 45-64 years = 1.6; OR 65-84 years = 1.6, respectively). However, for the group with 85 years or more, the first assessment

presented a higher risk when compared to the second assessment (OR ≥ 85 years = 2.2; OR ≥ 85 years = 1.0, respectively).

For the weight variable, in the first assessment of TISS-28, there was a greater risk of having higher nursing workload values for patients in critical situations with a higher percentile (OR = 1.5) and an intermediate percentile (OR = 1.9) when compared to the lower-percentile group. However, in the last evaluation of TISS-28, we found an odds ratio less than 1 for the same situation: higher percentile (OR = 0.6) and intermediate percentile (OR = 0.5), both non-significant.

For the last evaluation of TISS-28, this study found a non-significant relationship between a patient hospitalised for longer than 15 days. Finally, the critical situations with a classification in the Cullen IV class presented a significantly greater risk of higher workloads when compared to the other Cullen classifications (OR = 2.5).

INSERT TABLE 5 HERE

**Discussion**

The present study aimed to identify the most important factors related to patients affecting the nursing workload. According to the Health Ministry of Portugal (Serviço Nacional de Saúde, 2020), the average number of intensive care beds per 100,000 inhabitants in Portugal is steadily increasing, with the aim of reaching the European Union average of 11.5. The same source reports that in 2012, there were only 4.2 beds per 100,000 inhabitants, with a gradual increase to 5.66 beds per 100,000 inhabitants in December 2019 and 7.39 in April 2020. The increase in the number of beds was relevant and occurred within a short time. At a time when discussing the need for a response in terms of intensive care, it seemed important to study the sociodemographic, anthropometric and clinical characteristics of patients hospitalised in these units and the influence of these characteristics on the nurses' workload.

Regarding the sociodemographic characterisation of the sample, our results are similar to those of Macedo (2017) and Pedro (2019) from Portugal, also with a predominance of males over females and also relatively aged. Regarding the anthropometric characterisation, the sample of patients in the study of Pedro (2019) had an average weight of 77.4 kg, which is close to that found in our study (78.0 kg). In terms of clinical characterisation, a comparative

analysis between our results and those achieved in other studies shows that in our study, patients in critical situations remained hospitalised for a longer period than those in Macedo (2017), but for a shorter period than those in Pedro (2019), with an average of 8.7 days for a hospital in the Lisbon Region. Our results are similar to the average for the Centre Region of Portugal, which presents an average length of stay in the region of 7.9 days, with a minimum of 6.2 (Leiria Hospital) and a maximum of 8.8 days (Guarda Hospital) (Penedo et al., 2013).

Regarding the analysis of nurses' workload, we found a decrease in the average values of nursing workload from the first assessment to the last (34.2 ± 6.9 points and 29.3 ± 5.7 points, respectively). This was expected, since presumably, patients in the last assessment will improve their condition or, in the case of deaths, there may also have been a decrease in therapeutic investment.

The mean values of the TISS-28 showed an average of 32.4 ± 5.3 points over the entire length of stay. These global average values are higher than the values found by Macedo (2017) (29.25 ± 10.07 points). Catalão (2016) calculated the average of the scores for the 24 hours of care, presenting an average value of the annual scores of 143.38 points. Taking this average value and considering the scale of nursing work in the unit under study, the author found that in the morning shift, nurses make an average of 23.90 points. In the afternoon shift, the average is 35.85 points, and in the night shift, it is 35.85 points.

Considering that each point on the TISS-28 consumes 10.6 minutes of a nurse's working time, in an 8-hour shift, the nurses in our study spent an average of 343.4 minutes (5.7 hours), which reveals a high workload. Taking into account that the TISS-28 covers only about 43.3% of all nursing activities (Queijo & Padilha, 2009), this average value of 5.7 hours represents a value of 71.3% in an 8-hour shift, which is considerably higher than the value previously indicated.

