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Gender Measurement Invariance of the Learning Burnout Scale of Undergraduates (LBSU) among Chinese Undergraduates

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Abstract

This study aimed to examine the measurement invariance of the Learning Burnout Scale of Undergraduates (LBSU) across gender, addressing a significant gap in the literature despite the scale's widespread use in research. A sample of 619 undergraduate students was assessed using the LBSU. Both single-group and multi-group confirmatory factor analyses (CFAs) were conducted using AMOS 24.0 to evaluate the scale's psychometric properties and gender-based measurement invariance. Findings demonstrated that the LBSU exhibits robust psychometric properties for assessing academic burnout severity among undergraduate students. Moreover, the scale demonstrated measurement invariance across genders, suggesting that observed differences between male and female participants likely reflect genuine gender disparities rather than measurement artefacts, which contributes to the methodological rigor of academic burnout research in the Chinese context. The complex pattern of gender differences observed, coupled with the moderate levels of burnout across the sample, addresses the urgency of tailored effective interventions.

Keywords: Academic Burnout, Undergraduate Students, Psychometric Properties, Measurement Invariance, Gender

Introduction

Recent meta-analyses have revealed a concerning upward trend in academic burnout rates among undergraduate populations globally. For instance, a cross-temporal meta-analysis of studies conducted on Chinese undergraduates from 2005 to 2017 indicated a year-on-year increase in academic burnout levels (Yu et al., 2020). More recent studies have reported prevalence rates ranging from 7.4% to 59.9%, underscoring the escalating nature of this academic challenge (Al-Alawi et al., 2017; Frajerman et al., 2019; Wang & Lei, 2021; Zhou et al., 2022; Liu et al., 2023). These statistics highlight the urgency for comprehensive research

on academic burnout including its measurement, levels, influencing factors, outcomes and potential intervention strategies.

The concept of burnout, initially introduced by Freudenberger (1974) in the context of professional settings, has evolved significantly over the past five decades. Maslach's seminal work further refined this construct, proposing a three-dimensional model encompassing emotional exhaustion, depersonalization, and a diminished sense of personal accomplishment (Maslach, 1997). While early research primarily focused on workplace burnout, the last four decades have witnessed a growing interest in the manifestation of burnout within academic environments, leading to the emergence of "academic burnout" as a critical area of study (Kafry & Pines, 1980; Meier & Schmeck, 1985).

Academic burnout, also referred to as "student burnout," "learning burnout," or "school burnout," describes a state of emotional, physical, and cognitive exhaustion resulting from prolonged exposure to academic stressors (Wang et al., 2021). This phenomenon is characterized by a loss of interest and enthusiasm for studies, emotional detachment from academic pursuits, and a sense of reduced academic efficacy (Schaufeli et al., 2002). While these terms are often used interchangeably in the literature, they all emphasize the burnout emotions and behaviors displayed by students in academic settings (Cheng et al., 2020; Chunming et al., 2017).

The etiology of academic burnout is multifaceted, encompassing both individual and environmental factors. The development of academic burnout is influenced by a complex interplay of individual and environmental factors. At the individual level, several key predictors have been identified. Poor stress management strategies have been strongly associated with increased vulnerability to academic burnout (Tang et al., 2021). The degree of commitment to one's chosen field of study has been shown to inversely predict academic burnout levels (Lian et al., 2005). A robust negative correlation between self-efficacy and academic burnout has been consistently reported in the literature (Ling et al., 2014; Zhou et al., 2022). Environmental factors also play a crucial role in the etiology of academic burnout. The quality and nature of learning atmospheres significantly influence burnout susceptibility (Wu et al., 2018). Higher levels of social support have been associated with reduced academic burnout (Karim & Nigar, 2014). Exposure to significant stressors has been shown to positively predict academic burnout among college students (Freedy & Hobfoll, 1994; Lin & Huang, 2014).

