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Exploring the Relationship Between Balneotherapy and Anxiety in University Students: An Uncontrolled Study

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Background: The mental health of college students is a growing concern. According to the World Health Organization, one in eight people globally suffered from mental disorders in 2019. College students face various emotional challenges, including academic stress and peer pressure. In Spain, 49.5% of university students, particularly those in health sciences, experienced moderate to severe anxiety. While balneotherapy has shown therapeutic benefits, research on its impact on anxiety among college students is still lacking. The general objective of this research was to determine the efficacy of balneotherapy in reducing self-perceived anxiety among nursing students, and to identify potential moderating or interacting variables in this relationship. **Methods**: Uncontrolled study with pre- and post-measurement. The study included second-year nursing students enrolled in the 2023/2024 academic year. Non-probability convenience sampling was used. Sociodemographic data were collected, and the State-Trait Anxiety Inventory scale was used to assess self-perceived anxiety. The balneotherapy intervention consisted of a 20-minute session in a thermal pool with a circuit of jets. Data were collected before and after the intervention. The analysis included descriptive statistics and the Mann-Whitney U test for pre- and post-intervention differences. Additionally, a linear regression was conducted to identify moderating variables, with evaluation of residual linearity and independence using the Durbin-Watson statistic. **Results**: The study involved 125 university students, with a majority of women (76.8%) and the majority (88%) between 18 and 24 years old. Of the participants, 56% reported previous experience with anxiety, while 89.6% had not tried balneotherapy, and 64.8% had not engaged in relaxation therapies. The scale demonstrated high internal consistency, with Cronbach's alpha coefficients of 0.913 and 0.886 before and after the intervention, respectively. Following balneotherapy, the average anxiety score decreased by 9.05 points ($p<0.01$), and the prevalence of anxiety decreased from 12% to 1.6% ($p=0.002$). In the linear regression analysis, both pre-intervention anxiety scores and prior treatment for anxiety emerged as significant predictors ($p<0.001$), jointly explaining 45.2% of the variance. **Conclusions**: The study shows that balneotherapy significantly reduces anxiety among university nursing students, as indicated by improvements in anxiety scales and a decrease in the prevalence of anxiety. Prior anxiety and prior treatment emerge as crucial predictors of the response to balneotherapy. However, further studies with larger samples and long-term follow-up are warranted to substantiate these findings.

Keywords: students; nursing; education; anxiety; balneology; complementary therapies

1. Introduction

Mental health among college students has become one of the top issues of interest in recent decades [1,2]. The World Health Organization (WHO) defines mental health as a state of balance and well-being, in which individuals are aware of their capabilities, capable of managing daily stresses, functioning productively, and contributing positively to their community environment [3]. According to the WHO, in 2019, an estimated one in eight individuals globally, equivalent to around 970 million people, experienced some form of mental disorder [4].

In the university setting, emotional and psychological challenges can manifest in various forms, ranging from academic stress to social pressure. The transition to university life, marked by new

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academic and social demands, has contributed significantly to a rise in mental health issues [5,6]. This reality not only influences academic performance but also impacts quality of life and interpersonal relationships. Moreover, the SARS-CoV pandemic significantly altered how students manage anxiety. Within this framework, a recent literature review conducted in 2024 by McCormick et al. [7] underscores the notable surge in anxiety levels among university students when comparing the periods before and after the pandemic. The results indicate a significant increase from 23.6% to 33.9% ($p < 0.0001$). Additionally, a study conducted by the Spanish Ministry of Universities in 2023 [2] analyzed the emotional well-being of university students was analyzed, encompassing a total of 59,605 participants. Among them, 15% belonged to the field of health sciences. The findings highlight that approximately half of the respondents (49.5%) reported experiencing moderate to severe levels of anxiety [2]. Previous studies [8,9] have underscored that within the university student community, students pursuing careers in health sciences may be more prone to experiencing mental health disorders. Specifically, within the nursing profession, anxiety emerges as one of the most prevalent mental health conditions [10].