Novaretti et al. (2014) found that approximately 78.0% of incidents without injury and adverse events related to hospitalised patients were related to nursing interventions. These complications, attributed to nursing work overload, increased the number of days of hospitalisation and were also associated with an increased risk of mortality. Oliveira, Garcia and Nogueira (2016) concluded that the increase in the proportion of hours of nursing care provided to a patient in critical condition is associated with a decrease in the occurrence of adverse events, such as urinary tract infection, ulcer pressure, hospital pneumonia, infections

of skin lesions, complications in central venous access, shock, errors related to pharmacological therapy and postoperative complications.

In our study, a large score fluctuation was found in both assessments (first and last), which is in agreement with the results of Macedo (2017). The TISS-28 values ranged between 8 and 57 points in Macedo (2017) and between 14 and 51 points in our study. Catalão (2016) also found a large variation in the values recorded by nurses.

The *Basic activities* category had the highest percentage of time spent, followed by the *Cardiovascular support* category. These results are partially coincident with those of Catalão (2016), who found that the *Basic activities* category had the highest prevalence in relation to the others, followed by *Respiratory support* and *Renal support*. However, the *Cardiovascular support* category had a lower prevalence than the *Respiratory support*, *Renal support*, *Metabolic support* and *Specific interventions* categories.

In the first assessment (24 hours after admission), there were statistically significant differences in age and length of hospital stay. For the last assessment, the statistical differences were only significant for the age. Regarding the mean values of TISS-28, we observed a statistically significant difference for gender, age and length of stay.

Deepening the analysis of the relationship between these variables, we found that at admission and at discharge, for the gender variable, men had a greater chance of presenting higher values in the nursing workload than women. This result is consistent with the study of Samuelsson et al. (2015). However, Macedo (2017), carrying out a study identical to ours, but using the NAS, obtained contrary results: female patients increased the nursing workload.

The TISS-28 scores of the two assessment moments in the younger adults (age $\leq$ 44 years) were statistically different from the scores of older patients. Furthermore, the nursing workload increase was directly proportional to the age, leading to higher TISS-28 values. These results are partially in agreement with those of Ferretti-Rebustini et al. (2017), who found that aging can be considered an associated factor, but not a predictor of nursing workload in ICU. Sousa et al. (2009) found that, regardless of age, there was a similarity in the nursing workload on admission as well as in the evolution of the care needs of patients, with no statistically significant differences among groups with different ages, which was also not verified in our study. The results of Macedo (2017), regarding the assessment of the nursing workload using the NAS, revealed a significant influence of age on the nurses'

workload, in contrast to our study: the younger the patients, the higher the nursing workload values.

In the first assessment of TISS-28 (24 hours after admission), patients with a higher weight percentile most likely had higher values of nursing workload. However, in the last evaluation of TISS-28, patients with less weight on admission were more likely to have higher nursing workloads. The results of our study, for the first assessment, are consistent with those found in the literature and presented in the background (Robstad et al., 2018; Robstad, Westergren, Siebler, Söderhamn, & Fegran, 2019; Shea & Gagnon, 2015). Regarding the last assessment, Costa (2012) reported that the nutritional status of hospitalised patients had a significant impact. This author also mentions that caloric-protein malnutrition is a prevalent problem affecting between 30.0 and 60.0% of hospitalised patients, and many of them lose weight during hospitalisation. This phenomenon has a multifactorial origin such as severity of the disease, absence of support, adequate nutritional status, among others (Al-Dorzi, Tamim, Mundekkadan, Sohail, & Arabi, 2014). Thus, it seems possible that a patient with low weight on admission, and with calorie-protein malnutrition associated with hospitalisation, will lose weight, lowering his energy reserves and becoming more susceptible to risks inherent to hospitalisation (such as an increased risk of developing pressure ulcers), therefore increasing the nurses' workload.

According to Costa (2012), this situation is even more evident in critical patients since they present hypermetabolism and a marked hypercatabolism, in which their clinical condition (namely the presence of haemodynamic instability and, sometimes, the absence of an available enteral access) makes it impossible to proceed, in many cases, to an early nutritional supply. In this sense, this can justify the higher values of nursing workload in the last assessment.