The ramifications of academic burnout extend far beyond immediate academic performance, impacting various aspects of students' lives. Burnout has been consistently linked to reduced concentration and poor academic achievement (Fiorilli et al., 2017; Madigan & Curran, 2021). Academic burnout negatively correlates with psychological health and overall quality of life (Lyndon et al., 2017; Paloș et al., 2019). Students experiencing burnout often report difficulties in maintaining personal relationships (Lian et al., 2005). Long-term academic burnout has been associated with various physical health issues, including sleep disorders and increased susceptibility to illnesses (Jackson et al., 2016; Tang et al., 2021). Academic burnout has been linked to problematic behaviors such as truancy, substance abuse, and dropout (Jackson et al., 2016; Sanchez et al., 2015). More alarmingly, Prolonged exposure to academic burnout significantly increases the risk of developing severe mental health issues, including

depression, anxiety, and in extreme cases, suicidal ideation (Al-Alawi et al., 2017; May et al., 2015; Njim et al., 2019).

In an effort to understand academic burnout more comprehensively, researchers have explored its manifestation across various demographic variables, including gender, academic major, year of study, place of origin, university type, family income level, and parental marital status (Salmela-Aro & Tynkkynen, 2012; Tang et al., 2019). Cross-cultural differences have also been observed, with one study reporting significantly higher levels of emotional exhaustion and cynicism among Russian students compared to their Italian counterparts (Cabras et al., 2023).

Among the demographic variables studied, gender has emerged as a particularly intriguing yet contentious factor. The role of gender in academic burnout has garnered increasing scholarly attention, but findings remain inconsistent and often contradictory (Cabras et al., 2023; Palupi & Findyartini, 2019).

Studies utilizing the Maslach Burnout Inventory-Student Survey (MBI-SS) have reported divergent findings regarding gender differences. The MBI-SS, adapted by Schaufeli et al. (2002) from the original Maslach Burnout Inventory (MBI), is widely used internationally to assess academic burnout (Maslach, 1997). This instrument comprises three subscales: exhaustion, cynicism, and professional efficacy. Some studies have found that female students, particularly in high school settings, exhibit higher burnout scores, especially in the exhaustion dimension (Cabras et al., 2023; Herrmann et al., 2019; Walburg, 2014). Interestingly, this trend persists despite female students generally demonstrating greater academic success and higher levels of engagement compared to their male counterparts (Salmela-Aro et al., 2016; Vinter et al., 2021). Conversely, other research has indicated higher levels of burnout among male students (Aguayo et al., 2019; Bikar et al., 2018; Mulvey, 1988). Notably, a substantial body of literature suggests no significant gender differences in academic burnout levels (Backović et al., 2012; Galán et al., 2011).

In the Chinese context, where the Learning Burnout Scale of Undergraduates (LBSU) developed by Lian et al. (2005) is one of the most widely used scales for measuring academic burnout, similar inconsistencies in gender-based findings have been observed (Tang et al., 2021). The LBSU, adapted from the MBI, has been extensively employed to assess academic burnout among Chinese undergraduate students, with numerous studies validating its reliability and validity (Yu et al., 2020). However, the original scale development did not include gender difference analyses and subsequent studies have yielded conflicting results. While some research indicates significantly higher burnout levels among male students (Gao et al., 2018), other studies report higher burnout levels in female students (Wang, 2017). Moreover, a substantial body of research finds no significant gender differences in academic burnout levels (Liu et al., 2016). A meta-analysis encompassing 87 studies from 2005 to 2017 with a total sample of 38,615 students (15,849 males and 22,766 females), concluded that gender differences in undergraduate students' learning burnout scores were not statistically significant (Yu et al., 2020).

The inconsistent findings regarding gender differences in academic burnout raise important methodological questions. While differences in regional backgrounds and research subjects

may partially account for these discrepancies, it is crucial to consider the role of measurement invariance in interpreting these results (Byrne et al., 1989; Yue et al., 2022, 2023). Measurement invariance is a prerequisite for meaningful cross-group comparisons (Chen, 2007). Hence, the establishment of measurement invariance across genders is crucial for the valid comparison of mean scores between male and female participants (Cheung & Rensvold, 2002). Without ensuring measurement invariance, it remains unclear whether observed differences between groups reflect true disparities in the construct of interest or are artefacts of the measurement process itself.

