

Article

The association between Major Depressive Disorder and premature death risk in hematologic and solid cancer: A longitudinal cohort study

Federica Sancassiani,¹ Elena Massa,¹ Carla Pibia,¹ Giulia Perda,¹ Laura Boe,¹ Elena Fantozzi,¹ Giulia Cossu,¹ Giovanni Caocci,² Olga Mulas,² Emanuela Morelli,² Jutta Lindert,³ Eleonora Lai,¹ Antonio Egidio Nardi,⁴ Mario Scartozzi,¹ Giorgio La Nasa,^{1,2} Mauro Giovanni Carta¹

¹Department of Medical Sciences and Public Health, University of Cagliari, Italy; ²Hematology and CTMO, Businco Hospital, ARNAS "G. Brotzu", Cagliari, Italy; ³University of Applied Sciences Emden/Leer, Emden, Germany; ⁴Institute of Psychiatry, Federal University of Rio de Janeiro, Brazil

Abstract

Background: the aim was to verify the association between Major Depressive Disorders (MDD) and the risk of premature death in people with oncological diseases, and to collect evidence about the causality of a possible association from a longitudinal perspective.

Design and Method: it is a cohort study lasting 9 months, involving people with solid or hematologic cancers. The assessment was conducted by an *ad hoc* form to collect socio-demographic and clinical- oncological data, the PHQ-9 to screen MDD (cut-off ≥ 10) and the SF-12 to evaluate HRQoL. Relative Risk (RR) of early death between MDD exposed and not-exposed and Kaplan-Meier survival were carried out.

Results: people exposed to MDD during the follow-up were 107/263 (40.7%). Among them, 36 deceased during the observation period. Overtime, having MDD and death' occurrence showed a strong association (RR=2.15; 95% CI (1.10-4.20); $\chi^2=5.224$, $p=0.0022$), confirmed by Kaplan-Meier survival analysis ($\chi^2=4.357$, $p=0.037$). Among people who died, there was not any association between MDD, age, gender, HRQoL, cancer stage and site.

Conclusions: the study confirms the association between MDD and early death in people with cancer. The absence of any association between the onset of MDD and advanced stage of cancer may suggest that it could be due to the consequences of MDD in worsening the clinical conditions related to cancer. The findings point out the relevance of MDD' early detention among people with cancer.

Introduction

Major Depressive Disorder (MDD) is a recurring condition

and a leading source of disability worldwide.^{1,2} MDD is associated with impairment of Health-related Quality of Life (HRQoL) and with premature death for all-cause of mortality,^{4,5} included suicide.⁶ People suffering from depression have high rates of comorbidity with other psychiatric and non- psychiatric disorders;⁷ some studies showed that comorbid condition with MDD had worsened prognosis and showed higher mortality of the same conditions without depression.^{5,8-10} However, this data is still poorly confirmed, and the causal links of this association are not well clarified yet.

The World Health Organization pointed out that, in 2018, 9.6 million people worldwide are died from cancer.¹¹ The prevalence of MDD among individuals with cancer is approximately 12.5%, which is up to four-times the rate reported in population-based samples, that is around 3.3%.^{10,12}

Among patients with cancer, MDD was shown to be associated with a variety of negative clinical outcomes, such as poor compliance with anti-cancer treatment¹³ and low level of HRQoL.¹⁴⁻¹⁷ Several studies found that people suffering from cancer with comorbid MDD had higher early death risk.^{5,8,10,18} However, as described above for the general comorbidity of MDD with other diagnosis, so far little evidence has been accumulated to try to understand the causal link between early death and MDD in people suffering from cancer.

The primary end point of the present study was to verify the association between MDD episode over time (9 months) and higher death risk in people with solid and hematological cancers in a prospective analysis. Another aim was to establish if there were differences between other outcome indicators in the group of people with early death and, particularly, if the onset of MDD is associated with worse severity in the evolution of the tumor pathology. This is, in fact, a fundamental element to begin to understand whether it is depression that causes worsening in clinical conditions and death or *vice-versa*.

Significance for public health

This cohort study lasting 9 months pointed out a high prevalence of Major Depressive Disorder (MDD) among people with cancer. During the time of observation, 36 deceases occurred. A strong association was observed regarding the survival rates between the MDD exposed subjects who died along the time and the MDD not exposed who survived. This association could be due to the consequences of MDD, if considering that it was not found any significant association between MDD among patients who died and a worse HRQoL when the MDD episode had been occurred, nor with age, gender, cancer stage and site. These findings point out the importance of the early detention of MDD among people with cancer, to promptly provide effective interventions for a good management of symptoms related to cancer and depression. Further studies are needed to explore the causal association between MDD and premature death in people suffering from cancer.