We found that patients with a shorter stay (1 day and 2-7 days) had lower TISS-28 scores than patients with longer hospitalisation (8-14 days and ≥ 15 days), both in the first evaluation and in global average values. Besides, a patient hospitalised more than 15 days had a greater chance of obtaining a higher TISS-28 score when compared to a shorter period, probably due to a more unstable condition and the need of more rigorous monitoring and multiple therapeutic interventions, which is consistent with the results of Gonçalves et al. (2017). However, the results of Macedo (2017) are contrary, since the author found that shorter lengths of stay led to higher values of workload.

Considering the first evaluation of the TISS-28, we found that patients in critical condition with a classification in the Cullen Class IV had a greater chance of presenting a higher workload in the last evaluation. This means that patients in a more critical clinical situation, implying greater nursing workload at admission, also have a greater chance of causing a higher workload in the last evaluation, which is in accordance with the results of Sobrinho et al. (2019).

The high workload consequences, such as nurses' non-compliance with care guidelines, inadequate monitoring of patients, etc., can be at the patient level (including lower quality of care and safety), the patients' relatives´ level (including dissatisfaction with the care provided) and the nurse's level (including lower quality of working life) (Bahadori et al., 2014). Thus, it seems important to consider the factors identified in our study as potential influencers of the workload of nurses in the calculation of safe nursing care allocations and in the distribution of the number of patients by each nurse. Also, the clear responsibilities and authorities of nurses, patients' admission based on the capacity of wards, the use of modern technologies and equipment, providing basic training for new nurses, etc. can decrease the nurses' workload.

## Conclusions

Many adverse events and incidents in intensive care settings are attributed to nursing interventions, often due to work overload and inadequate human resource ratios to respond to the care required by patients in critical condition. Therefore, analysing the nursing workload in critical care contexts can be an important strategy to assist and support the management of the nursing care process.

We carried out a retrospective study on a sample of 730 patients in critical condition to analyse the nursing workload based on the evaluation records of the TISS-28. Male patients, with older age, longer hospital stay and classified in Cullen Class IV in the first assessment, were more likely to have higher TISS-28 values and, consequently, a greater nursing workload. We also found that patients with higher weight, in the first assessment, had a greater probability of higher nursing workload values. However, patients with less weight on admission were more likely to have a higher nursing workload in the last assessment.

Difficulties experienced in extracting electronic data from the information system used in the intensive care unit represented a limitation to this study as it was not possible to analyse some of the variables referred to in the literature, such as height, to calculate Body Mass Index (BMI), medical diagnosis, provenance, the clinical situation in the last assessment (discharge or death) or the occurrence of adverse events…

**Relevance to clinical practice**

We believe that this work can contribute to the implementation of measures to improve performance in nursing interventions, based on the redefinition of care priorities, increased productivity, human resources management and reduction of additional costs to the organisation, related to possible adverse events, among others. Thus, applying an adequate management of the nursing workload and good safety practices will contribute to the reduction of adverse events and to the reduction of the risk associated with health care by nurses.

We therefore hope that this study can contribute to a deeper understanding of the work overload problem of nurses within the scope of human resources management in the ICU hospital area. This analysis aims at the continuous improvement of care of nursing, leading to a decrease in work overload-related adverse events and implications for nurses' mental health.

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Table 1. Sociodemographic and anthropometric characterization of the studied patients (n = 730)

| **Sociodemographic and anthropometric variables** | **N** | **%** |
|---|---|---|
| **Gender** | | |
| Male | 442 | 60.5 |
| Female | 288 | 39.5 |
| **Age (years)** | | |
| ≤ 44 | 114 | 15.6 |
| 45-64 | 235 | 32.2 |
| 65-84 | 343 | 47.0 |
| ≥ 85 | 38 | 5.2 |
| **Weight at admission (Kg)*** | | |
| ≤ P25% | 140 | 32.2 |
| P26%-P75% | 129 | 29.7 |
| > P75% | 166 | 38.2 |

* (n=435); Weight (Kg): Men: P25%=73.0; P50%=79.1; P75%=95.3; Woman: P25%=59.4; P50%=64.7; P75%=71.3 (Nogueira, 2016).