Measurement invariance, defined as the consistency of metric properties across different observational conditions (Borsboom et al., 2008), is typically evaluated through a series of increasingly restrictive confirmatory factor analytic (CFA) models (Maiolatesi et al., 2022). These models assess the extent to which measurement parameters are equivalent across different groups (Collison et al., 2021; Little, 1997). This process ensures that observed differences between groups reflect true disparities rather than measurement artefacts (Chen, 2007). Confirmatory factor analysis, a powerful statistical technique, examines whether the relationships between factors and their corresponding items align with the theoretical framework underpinning the construct (Collier, 2020). This process not only tests the measurement model but also serves to validate the construct validity of the scales (Brown, 2015).

Despite the widespread use of the LBSU in Chinese academic settings and its demonstrated psychometric properties, there is a notable dearth of research examining its measurement invariance across genders. This gap in the literature raises questions about the comparability of LBSU scores between male and female participants and the validity of gender-based comparisons in academic burnout research using this instrument. This gap is particularly significant given that measurement invariance is a prerequisite for meaningful cross-gender comparisons (Chen, 2007).

To sum up, given the inconsistent findings regarding gender differences in academic burnout and the limited exploration of the LBSU's measurement invariance, there is a pressing need for rigorous investigation in this area. Therefore, the current study aims to address these gaps by pursuing the following objectives: (1) To examine the cross-gender measurement invariance of the LBSU in a sample of Chinese undergraduate students using multi-group confirmatory factor analysis; (2) To determine the nature and extent of gender differences in academic burnout levels among Chinese undergraduate students, contingent upon establishing measurement invariance; (3) To determine the levels of academic burnout among the selected sample.

By addressing these objectives, this study aims to bridge an important gap in the literature on academic burnout, particularly in the Chinese context. Through rigorously examining the measurement invariance of the LBSU across gender and subsequently investigating gender differences in academic burnout, this study seeks to contribute to the methodological rigor of academic burnout research and provide a more nuanced understanding of gender-related aspects of this critical academic phenomenon.

Methods

Participants

The study sample comprised 625 undergraduate students recruited from three Chinese universities using a stratified random sampling method. Following data screening, six questionnaires were excluded, resulting in a valid response rate of 99.04%. The final sample (n = 619) consisted of 349 females and 270 males, with a mean age of 19.23 years (SD = 1.07). This sample size was deemed sufficient for conducting Confirmatory Factor Analysis (CFA) on the 20-item LBSU instrument, in accordance with recommendations in the literature (Hair et al., 2010).

Procedure

Prior to data collection, the study protocol received approval from the Ethics Committee for Research involving Human Subjects at the University. Participants' academic burnout levels were assessed via an anonymous online survey. All participants were provided with information regarding the study's purpose, assurances of confidentiality, and their right to withdraw at any time. Informed consent was obtained from all respondents before their participation. Data collection was facilitated through the Questionnaire Star platform, a widely utilized online survey tool in China. The electronic questionnaire link was disseminated via WeChat.

Measurement

The Learning Burnout Scale of Undergraduates was employed to assess academic burnout, which was compiled by Lian et al. (2005) and adapted from the Maslach Burnout Inventory (Maslach, 1997). It comprises 20 items across three sub-constructs: Low Mood (LM; 8 items), Inappropriate Behavior (IB; 6 items), and Low Sense of Accomplishment (LSA; 6 items). Responses are recorded on a five-point Likert-type scale, ranging from 1 to 5, with higher aggregate scores indicating more severe academic burnout.

The internal consistency reliability of the LBSU was evaluated using Cronbach's alpha coefficient, a widely accepted measure for Likert-type scales (Leech et al., 2014). The overall scale demonstrated robust internal consistency ($\alpha = 0.857$), surpassing the conventional threshold of 0.7 (Nunnally, 1978). The sub-constructs also exhibited satisfactory reliability: LM ($\alpha = 0.794$), IB ($\alpha = 0.756$), and LSA ($\alpha = 0.732$). Furthermore, the scale demonstrated good validity within the context of this study.

Statistical Analysis

The study employed SPSS 26.0 and AMOS 24.0 for data processing and analysis. Initial data preparation, including screening and descriptive analyses, was executed using SPSS. AMOS facilitated the Confirmatory Factor Analysis (CFA) to scrutinize the LBSU's psychometric properties. Scale reliability was assessed using Cronbach's alpha, with a threshold of 0.70 (Nunnally, 1978). The CFA utilized Maximum Likelihood Estimation, given the data's conformity to parametric assumptions.