Design and Methods

Study design

It is a cohort study, lasted 9 months. Among a study population of people with solid or hematological cancers, two cohorts were assessed: one included people exposed to at least one MDD episode (MDD-E) during the observation period; the other one was composed by MDD not-exposed (MDD-NE). The main outcome was the number of deaths in the two cohorts. People in the cohort with depression were those that, at the baseline, showed a depressive episode or those that had the onset of depressive episode during the observational period (changing of cohort).

Furthermore, we also built a case control study on the cohort (cases: people with depressive episode; controls: people without depressive episode), to verify the factors associated with death at the beginning of the study.

Recruitment procedures, study sample issues

Since 2018, the study has been conducting in Cagliari, Italy, at the Oncology Unit, University-Hospital and at the Hematology Unit and Stem Cell Transplantation Center, "Businco" Hospital. The study population includes people aged ≥ 18 years, of both genders, with histologic confirmation of a solid or hematologic malignant cancer and receiving active anti-cancer treatment. After the baseline evaluation (T0), the study protocol includes a series of repeated measures for each subject: after 3 (T1), 6 (T2) and 9 months (T3) from T0.

Assessment tools

Ad-hoc form was used to collect socio-demographic and clinical-oncological anamnestic data: gender; age; marital status; employment status; educational level; kind of the oncology service; time from taking in charge at the oncology unit; cancer site and stage; intent of treatment; toxicity of treatments according to Common Toxicities Criteria for Adverse Events (CTCAE),¹⁹ response and adherence to treatment.

The Italian Version²⁰ of the "Patient Health Questionnaire" (PHQ-9) [21] was used to assess depressive symptoms in the last two weeks. The PHQ-9 is a self-questionnaire usually used in population studies that could be administered also by phone for screening MDD or for the evaluation of the severity of depressive symptoms. It is relatively feasible, pointing out scores to each of the nine DSM-IV-TR criteria for MDD, proposed in the form of 9 item. As a continue variable to establish the severity of depressive symptoms, the scores of each item can range from 0 (complete absence) to 3 (almost every day). To screen MDD, the total score assigns ranks within the following: 0-4 (minimal), 5-8 (mild), 9-14 (moderate), 15-19 (moderately severe), 20-27 (severe).

The Italian version²² of the self-report questionnaire "Short Form Health Survey - 12 item" (SF-12)²³ was administered to evaluate the perceived HRQoL in the last month. The instrument includes 12 items and investigates two sub-dimensions (physical and psychosocial health). The total score ranges from 12 to 47, with higher scores reflecting a better perceived HRQoL.

Statistical analyses

Data collection and data-entry in a dedicate database were anonymously for each subject. Data were analyzed with the Statistical Package for Social Science (SPSS) version 24 (Chicago, IL, USA). Descriptive statistics were used for continuous (mean \pm SD; N and %) and nominal (N and %) variables, to point

out the socio-demographic and clinical-oncological characteristics of the samples at the baseline (T0), after 3 months (T1), 6 months (T2) and 9 months (T3), data regard N (%) of evaluated patients. PHQ-9 score ≥ 10 was used to define MDD-E subjects during the period of observation. To calculate the Relative Risk (RR), the two cohorts (MDD-E and MDD-NE) were evaluated overtime about the death' and other inauspicious outcomes' incidences by χ^2 test and the Kaplan-Meier survival function. One-way ANOVA, Kruskal-Wallis and χ^2 test were used to evaluate the association between MDD and HRQoL, age, gender, cancer stage and site at T0, as well as between MDD-E subjects who died overtime and HRQoL when the MDD episode had been occurred, age, gender, cancer stage and site at T0.

Results

The study cohort includes N 263 people with solid (201, 76.4%) and hematologic cancers (62, 23.6%) (Table 1). Women were 132 (50.2%); the mean \pm SD age was 61.2 \pm 13.6 years. More than half had a high-school diploma or a university degree (139; 52.6%). Most of the subjects were married (175; 66.5%), 57 (21.7%) singles, 10 (3.8%) divorced and 21 widows (8%); (see Table 1 for details and the other characteristics of the study cohort).