Table 2. Characterization of the length of stay of the studied patients (n = 730)

| Variables related to the length of stay | N | % |
|---|---|---|
| **Year of hospitalization** | | |
| 2015 | 171 | 23.4 |
| 2016 | 122 | 16.7 |
| 2017 | 120 | 16.4 |
| 2018 | 137 | 18.8 |
| 2019 | 180 | 24.7 |
| **Length of stay (days)** | | |
| 1 | 87 | 11.9 |
| 2-7 | 387 | 53.1 |
| 8-14 | 147 | 20.1 |
| ≥ 15 | 109 | 14.9 |
| **Cullen Classes in the TISS-28 first assessment** | | |

| | | |
|---|---|---|
| Class I – until 9 points | 0 | 0 |
| Class II – 10 to 19 points | 15 | 2.1 |
| Class III – 20 to 39 points | 555 | 76.0 |
| Class IV – above 40 points | 160 | 21.9 |
| **Cullen Classes in the TISS-28 last assessment*** | | |
| Class I – until 9 points | 0 | 0 |
| Class II – 10 to 19 points | 19 | 3.0 |
| Class III – 20 to 39 points | 592 | 92.1 |
| Class IV – above 40 points | 32 | 5.0 |
| **Cullen Classes of the TISS-28 assessment average** | | |
| Class I – until 9 points | 0 | 0 |
| Class II – 10 to 19 points | 11 | 1.5 |
| Class III – 20 to 39 points | 678 | 92.9 |
| Class IV – above 40 points | 41 | 5.6 |

* (n=643)

Table 3. Number of therapeutic interventions assessed by TISS-28 and corresponding time spent (n = 730)

| **Categories and therapeutic interventions of TISS-28** | **Total of patients** | | **Number of interventions** | **Spent Minutes** | **Percentage of total care time per intervention** |
|---|---|---|---|---|---|
| | **N** | **%** | **M ± SD** | **M ± SD** | **%** |
| **Basic activities** | | | | | |
| Basic Monitoring | 730 | 100.0 | 7.7 ± 9.8 | 407.2 ± 516.8 | 14.8 |
| Analysis | 722 | 98.9 | 7.6 ± 9.5 | 80.2 ± 100.9 | 2.9 |
| Single medication | 52 | 7.1 | 0.1 ± 0.6 | 2.9 ± 12.7 | 0.1 |