Anxiety, a prevalent phenomenon in contemporary society, manifests as a state of agitation and worry. It can be defined as a disturbance of tranquility and is associated with various disorders, particularly neuroses [11–13]. Despite its negative connotations, anxiety serves an adaptive function by acting as a defense mechanism against potential harm. Furthermore, it manifests as a fear of specific situations, especially within social contexts. The intensity of anxiety can vary based on an individual's inherent emotional disposition and their perception of anxious situations [11–13]. Globally, it is estimated that approximately 301 million people experience anxiety disorders, including 58 million children and adolescents [4]. The mental health strategy outlined by the Spanish Ministry of Health for the period 2022-2026 [14] indicates that in Europe, around 14% of the population aged 15 and over suffers from anxiety disorders annually.

Previous research has identified various techniques to alleviate anxiety, such as the practice of yoga, mindfulness, breath control, therapeutic touch, physical exercise, and maintaining proper nutrition, among others [15–19]. Among the available techniques, balneotherapy, or the use of water for therapeutic purposes, represents one of the earliest medical approaches aimed at promoting both physical and mental health [20]. This practice involves the application of mineral-medicinal waters for therapeutic purposes and encompasses the environmental surroundings of spas [21]. These establishments include a range of sanitary and accommodation facilities situated near a spring, where various treatments with mineral-medicinal waters are administered, both orally and topically [21].

The effects of balneotherapy are influenced by various factors, including thermal aspects (such as temperature), mechanical aspects (hydrostatic pressure, flotation, hydrodynamic resistance), chemical aspects (water mineralization), and psychological and environmental stimuli. These elements collectively contribute to a diverse range of benefits, such as analgesic effects, muscle relaxation, and improved venous return, among others [20].

Balneotherapy has a rich historical usage in treating a diverse array of health issues, spanning dermatological conditions [22], musculoskeletal diseases [23,24], nervous system disorders such as Parkinson's disease [25], cardiovascular diseases [26,27], cancer [27,28], and various other pathologies. Additionally, research suggests that balneotherapy can serve as an effective alternative for reducing anxiety levels in individuals with generalized anxiety disorders compared to traditional pharmacological treatments [29], as well as for reducing anxiety during childbirth [30]. However, there remains a scarcity of studies focusing on the therapeutic effects of balneotherapy on mental health, particularly among young individuals without prior pathologies.

To the best of our knowledge, no studies have investigated the relationship between anxiety and balneotherapy within the university population. Therefore, the objectives of our research were to determine the efficacy of balneotherapy in reducing self-perceived anxiety among nursing students and to identify potential moderating or interaction variables in this relationship.

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2. Materials and Methods

2.1. Design

Uncontrolled study with pre- and post-measurement.

2.2. Population and Sample

The study population consisted of second-year nursing students who were enrolled in the subject "Scientific Evidence of Complementary Care" during the 2023/2024 academic year. A non-probability convenience sampling method was used for this study.

Inclusion criteria: Participation criteria included enrolment in the class group and voluntary acceptance to participate in the study.

Exclusion criteria: Exclusion criteria included participants with visual impairments that made it difficult to read the questionnaires and students who did not agree to participate in the research.

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the University of Jaén (Reference: 20240118/ENE. PRY). All participants signed the informed consent form.

2.3. Measurement

Sociodemographic variables: An ad hoc questionnaire was used to collect the following information: sex, age (dichotomized as: 18 to 24 years old or 25 or older to ensure participant anonymity), previous episode of anxiety (yes or no), previous therapy with balneotherapy or relaxation therapy (yes or no), previous mental health diagnosis (yes or no), anxiety treatment (yes or no), anxiety diagnosis (yes or no), and awareness of the benefits of balneotherapy (yes or no).