People with a depressive episode during the cohort were 107/263 (40.7%), people without 156/263 (59.3%). Along time of the observation, in the "MDD-Exposed" cohort, months/person were 586.5. In the "MDD-Not Exposed" cohort, months/person were 900 (Table 2).

Table 2 also shows that, at T1, after 3 months from the baseline, n 23 (8.7%) people were deceased, at T2, after 6 months from the baseline, other n 11 (4.2%) people were deceased and at T3, after 9 months from the baseline, other n 2 (0.8%) people were deceased. Furthermore, considering the 36 deaths occurred in the overall sample, 21 occurred in the cohort of people exposed to MDD (MDD-E) and 15 in the cohort of people not exposed to MDD (MDD-NE), the Relative Risk (RR) was=2.15; 95% CI

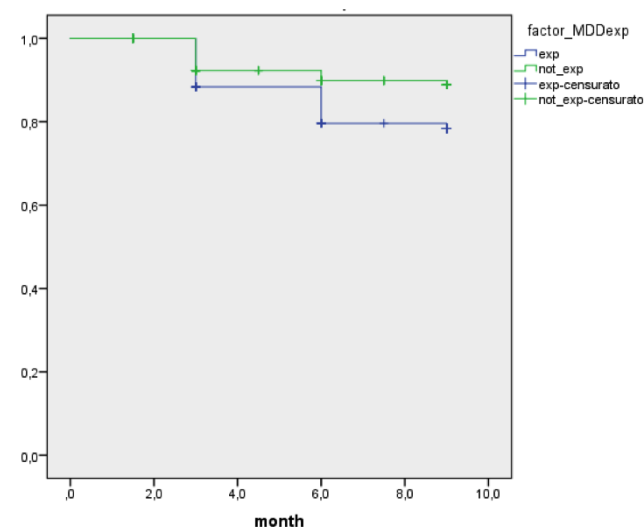


Figure 1. Kaplan-Meier survival function: differences about Major Depressive Disorder (MDD) exposed and not exposed subjects who survived over time (9 months).

(1.10-4.20); $\chi^2=5.224$, $p=0.0022$), the Kaplan-Meier survival curve confirmed the result (Log-Rank Mantel-Cox $\chi^2=4.357$, $p=0.037$; Table 3, Figure 1).

Table 4 shows that female gender (χ^2 with Fisher exact test=4.338, df 1, $p=0.045$) and a worse HRQoL ($F=51.008$, df 1,261,262; $p=0.000$) were significantly associated with MDD.

Finally, as shown in Table 5, among the 21 MDD-E and the 15 MDD-NE subjects who died along the time, the SF-12 mean \pm SD scores when the MDD episode had been occurred were 26.7 \pm 7.3 and 27.6 \pm 5.7 respectively, without any significant difference. Considering age, gender, the cancer stage and site at T0, there were not any significant difference between the two groups.

Discussion

The present study pointed out that, according to PHQ-9 \geq 10 score, 40.7% patients with a solid or hematological cancer presented at least one MDD episode along the time of observation. This data is higher if compared with a previous meta-analyses²⁴ that pointed out a pooled mean prevalence of depression in patients with cancer ranged from 8% to 24%, depending by the type of instrument used to assess MDD (other self-report questionnaire different from PHQ-9 or semi-structured diagnostic interviews based on DSM-III-R/IV or ICD-10 criteria), the type of cancer and treatment phase. However, the use of PHQ-9 as MDD screening instrument in the oncological field is high recommended²⁵⁻²⁷ and, ideally, it might be followed by an evaluation by a semi-structured interview based on DSM or ICD criteria (i.e., SCID) when the costs and benefits of routinely screening all patients with cancer admit to use of both kind of tools.²⁷ This is not the case of the present study, in which the assessment was carried out only by self-reported instruments. Hence, the higher MDD prevalence obtained should be confirmed by diagnoses obtained with semi-structured interviews, also because of the PHQ-9 \geq 10 score used as the cut-off to detect MDD exposed patients. In fact, this is a threshold usually recommended for screening general medical and primary care patients, but it allows to reduce the number of MDD false-positive subjects at the cost of missing more false-negatives,²⁶ and this could be a limitation. The study confirms also that MDD is more prevalent among women^{2,28} and that MDD is associated with a worse HRQoL in people suffering from cancer.^{3,14,15,17}

Furthermore, the present study pointed out that, from the baseline, 36 deceases occurred. A significant difference in the Relative Risk (RR) was observed regarding only the survival rates between the 21 MDD exposed subjects who died along the time and the 15 MDD not-exposed subjects who survived. There could be two main hypotheses to explain this association.