| | | | | | |
|---|---|---|---|---|---|
| Intravenous multiple medication | 715 | 97.9 | 7.5 ± 9.7 | 239.0 ± 308.8 | 8.7 |
| Simple change of clothes | 617 | 84.5 | 5.3 ± 6.2 | 56.7 ± 66.1 | 2.1 |
| Complex change of clothes | 315 | 43.2 | 2.3 ± 5.8 | 24.1 ± 61.4 | 0.9 |
| Drainage | 714 | 97.8 | 7.4 ± 9.3 | 235.6 ± 295.5 | 8.6 |
| **Respiratory support** | | | | | |
| Artificial ventilation | 586 | 80.3 | 5.8 ± 9.4 | 307.3 ± 497.5 | 11.2 |
| Ventilatory support | 503 | 68.9 | 1.8 ± 2.2 | 37.7 ± 46.7 | 1.4 |
| Airway care | 573 | 78.5 | 5.9 ± 9.7 | 62.4 ± 103.1 | 2.3 |
| Supportive measures of lung function | 695 | 95.2 | 7.3 ± 9.8 | 77.4 ± 103.7 | 2.8 |
| **Cardiovascular support** | | | | | |
| Single vasoactive drug | 508 | 69.6 | 3.3 ± 4.0 | 106.1 ± 127.6 | 3.9 |
| Multiple vasoactive drugs | 132 | 18.1 | 0.7 ± 6.5 | 31.1 ± 273.8 | 1.1 |
| Volume replacement | 294 | 40.3 | 0.9 ± 1.6 | 36.1 ± 68.1 | 1.3 |
| Peripheral arterial line | 716 | 98.1 | 7.6 ± 9.7 | 400.7 ± 516.5 | 14.6 |
| Hemodynamic monitoring | 18 | 2.5 | 0.1 ± 0.4 | 3.9 ± 30.8 | 0.1 |
| Central venous catheter | 651 | 89.2 | 7.1 ± 9.7 | 149.9 ± 206.3 | 5.4 |
| Cardiorespiratory resuscitation | 10 | 1.4 | 0.0 ± 0.3 | 0.7 ± 7.9 | 0.0 |
| **Renal support** | | | | | |
| Dialytic techniques | 100 | 13.7 | 0.7 ± 2.2 | 20.7 ± 69.6 | 0.8 |
| Urine output monitoring | 726 | 99.5 | 7.6 ± 9.8 | 162.1 ± 206.9 | 5.9 |
| Forced diuresis | 460 | 63.0 | 3.2 ± 4.6 | 102.2 ± 146.6 | 3.7 |
| **Neurological support** | | | | | |
| Intracranial pressure monitoring | 0.0 | 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 |
| **Metabolic support** | | | | | |
| Complicated alkalosis/metabolic acidosis treatment | 216 | 29.6 | 0.6 ± 1.1 | 23.4 ± 46.5 | 0.8 |
| Parenteral feeding | 94 | 12.9 | 0.8 ± 2.8 | 25.8 ± 88.2 | 0.9 |
| Nasogastric Tube Feeding | 388 | 53.2 | 4.6 ± 8.5 | 97.5 ± 180.7 | 3.5 |
| **Specific interventions** | | | | | |
| Unique specific intervention in the ICU | 354 | 48.5 | 0.8 ± 1.2 | 26.4 ± 36.9 | 1.0 |
| Multiple specific interventions in the ICU | 202 | 27.7 | 0.3 ± 0.6 | 17.5 ± 31.0 | 0.6 |
| Specific interventions outside the ICU | 149 | 20.4 | 0.3 ± 0.8 | 16.6 ± 40.3 | 0.6 |

Table 4. Relationship between the variables under study and the TISS-28 assessment throughout the length of stay