Construct validity was determined through an examination of overall model fit indices. Model fit was evaluated using multiple indicators: Root Mean Square Error of Approximation (RMSEA < 0.08), Comparative Fit Index (CFI > 0.90), chi-square/degrees of freedom ratio

(χ^2/df < 5.0), and Standardized Root Mean Square Residual (SRMR ≤ 0.08) (Hu & Bentler, 1999; Kline, 2015).

To assess measurement invariance across gender, multigroup CFA was conducted. This process involved a hierarchical assessment of nested models, progressively imposing stricter constraints. The evaluation criteria for measurement invariance were predicated on changes in fit indices between successive models: ΔRMSEA < 0.015, ΔSRMR < 0.03, and ΔCFI < 0.01. These thresholds align with contemporary psychometric standards (Chen, 2007; Cheung & Rensvold, 2002; Kang et al., 2016).

Notably, the chi-square difference test was excluded as a criterion for assessing measurement invariance deliberately. This decision was informed by its recognized limitations, including hypersensitivity to sample size and inadequate discriminative capacity between invariant and non-invariant models (Kline, 2015; Meade et al., 2008; Putnick & Bornstein, 2016). The approach, leveraging multiple fit indices, represents a more robust and nuanced evaluation of measurement invariance, aligning with current best practices in psychometric research. The difference in academic burnout between male and female students was tested using an independent t test.

Results

Descriptive Analyses

Table 1 presents the descriptive statistics for LBSU and its constituent sub-constructs (LM, IB, ISA) across the entire sample and disaggregated by gender. The scale is a five-point Likert scale with a medium of 3 and the mean scores of the participants were around 3, indicating moderate levels of academic burnout were found in the sample. For the overall sample, the mean values of LBSU and its sub-constructs ranged from 2.47 to 2.92, with standard deviations spanning 0.50 to 0.75. When stratified by gender, male participants exhibited mean values ranging from 2.48 to 2.97 (SD = 0.50 to 0.77), while female participants' means ranged from 2.47 to 2.89 (SD = 0.50 to 0.72). Notably, the skewness and kurtosis values for all variables across all three groups (overall, male, and female) were consistently below 1, suggesting that the data adhered to a normal distribution (Tabachnick et al., 2013).

Table 1
Descriptive analyses of the LBSU and its sub-constructs (Overall [Male, Female])

Constructs/Sub-constructs	M	SD	Skewness	Kurtosis
LM	2.92(2.97,	0.72(0.72,	-0.17 (-0.20, -	-0.22 (-0.26, -
IB	2.73(2.80,	0.75(0.77,0.72)	0.18 (0.10, 0.23)	-0.30 (-0.03, -
ISA	2.76(2.80,	0.61(0.65,	0.24 (0.29, 0.14)	0.25 (0.73, -0.46)
LBSU	2.47(2.48,	0.50(0.50,	0.22 (0.18, 0.25)	-0.29 (-0.55, -

Single-Group Confirmatory Factor Analysis

Table 2 delineates the results of single-group Confirmatory Factor Analyses (CFAs) conducted on the overall sample and gender-specific subsamples. For the aggregate sample, the three-factor solution of LBSU demonstrated satisfactory model fit indices (χ^2/df = 3.293, RMSEA = 0.061, CFI = 0.931, SRMR = 0.052), with all standardized factor loadings exceeding 0.50. Given

that all fit indices were within acceptable parameters, the model was deemed appropriate. A comparative analysis between the three-factor model and a unidimensional alternative revealed the superiority of the former in representing the LBSU construct.

Gender-specific analyses yielded similarly robust results. For the male subsample, the model exhibited good fit (χ^2/df = 2.280, RMSEA = 0.069, CFI = 0.910, SRMR = 0.044), with all standardized factor loadings surpassing 0.50. The female subsample demonstrated comparable, if not superior, fit indices (χ^2/df = 1.926, RMSEA = 0.052, CFI = 0.951, SRMR = 0.048), again with all standardized factor loadings exceeding 0.50. These results, evaluated against established criteria, provide strong support for the acceptability of the three-factor LBSU model across both gender subgroups.