One of these regards the impact of the MDD in worsening the clinical conditions of people suffering from cancer, precipitating the occurrence of death. Patients with cancer and MDD could suffer from a significant distress and impaired functioning, such as a lack of interest in daily activities, including the poor inclination to taking care of themselves, as well as from several disturbances in sleeping and eating. Otherwise, patients with cancer could just start to "let themselves go" because of the worsening in their clinical conditions due to cancer, resulting in a bad mood that could degenerate in MDD episode. Both hypotheses could be right.

However, findings pointed out any significant association between MDD episodes among patients who died and a worse HRQoL when the MDD episode had been occurred, nor with other factors such as age, gender and the cancer stage and site at T0 (baseline). This is an important indication that may confirm the

Table 1. Socio-demographic and clinical characteristics of the study sample.

Variable	n	%	
Gender	Male	131	49.8
	Female	132	50.2
Marital status	Single	57	21.7
	Married	175	66.5
	Divorced	10	3.8
	Widow	21	8
Employment status	Housewife	32	21.2
	Unemployed	13	8.6
	Employed	49	31.5
	Retired	57	37.7
Education level	<Primary school	1	0.4
	Primary school	32	12.2
	Secondary school	93	35.4
	High school	100	38
	University degree	32	12.2
	Military Academy	1	0.4
	Higher	4	1.5
Kind of service	Day hospital	217	82.5
	Hospital ward	46	17.5
Timing of taking care at the Oncology service	First visit	9	3.4
	<6 months	102	38.8
	6-12 months	48	18.3
	>12 months	103	39.2
	Not evaluated	1	0.4
Cancer site	Gastroenteric	94	35.7
	Gynecological	32	12.2
	Breast	32	12.2
	Lung	16	6.1
	Head and neck	1	0.4
	Rare	9	3.4
	Uro-genital	17	6.5
Cancer stage	1	10	3.8
	2	29	11
	3	45	17.1
	4	178	67.7
	Not evaluated	1	0.4
Toxicity of treatments*	0	72	47.7
	1	25	16.6
	2	38	25.2
	3	14	9.3
	4	2	1.3
Intent of treatment	Adjuvant	41	15.6
	New adjuvant	4	1.5
	Curative	31	11.8
	Palliative	156	59.3
	Maintenance	25	9.5
	Support	5	1.9
Response to treatment	Absence of cancer	38	14.4
	Ongoing	82	31.2
	In progress	47	17.9
	Partial	25	9.5
	Stable	65	24.7
	Not evaluated	6	2.3
Adherence after 3 months of treatment	No	27	10.3
	Yes	229	87.1
	Not evaluated	7	2.7

*The toxicity of treatment was scored from 0 (mild) to 4 (death), according to common toxicities criteria. (CTC), version 4.019; available from: https://ctep.cancer.gov/protocoldevelopment/electronic_applications/ctc.htm#ctc_50

Table 2. The association between MDD “positive-exposed” subjects according to PHQ-9 ≥10 score and deceases occurred from T0 to T3 (9 months).

	PHQ-9 ≥10 “positive” (exposed to MDD)	PHQ-9<10 “negative” (not exposed to MDD)	Total
From T0 to T3 (9 months), n (%)	107 (40.7%)	156 (59.3%)	263 (100%)
Months/person (sum)	586.5	900	9 months (from T0 to T3)
Deceases (after 3 months from the baseline - T1), n (%)			23 (8.7%)
Deceases (after 6 months from the baseline – T2), n (%)			11 (4.2%)
Deceases (after 9 months from the baseline – T3), n (%)			2 (0.8%)
Deceases (total), n (%)	21 (58.3%)	15 (41.7%)	36 (100%)
Relative risk			2.15; 95% CI (1.10-4.20) $\chi^2=5.224$, $p=0.0022$

Table 3. Kaplan-Meier survival analysis about MDD exposed and not exposed subjects who died over time (9 months).

Status	Total	n deceased	Censored (survivors) n %	Associations	χ^2 test	Df	p
MDD exposed	107	21	86 80.4%	Log-rank (mantel-cox)	4.357	1	0.037
MDD not exposed	156	15	141 90.4%	Breslow (generalized wilcoxon)	3.884	1	0.049
				Tarone-ware	4.133	1	0.042

MDD, Major Depressive Disorder.