Dependent variable: The State-Trait Anxiety Inventory (STAI_AE) scale was used to evaluate self-perceived state anxiety. This self-administered instrument comprises 20 items [31], using a 4-point Likert scale, with a total score ranging from 0 and 60 points. Scores for 10 items are reversed (1, 2, 5, 8, 10, 11, 15, 16, 19, 20). For female participants, a score of 23 points or higher indicated a medium-high anxiety category, while a score of 32 or higher denoted a very high level of anxiety. For male participants, a score of 20 points or higher was indicative of a medium-high anxiety category, while 29 or higher indicated a very high level of anxiety.

This questionnaire has been used in over 3,000 studies, demonstrating its effectiveness and utility as a tool for subjectively assessing anxiety [32]. Moreover, in the Spanish validation, the anxiety/state subscale yielded a Cronbach's alpha ranging between 0.90 and 0.93 [32], indicating high internal consistency.

Independent variable: Balneotherapy

Intervention: The university students underwent a 20-minute circuit of jets in a thermal pool located in the "San Andrés" spa, in the municipality of Canena, Jaén, Spain. The spa's waters have been authorized by Royal Order since March 17, 1853, and declared of public utility on March 17, 1948. Since 1998, it has been surrounded by a protection perimeter. The spa's waters are tasteless, odorless and colorless, with a flow rate of 2115 l/s and a temperature of 20.7º (hypothermal). They possess a mineralization level of 616 mr/l, characterized by medium mineralization with a dry residue at 110ºC. The water is hard and composed of calcium-sodium-magnesium bicarbonate.

2.4. Data Collection

Data collection took place in February 2024. Initially, data were collected before the implementation of the balneotherapy intervention. Subsequently, following the completion of the intervention, a second round of data collection was conducted (45 minutes post-intervention).

Prior to data collection, the participants were briefed on the research objectives and methodology, with emphasis placed on the voluntary nature of their participation, the confidentiality of the process, and the approval of the study by the ethics committee.

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2.5. Data Analysis

The descriptive analysis of the quantitative variables was conducted using measures of central tendency and dispersion. For qualitative variables, frequencies and percentages were calculated, along with their respective confidence intervals (CI).

To investigate the first objective, a new variable called "increment" was created, representing the difference between the total scores obtained in the post-intervention questionnaire and those obtained in the pre-intervention questionnaire. The mean of the increment, its standard deviation (sd), and its confidence interval were calculated. A bivariate analysis was conducted, with the difference in scores before and after the intervention established as the dependent variable and the sociodemographic variables as independent. The non-parametric Mann-Whitney U test was used to perform the contrasts. The difference in the prevalence of anxiety, according to the established cut-off points, was assessed using the McNemar test for paired samples. The effect size was calculated using biserial rank correlation.

To investigate the second objective, a linear regression was performed to identify potential moderating or interaction variables. Sociodemographic variables that achieved statistical significance in the bivariate analysis were included as independent variables. The linearity and independence of the residuals were checked using the Durbin-Watson statistic, with optimal values between 1.5 and 2.5. The final model's conditioning index was aimed to be below 30 points. The goodness-of-fit of the model was assessed using the R2 value.

Analyses were performed using SPSS Statistics 23, except for the confidence intervals (Cis) of the frequency measures, which were calculated with EpiDat 4.2.

3. Results

3.1. Description of Sample Characteristics

The total sample consisted of 125 university students, of whom 96 (76.8%) were women, and 110 (88%) were between 18 and 24 years old.

56% of the students had experienced a previous episode of anxiety, 89.6% had not undergone balneotherapy therapy before, and 64.8% had not engaged in relaxation therapy prior to the intervention. The descriptive data of the sample are presented in Table 1.

Table 1. Sociodemographic characteristics of the students (N= 125).