Table 2
Model Fit Indices of Single-Group CFA

Sample	χ^2 (df)	χ^2/df	RMSEA	CFI	SRMR
Overall (n = 619)	243.662(74)	3.293	0.061	0.931	0.052
Male (n = 270)	168.693(74)	2.280	0.069	0.910	0.044
Female (n = 349)	142.515(74)	1.926	0.052	0.951	0.048

The construct validity of the LBSU was further supported by the good model fit observed in the CFAs and the significant factor loadings of items on their respective subscales. These results provide evidence for the convergent and discriminant validity of the instrument, suggesting that the LBSU effectively captures the distinct yet related dimensions of academic burnout.

Measurement Invariance Across Gender

To assess measurement invariance across gender, a series of increasingly constrained multi-group CFA models were evaluated. The analysis progressed through four levels of invariance: configural, metric (weak factorial), scalar (strong factorial), and strict factorial invariance. These models were tested using a sample size of 619. The results of the measurement invariance testing are presented in Table 3.

Table 3
Model fit Indices for Measurement Invariance Across Gender

Model	χ^2 (df)	χ^2/df	$\Delta\chi^2$ (Δdf)	RMSEA (ΔRMSEA)	CFI (ΔCFI)	SRMR (ΔSRMR)
Configural	311.236	2.103	-	0.042(-)	0.933(-)	0.070(-)
Metric	325.522	2.047	14.286	0.041(-	0.932(-	0.071(0.001)
Scalar	331.957	2.012	6.435	0.040(-	0.932(0.000)	0.072(0.001)
Strict	367.021	2.050	35.064	0.041(0.001)	0.923(-	0.074(0.002)

The configural invariance model demonstrated acceptable fit ($\chi^2(148) = 311.236$, $p < 0.001$; CFI = 0.933; RMSEA = 0.042; SRMR = 0.070), indicating that the same factor structure holds across gender groups.

Metric invariance was tested by constraining factor loadings to be equal across groups. This model also showed acceptable fit ($\chi^2(159) = 325.522$, $p < 0.001$; CFI = 0.932; RMSEA = 0.041; SRMR = 0.071). The change in fit indices (ΔCFI = -0.001, ΔRMSEA = -0.001, ΔSRMR = 0.001) was minimal, which can meet the criteria, supporting metric invariance.

Scalar invariance was examined by additionally constraining item intercepts to be equal across groups. This model maintained good fit ($\chi^2(165) = 331.957$, $p < 0.001$; CFI = 0.932; RMSEA = 0.040; SRMR = 0.072). The change in fit indices (ΔCFI = 0.000, ΔRMSEA = -0.001, ΔSRMR = 0.001) was negligible, indicating scalar invariance.

Finally, strict invariance was tested by constraining residual variances to be equal across groups. This model showed a slight decrease in fit ($\chi^2(179) = 367.021$, $p < 0.001$; CFI = 0.923; RMSEA = 0.041; SRMR = 0.074). The changes in fit indices (ΔCFI = -0.009, ΔRMSEA = 0.001, ΔSRMR = 0.002) were more pronounced than in previous steps but still within acceptable limits.

The results provide strong evidence for measurement invariance across gender groups up to the scalar level. The configural invariance model demonstrated an acceptable fit, indicating that the same factor structure is applicable across genders. The minimal changes in fit indices when imposing metric and scalar invariance constraints suggest that factor loadings and item intercepts are equivalent across groups.

While the strict invariance model showed a slightly larger decrease in model fit, the changes in fit indices were still within the commonly accepted thresholds (Cheung & Rensvold, 2002; Kang et al., 2016; Rutkowski & Svetina, 2017). This suggests that even residual variances may be considered invariant across gender groups, although this conclusion should be drawn with caution. These findings support the use of this measurement model for comparisons across gender groups, as the construct is measured equivalently for males and females up to the scalar level, with potential equivalence at the strict level.

Gender Differences Test

An independent samples t test was conducted to compare the LBSU scale and its sub-constructs between male and female students (n = 619). The results revealed no significant difference in overall LBSU scores between males (M = 2.48, SD = 0.50) and females (M = 2.47, SD = 0.50), t = 0.300, p = 0.764 (Table 4).