Table 4. Factors associated with MDD (PHQ-9 ≥10) in the overall sample.

	SF-12 mean±SD (T0)	Age mean±SD	Gender F/M n (%)	Cancer stage at T0 (1,2,3,4)	Cancer site at T0
PHQ-9 ≥10 “positive” (exposed to MDD) n=107	29.05±6.3	61.2±14.3	F=62/107 (57.9%) M=45/107 (42.1%)	Stage 1= 6/107 (5.6%) Stage 2= 9/107 (8.4%) Stage 3= 18/107 (16.8%) Stage 4= 74/107 (69.2%)	Blood= 22/107 (21%) Breast= 15/107 (14%) Gastroenteric= 41/107 (38%) Gynecological= 12/107 (11%) Head and neck= 0/107 (0%) Lung= 4/107 (4%) Rare= 3/107 (3%) Uro-genital= 10/107 (9%)
PHQ-9 <10 “negative” (not exposed to MDD) n=156	34.3±5.5	61.2±13.2	F=70/156 (44.9%) M=86/156 (55.1%)	Stage 1= 4/156 (2.6%) Stage 2= 20/156 (12.8%) Stage 3= 27/156 (17.3%) Stage 4= 104/156 (66.7%) Not reported= 1/156 (0.6%)	Blood= 40/156 (25%) Breast= 17/156 (11%) Gastroenteric= 53/156 (34%) Gynecological= 20/156 (13%) Head and neck= 1/156 (1%) Lung= 12/156 (8%) Rare= 6/156 (4%) Uro-genital= 7/156 (4%)
One-way ANOVA	F=51.008, df 1,261,262	F=0.001, df 1,261,262			
χ^2			4.338, df 1		6.332, df 7
Kruskal-Wallis				0.082, df 1	
p	0.000	0.978	0.045*	0.774	0.499*

MDD, Major Depressive Disorder; *Fisher exact test.

role of MDD in worsening the clinical conditions of people suffering from solid or hematological cancers, also by increasing the death risk.

Other studies pointed out that MDD or severe depressive symptoms are independent risk factors for cancer mortality, mainly when cancer is in advanced stadium,^{29,30} with a 26% greater mortality rate among patients with depressive symptoms and a 39% higher mortality rate among those with a diagnosis of MDD.⁹

Otherwise, differently also from the findings of the present study, some research showed that the impact of MDD on mortality rate may change by cancer site: being higher in people with lung, gastrointestinal and brain cancer, and lower in those with urogenital and skin cancer.³¹ In any case, an amount of studies, conducted also by animal models, agreed on some hypothesis to explain the relation between depression and cancer, mainly from behavioral and neuro-biological perspectives.^{9,10,32-35} One hypothesis regards the chronic activation of the hypothalamus-pituitary-adrenal (HPA) axis, that could be a mediator of the effect of depression on cancer progression:³⁵ an excessive activation of the HPA axis may modify the functioning of the cellular immune system, increasing the potential for malignant cancer fast progression.

Furthermore, pro-inflammatory cytokines (i.e., interleukin-1 α and β , tumor necrosis factor- α , interleukin-6) are modified by emotions, and have been shown to increase in depression by a dysregulated production and functioning linked also to a disrupted HPA

axis activation that may influence cancer outcomes and prognosis.³⁴⁻³⁶

Other hypotheses regard the role of psychosocial stressors as modulators of immune response in depression and cancer.¹⁰ Particularly, poor social support, lack of familiar bonding, a history of childhood trauma and adverse life experiences increase the vulnerability to chronic diseases, including MDD and cancer,³⁷ as well as to cancer mortality across several kinds of cancer.³⁰ Particularly, these psychosocial factors are associated with cognitive difficulties, mainly on memory, which could have a role in diminishing treatment compliance,¹⁰ as well as with unhealthy lifestyle, such as delay in treatment-seeking, eating and sleeping habits, smoking and alcohol abuse, lack of physical activity.³⁰

Notably, findings of the present study showed another interesting data regarding patients who died along the time of observation. Even if mostly of these patients, both those exposed or not exposed to MDD, exhibited a severe cancer stadium (the 4th) at the baseline, there was not any significant association between this variable and the occurrence of MDD episodes along the time, nor with the cancer site as already said above. These evidences confirm that MDD may precipitate the clinical outcomes of patients with cancer and increases their death risk. Furthermore, this data points out the importance of the early detention of depressive symptoms and other early signs of psychosocial distress in this kind of population by prompt and reliable screening interventions. In this way, it is

Table 5. Factors associated with death in the overall sample [MDD (PHQ-9 \geq 10)].