CHARACTERISTICS		n	%
Age	18 to 24 years old	110	88
	25 or more	15	12
Sex	Male	29	23,2
	Female	96	76,8
Previous Episode of Anxiety	Yes	70	56
	No	54	43,2
Previous Balneotherapy Therapy	Yes	13	10,4
	No	112	89,6
Previous relaxation therapy	Yes	44	35,2
	No	81	64,8
Previous mental health diagnosis	Yes	24	19,2
	No	101	80,8
Anxiety Treatment	Yes	24	19,2
	No	101	80,8
Previous diagnosis of anxiety	Yes	26	20,8
	No	99	79,2
Learn about the benefits of balneotherapy	Yes	68	54,4
	No	57	45,6

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3.2. Description of the Potential Efficacy of the Intervention

The Anxiety Assessment Scale (STAI_AE) showed very good internal consistency, with a Cronbach's alpha value of 0.913 in the pre-intervention assessment and 0.886 in the post-intervention assessment. The mean score of the STAI_AE scale was 17.69 in the pre-intervention assessment (SD: 9.44), decreasing by an average of 9.05 points (SD: 8.03) after the intervention (p<0.01).

Prior to the intervention, anxiety was prevalent in 15 participants (12%) according to the STAI_AE scale. This prevalence decreased to 2 participants (1.6%) in the post-intervention evaluation (p=0.002). An analysis by sex revealed no statistically significant differences in the presence of anxiety (STAI_AE) before the intervention ($\chi^2 = 0.703$; p=0.402) or after the intervention ($\chi^2 = 0.614$; p=0.433).

In the bivariate analysis conducted prior to the intervention, participants who had experienced an episode of anxiety, regardless of whether they had a current diagnosis, exhibited significantly higher levels of anxiety (STAI_AE). Additionally, participants who were not aware of the benefits of balneotherapy for their health also had higher anxiety levels. These differences persisted in the post-intervention evaluation (Tables 2 and 3).

Table 2. Bivariate analysis of the state anxiety scale (STAI_AE) prior to the intervention (N= 125).

Variable	Category	M (SD)	Contrast	p-Value	Effect size
Sex	Male	14.55 (9.77)	W=1064.5	0.056	-
	Female	18.48 (9.29)			
Age	<25 years	18.06 (9.37)	W=1025	0.129	-
	>26 years	13.33 (10.07)			
Previous Episode of Anxiety	Yes	20.61 (9.67)	W=2640.5	<0.001	0.397
	No	13.89 (7.74)			
Previous Balneotherapy Therapy	Yes	16 (8.27)	W=650.5	0.533	-
	No	17.75 (9.66)			
Previous relaxation therapy	Yes	17.16 (10.82)	W=1651	0.500	-
	No	17.79 (8.78)			
Previous mental health diagnosis	Yes	24.29 (11.75)	W=1726	0.001	0.424
	No	15.97 (8.19)			
Anxiety Treatment	Yes	20.71 (11.26)	W=1448	0.140	-
	No	16.82 (8.95)			
Previous diagnosis of anxiety	Yes	21.46 (11.49)	W=1621	0.042	0.260
	No	16.55 (8.7)			
Learn about the benefits of balneotherapy	Yes	15.74 (9.16)	W=1477.5	0.022	0.238
	No	19.75 (9.55)			

M:medium; SD: standard deviation; W: Mann-Whitney U contrast statistic.

Table 3. Bivariate analysis of the state anxiety scale (STAI_AE) post-intervention (N= 125).

Variable	Category	M (SD)	Contrast	p-Value	Effect size
Sex	Male	7.34 (7.66)	W=1650.5	0.179	-
	Female	9.67 (8.09)			
Age	<25 years	9.19 (7.47)	W=782	0.928	-
	>26 years	8 (11.94)			
Previous Episode of Anxiety	Yes	10.73 (9.02)	W=1340.5	0.009	0.277
	No	7.04 (5.93)			
Previous Balneotherapy Therapy	Yes	7.85 (8.77)	W=753	0.800	-
	No	9.2 (7.98)			
	Yes	9.27 (8.01)	W=1746	0.944	-