| Variables under study | TISS-28 first assessment (n=730) | | TISS-28 last assessment (n=643) | | TISS-28 average values (n=730) | |
|---|---|---|---|---|---|---|
| | M ± SD | Statistical result | M ± SD | Statistical result | M ± SD | Statistical result |
| **Gender** | | | | | | |
| Male | 34.5 ± 6.9 | F(1;728)=2.2; | 29.6 ± 5.8 | F(1;641)=3.6; | 32.8 ± 5.2 | F(1;728)=4.4; |
| Female | 33.7 ± 6.9 | p=0.139 | 28.8 ± 5.4 | p=0.058 | 31.9 ± 5.4 | p=0.036 |
| **Age (years)** | | | | | | |
| ≤ 44 | 31.2 ± 7.6 | $\chi^2(3)=28.4$ | 26.6 ± 6.0 | $\chi^2(3)=39.2$ | 30.0 ± 5.5 | $\chi^2(3)=29.5$ |
| 45-64 | 34.2 ± 6.8 | p<0.001 | 29.2 ± 5.8 | p<0.001 | 32.6 ± 5.2 | p<0.001 |
| 65-84 | 34.8 ± 6.7 | MC: ≤ 44; | 30.3 ± 5.3 | MC: ≤ 44; | 33.0 ± 5.2 | MC: ≤ 44; |
| ≥ 85 | 36.7 ± 4.5 | 45-64= 65-84 = ≥ 85 | 29.9 ± 4.1 | 45-64= 65-84 = ≥ 85 | 33.6 ± 3.6 | 45-64= 65-84 = ≥ 85 |
| **Length of stay (days)** | | | | | | |
| 1 | 31.0 ± 8.8 | $\chi^2(3)=37.9$ | n.a. | $\chi^2(2)=7.0$ | 31.0 ± 8.8 | $\chi^2(3)=57.9$ |
| 2-7 | 33.6 ± 6.6 | p<0.001 | 29.1 ± 5.7 | p=0.051 | 31.6 ± 5.1 | p<0.001 |
| 8-14 | 35.7 ± 6.1 | MC: 1=2-7; | 28.9 ± 5.4 | | 33.8 ± 3.2 | MC: 1=2-7; |
| ≥ 15 | 36.6 ± 6.1 | 8-14 = ≥ 15 | 30.5 ± 5.8 | | 34.8 ± 2.6 | 8-14 = ≥ 15 |
| **Total** | **34.2± 6.9** | | **29.3 ± 5.7** | | **32.4 ± 5.3** | |
| **Weight at admission (Kg)*** | | | | | | |
| ≤ P25% | 34.1 ± 4.6 | F(2;432)=2.3; | 29.7 ± 6.4 | F(2;391)=0.5; | 32.5 ± 4.8 | F(2;432)=1.5; |
| P26%-P75% | 35.8 ± 6.2 | p=0.103 | 29.5 ± 5.4 | p=0.619 | 33.5 ± 4.4 | p=0.225 |
| ≥ P75% | 35.0 ± 7.0 | | 29.1 ± 5.7 | | 32.9 ± 5.1 | |
| **Total*** | **34.9 ± 6.5** | | **29.4 ± 5.8** | | **33.0 ± 4.8** | |

* (TISS-28 first assessment [n=435]; TISS-28 last assessment [n=394]; TISS-28 average values [n=435])

n.a. – not applicable; MC – Multiple comparisons.

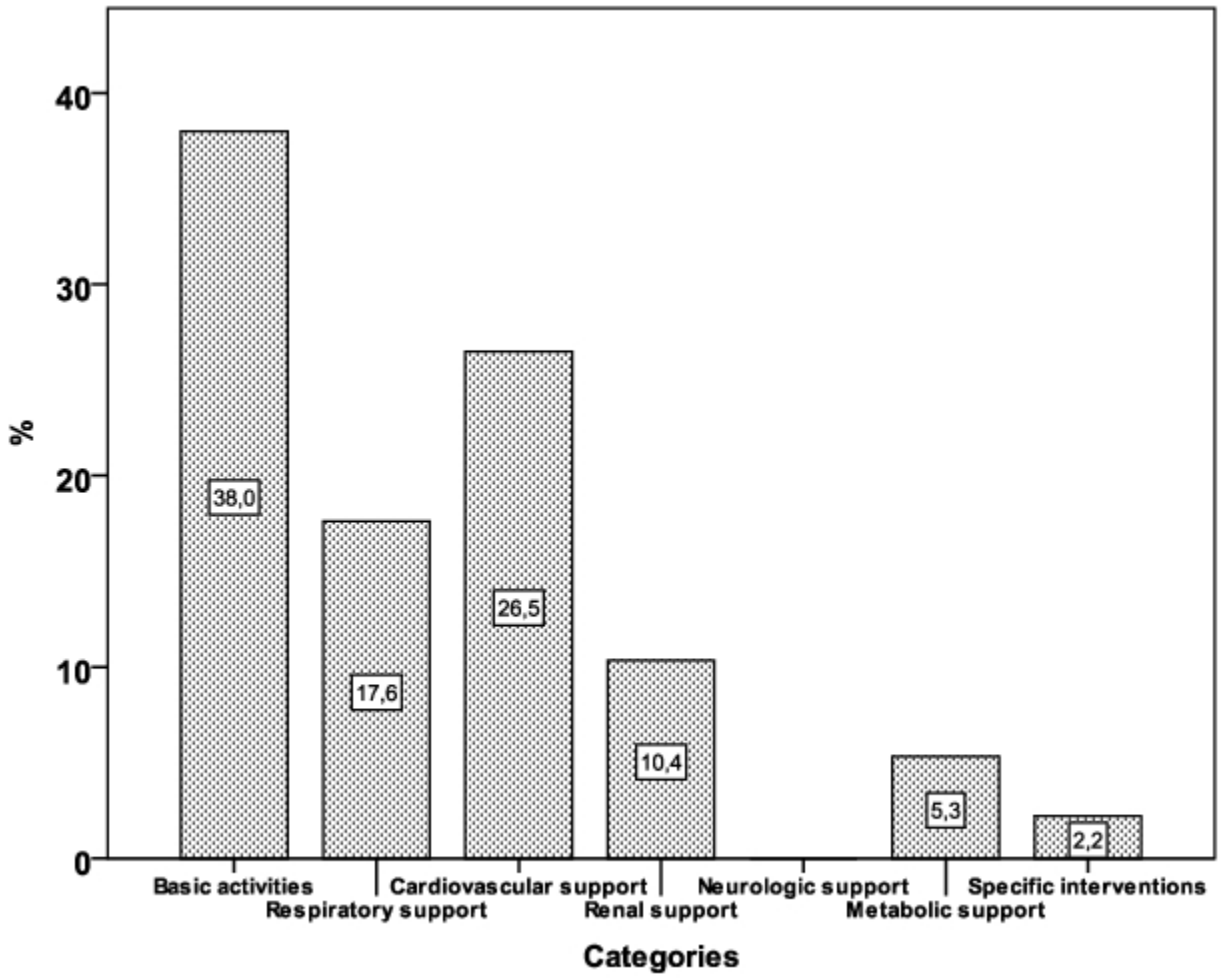
Table 5. Results of logistic regression for TISS-28 categorized into two groups (Cullen Classes I-II-III and Cullen Class IV) in the first and last evaluation