	SF-12 mean \pm SD (corresponding to MDD episode)	Age mean \pm SD	Gender F/M n (%)	Cancer stage at T0 (1,3,4)	Cancer site at T0
PHQ-9 \geq 10 "positive" (exposed to MDD) who died n=21	26.7 \pm 7.3	63.3 \pm 13.1	F=11/21 (52.4%) M=10/21 (47.6%)	Stage 1=1/21 (5%) Stage 3=3/21 (14%) Stage 4=17/21 (81%)	Blood=0/21 (0%) Breast=1/21 (5%) Gastroenteric=14/21 (66%) Gynecological=1/21 (5%) Head and neck=0/21 (0%) Lung=2/21 (9.5%) Rare=1/21 (5%) Uro-genital=2/21 (9.5%)
PHQ-9 <10 "negative" (not exposed to MDD) who died n=15	27.6 \pm 5.7	65.7 \pm 12.3	F=4/15 (26.7%) M=11/15 (73.3%)	Stage 1=0/15 (0%) Stage 3=2/15 (13%) Stage 4=13/15 (87%)	Blood=1/15 (6.7%) Breast=1/15 (6.7%) Gastroenteric=8/15 (53.1%) Gynecological=1/15 (6.7%) Head and neck=1/15 (6.7%) Lung=1/15 (6.7%) Rare=1/15 (6.7%) Uro-genital=1/15 (6.7%)
One-way ANOVA	F=0.168, df 1,34	F=0.310, df 1,34			
X ²			2.380, df 1	4.228, df 7	
Kruskal-Wallis				0.246, df 1	
p	0.684	0.582	0.176*	0.620	0.902*

MDD, Major Depressive Disorder; *Fisher exact test.

possible to support people suffering from cancer in managing the impact of MDD since its early signs. In addition to antidepressant,¹³ several psychosocial interventions may be effective in improving depressive symptoms and psychosocial distress, by enhancing resilience, social support and adaptive coping strategies to stress management, such as cognitive behavioral therapy, mindfulness-based therapy, multimodal approaches including psychoeducational interventions, counseling, hypnosis and relaxation techniques, therapeutic dialogue provided by a “trained helper”, motivational interviewing.^{10,38-40}

The present study has some limitations. Firstly, the small sample size did not allow to perform robust analyses for confounding factors, regarding all the variables that may be associated with

death’ risk in people with cancer (i.e., the kind of hematologic cancer). The analyses performed in this study allowed to point out just several associations with MDD exposition, without establish a cause-effect direction. Furthermore, MDD exposition was evaluated just by a self-report screening instrument (PHQ-9), without a standardized diagnostic interview based on DSM or ICD criteria.

Finally, it was estimated the sum months/person to fix the occurrence of the decease and the MDD episode just on the basis of the timing of observation (3 months from one to another evaluation, until 9 months) by the mean about months elapsed between successive evaluations.

Correspondence: Elena Massa, Department of Medical Sciences and Public Health, University of Cagliari, Cittadella Universitaria di Monserrato - Asse Didattico E, SS 554 bivio Sestu, 09042 Monserrato (CA), Italy. Tel. +39.070.675-250.
E-mail: dinetto13112012@gmail.com

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Contributions: FS, MGC, study concept and organization, manuscript first drafting; FS, EM, MGC, coordinated the reworking of the draft after the suggestions of all the co-authors; CP, GP, LB, GC, OM, EM, EL, collected the data during the evaluations and contribute to the discussion of the findings; JL, AEN, MS, GC, GLN, contributed to the interpretation and discussion of the findings and revised the initial draft into a more general framework. All authors contributed to the writing of the final manuscript, which they all approved for submission. Each author has studied the manuscript in the submitted form, has agreed being cited as co-author, and has accepted the order of authorship.

Conflict of interests: The authors declare that they have no competing interests, and all authors confirm accuracy.

Ethical approval and consent to participate: The study was approved by the independent Ethical Committee of the Azienda Ospedaliero Universitaria di Cagliari, Italy (n. PG/2018/13269). A written informed consent was obtained from each subject after they were provided with full descriptions of the aims and procedures of the study, made aware of data protection and ensured they could terminate at any time. All procedures were carried out in accordance with the Helsinki Declaration.

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