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Previous relaxation therapy	No	8.94 (8.1)			
Previous mental health diagnosis	Yes	13.08 (9.29)	W=801	0.012	0.33
	No	8.09 (7.44)			
Anxiety Treatment	Yes	12.79 (9.41)	W=887	0.048	0.261
	No	8.16 (7.45)			
Previous diagnosis of anxiety	Yes	10.39 (8.96)	W=1159	0.482	-
	No	8.70 (7.79)			
Learn about the benefits of balneotherapy	Yes	8.12 (7.99)	W=2174.5	0.184	-
	No	10.16 (8.04)			

M:medium; SD: standard deviation; W: Mann-Whitney U contrast statistic.

3.3. Description of Linear Regression Results

Four variables were introduced into the regression model (Table 4), resulting in a final model that included the constant and four predictor variables. Of these, two variables showed a significant effect: the pre-intervention score and having received treatment for anxiety prior to the balneotherapy session. The model demonstrated a high correlation with the anxiety scale score (0.686) and an explanatory capacity of 45.2% of the variance. The ANOVA for the multiple regression model indicated a statistically significant relationship ($F = 26.174$; $p < 0.001$). The model's collinearity, assessed by the conditioning index, was 9.193, indicating low collinearity. The Durbin-Watson statistic was 2.108, suggesting that the residuals were independent.

Table 4. Linear regression analysis between the moderating variables and the increase variable.

Dependent variable: Increase				
	B	**Typical error of B Typical error of B**	**B standardized**	**p-Value (Sig)**
Previous STAI_AE Total Score	-.574	.064	-.672	.000
Previous Anxiety Episode	-.125	1.214	-.008	.918
Previous mental health diagnosis	-.747	1.623	-.018	.646
Anxiety Treatment	3.477	1.599	.049	.032

4. Discussion

The main objective of our study was to investigate the efficacy of balneotherapy in reducing anxiety levels among nursing students. To our knowledge, this is the first study to link balneotherapy to the anxiety levels of college students. Our results indicate that balneotherapy could reduce the score obtained in the STAI_AE questionnaire by 15%. The bivariate analysis showed a significant association between the balneotherapy intervention and students who had a previous episode of anxiety, as well as those who were unaware of the benefits of balneotherapy for their health. Additionally, linear regression analyses showed a significant effect between prior anxiety score and having received treatment for anxiety prior to balneotherapy intervention with the increment variable.

Our research found that the majority of these students exhibited moderate-to-weak anxiety. These results differ from other findings that report the percentage of nursing students with moderate-to-high anxiety to be between 75% [33] and 40% [34]. These discrepancies could be attributed to the fact that our measurements took place before an examination, while moderate levels of anxiety

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without the presence of a stressor suggest the need to study this phenomenon further and explore possible interventions.

Anxiety is a common problem among college students, as they can feel overwhelmed by academic pressure, expectations from their families, and competition with peers. This anxiety can negatively affect their academic performance, emotional well-being, and overall health [35]. There is evidence that students in health disciplines, particularly medicine and nursing, suffer more stress, anxiety, and depressed mood compared to other university students [36,37].

Our sample was composed mostly of women, and although our study did not find significant differences based on sex, other research has highlighted disparities in anxiety prevalence. Studies by Bandelow and Michaelis [38] and Remes et al. [39] found that women are twice as likely to develop anxiety disorders compared to men. One possible explanation for this disparity may be biological differences; hormonal fluctuations in the menstrual cycle have been suggested to influence women's vulnerability to anxiety [40,41]. Additionally, sociocultural factors may play a role in this sex difference. Factors such as women's social roles, poverty, educational level, marital status, income level, social support, childhood adversity, and cultural norms may increase their propensity to experience anxiety compared to men.

Moreover, various studies have shown that women tend to have higher levels of self-demand and perfectionism, and they may cope with stressful situations differently than men, further contributing to gender differences in anxiety [38,42]. It is important to consider these differences when designing prevention and treatment strategies for anxiety disorders to ensure they are effective for both men and women [38].