| Variables under study | TISS-28 first assessment (n=730) | | TISS-28 last assessment (n=643) | |
|---|---|---|---|---|
| | **OR** | **CI de 95%** | **OR** | **CI de 95%** |
| **Gender** | | | | |
| Male | 1.19 | [0.83;1.71] | 1.59 | [0.72;3.49] |
| Female (Ref. Group) | - | - | - | - |
| **Age (years)** | | | | |
| ≤ 44 (Ref. Group) | - | - | - | - |
| 45-64 | 1.55 | [0.86;2.80] | 1.85 | [0.51;6.79] |
| 65-84 | 1.57 | [0.89;2.76] | 2.07 | [0.59;7.20] |
| ≥ 85 | 2.17 | [0.91;5.15] | 1.02 | [0.10;10.15] |
| **Weight at admission (Kg)*** | | | | |
| ≤ P25% (Ref. Group) | - | - | - | - |
| P26%-P75% | 1.87 | [1.04;3.36] | 0.50 | [0.18;1.39] |
| > P75% | 1.53 | [0.87;2.70] | 0.53 | [0.21;1.33] |
| **Length of stay (days)** | n.a. | n.a | | |
| 1 | | | n.a. | n.a. |
| 2-7 (Ref. Group) | | | - | - |
| 8-14 | | | 0.61 | [0.23;1.66] |
| ≥ 15 | | | 1.02 | [0.40;2.58] |
| **TISS-28 first assessment** | n.a | n.a. | | |
| Cullen I-II-III (Ref. Group) | | | - | - |
| Cullen IV | | | 2.48 | [1.20;5.16] |