In light of the literature reviewed, no previous studies have been found that relate balneotherapy as a relaxation technique to anxiety in university students. However, several studies have been identified other relaxation techniques used to reduce anxiety in this population, such as guided breathing [43], deep and conscious breathing [44,45], laughter therapy [46], progressive muscle relaxation [47,48], and orientation programs for students [49]. Additionally, meditation, yoga, and guided imagery have also been shown to be effective in reducing anxiety in college students [15–19].

Given our results, which indicate a 15% reduction in the STAI_AE instrument score, balneotherapy could be considered an additional measure to relieve anxiety. Balneotherapy, a therapeutic technique using thermal waters with medicinal properties, has the potential to treat various physical and psychological conditions effectively.

In this way, balneotherapy shows potential beneficial effects in reducing anxiety among university nursing students. Given that no previous studies have determined the effectiveness of balneotherapy for this specific group, we can compare our findings with a study conducted by Kelly and Bird in 2021 [50]. In their study, 42 college students were subjected to cold water immersion for 20-minute sessions over two weeks. The results showed improvements in mood, and reductions in tension, anger, depression, and fatigue compared to a control group that did not undergo the immersion.

While Kelly and Bird's study did not include nursing students, who often experience higher levels of pressure due to direct patient contact, it supports the idea that water-based therapies can positively impact menta health.

Further research is required to gain a deeper understanding of the underlying mechanisms of balneotherapy and its efficacy in various settings. However, current studies support the use of balneotherapy as a safe and effective option for improving mental health and well-being across different population groups.

Educational institutions play a crucial role in promoting the implementation of relaxation techniques and providing resources and support to students. By equipping students with effective tools to manage their anxiety, institutions can enhance students' overall well-being and academic performance. This proactive approach can also contribute to better patient care and the safety, effectiveness and efficiency of the healthcare system.

In terms of limitations, this study used a non-probabilistic convenience sample, as students who had access to the subject related to the balneotherapy intervention were selected. This sampling

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method may introduce selection bias and limit the generalizability of the findings to broader student populations. Another limitation of the study is the insufficient timing between pre- and post-evaluations, which may not allow the observation of significant effects, particularly concerning long-term changes. Furthermore, it is crucial to consider the potential confounding effects caused by uncontrolled variables between the pre- and post-intervention periods. These uncontrolled variables could introduce biases and make it challenging to isolate the actual effect of the intervention or event under study.

For future research, it would be advisable to replicate this study using a larger sample size obtained through probability sampling methods. Additionally, conducting more measurements and/or interventions with balneotherapy would be pertinent to verify its real efficacy in the university population.

5. Conclusions

Our research indicates that balneotherapy has a significant impact on reducing anxiety levels among undergraduate nursing students, as evidenced by improvements in anxiety scale scores from pre- and post-intervention assessments. Moreover, a notable decrease in the prevalence of anxiety was observed following a balneotherapy session. The findings also suggest that pre-intervention anxiety and previous treatment for anxiety are important predictors of response to balneotherapy. These results highlight the potential benefit of balneotherapy as an effective strategy for managing anxiety in college students.

However, it is important to acknowledge the limitations of the study, such as the use of a convenience sample and the absence of long-term follow-up assessments. Future research with larger, more diverse samples and longitudinal designs could offer a more comprehensive understanding of the effects of balneotherapy on anxiety. This could provide more robustly evidence to inform clinical and educational practices in this field, ultimately enhancing mental health support for college students.

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Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors upon request.

Use of Artificial Intelligence: Please describe in detail any and all uses of artificial intelligence (AI) or AI-assisted tools used in the preparation of the manuscript. This may include, but is not limited to, language translation, language editing and grammar, or generating text. Alternatively, please state that “AI or AI-assisted tools were not used in drafting any aspect of this manuscript”.

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