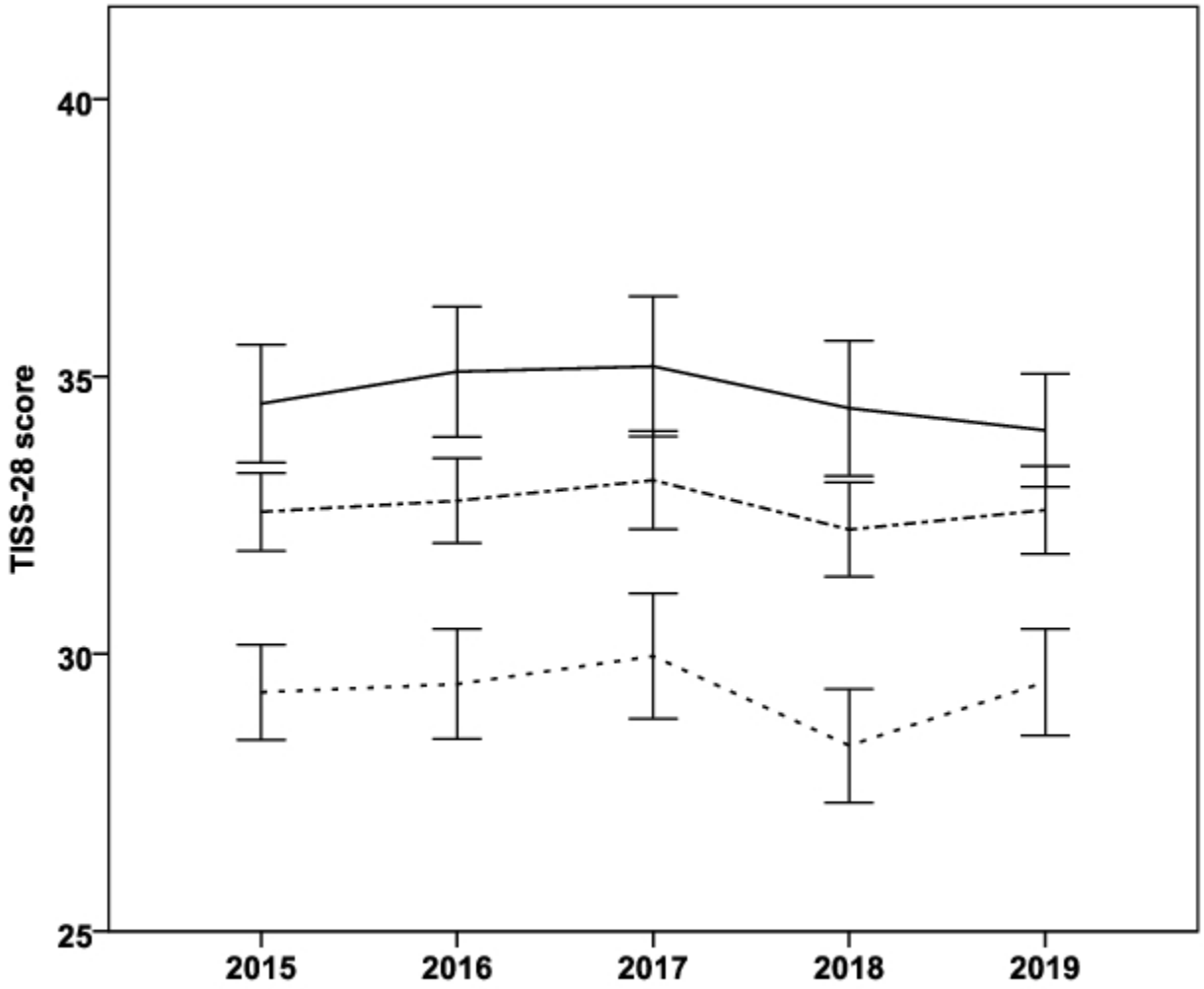
* TISS-28 first assessment [n=435]; TISS-28 last assessment [n=394]; The interest group is only formed by the Class of Cullen IV.

**Figure 1.** Percentage of time spent by TISS-28 category (n=730).

**Figure 2.** Mean and 95%CI for TISS-28 scores between 2015 and 2019 period. Continuous line represents TISS-28 first assessment, semi-continuous line represented TISS-28 average assessment, and dashed line represents the TISS-28 last assessment.




jocn_15570_f1.jpg

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