Table 4
Independent t test of the LBSU and its sub-constructs (n=619)

Constructs/Sub-constructs	Male	Female	t	p
LM	2.97(0.72)	2.89(0.72)	1.389	0.165
IB	2.80(0.77)	2.67(0.72)	2.255	0.024
ISA	2.80(0.65)	2.73(0.58)	1.428	0.154
LBSU	2.48(0.50)	2.47(0.50)	0.300	0.764

Analysis of the sub-constructs showed mixed results. For Low Mood (LM), no significant difference was found between males (M = 2.97, SD = 0.72) and females (M = 2.89, SD = 0.72),

t = 1.389, p = 0.165. Similarly, Low Sense of Accomplishment (LSA) did not differ significantly between males (M = 2.80, SD = 0.65) and females (M = 2.73, SD = 0.58), t = 1.428, p = 0.154. However, a significant difference was observed in the Inappropriate Behavior (IB) sub-construct, with males (M = 2.80, SD = 0.77) scoring higher than females (M = 2.67, SD = 0.72), t = 2.255, p = 0.024. This finding suggests that male students reported higher levels of inappropriate behavior related to their studies compared to their female counterparts.

These results indicate that while overall academic burnout levels are similar across genders, there may be specific aspects, particularly inappropriate behavior, where male students experience higher levels of burnout.

Discussion

The present study aimed to examine the cross-gender measurement invariance of the LBSU in a sample of Chinese undergraduate students using multi-group CFA, addressing a critical gap in the literature, and determining the nature and extent of gender differences in academic burnout within the Chinese higher education context, contingent upon establishing measurement invariance. To achieve the above research objectives, the psychometric properties of the LBSU were examined. Moreover, the levels of academic burnout among the selected sample were determined. The findings provide valuable insights into the measurement of academic burnout, as well as its manifestation across gender groups.

Psychometric Properties of the LBSU

The psychometric properties of the LBSU were found to be robust in the current study. The instrument demonstrated good internal consistency reliability, with Cronbach's alpha coefficients exceeding the recommended threshold of 0.70 for all three subscales. The construct validity of the LBSU was further supported by the good model fit observed in the CFAs and the significant factor loadings of items on their respective subscales. These results indicate the good reliability and validity of the LBSU as a valid assessment tool for measuring academic burnout among Chinese undergraduate students, which corroborates the findings of previous research that has validated the LBSU in various Chinese academic settings (Chen et al., 2022; Cheng et al., 2020; Lian et al., 2005; Tang et al., 2021; Wang et al., 2021; Wang et al., 2023; Yu et al., 2020; Zhou et al., 2022).

The results of the single-group CFAs demonstrated a good model fit for the three-factor structure of the LBSU in both the overall sample and gender-specific subsamples. This finding aligns with the original conceptualization of the LBSU by Lian et al. (2005) and supports the multidimensional nature of academic burnout as measured by this instrument. Moreover, the three-factor solution of academic burnout observed in the current study is in line with the findings of previous research conducted in various cultural contexts using MBI-SS (Al-Alawi et al., 2017; Teuber, Nussbeck & Wild, 2021; Liu et al., 2023). This cross-cultural consistency further underscores the universality of the three-factor structure of academic burnout and supports the use of the LBSU as a valid assessment tool.

The robustness of the model fit across different sample configurations strengthens the construct validity of the LBSU and its applicability to both male and female students in Chinese universities. The consistency in factor structure across the overall sample and gender-specific subsamples is particularly noteworthy, as it suggests that the conceptualization of academic

burnout as measured by the LBSU is applicable to both male and female students. This finding provides a solid foundation for examining the measurement invariance for the LBSU across gender groups, comparing burnout levels between genders, and investigating potential differences in the manifestation of burnout symptoms among Chinese undergraduates.

Measurement Invariance Across Gender

One of the key findings of this study is the establishment of measurement invariance for the LBSU across gender groups. The results demonstrated good configural, metric, scalar, and strict invariance, indicating that the instrument measures academic burnout equivalently for male and female students. This finding is crucial for several reasons.

Firstly, the establishment of configural invariance suggests that male and female students conceptualize academic burnout in the same way, with the same number of factors and pattern of item-factor relationships. This provides a foundation for meaningful comparisons between gender groups. Secondly, the demonstration of metric invariance indicates that the strength of the relationships between items and their respective factors is similar for male and female students. This allows for valid comparisons of the relationships between academic burnout and other constructs across gender groups. Thirdly, the establishment of scalar invariance suggests that the item intercepts are equivalent across genders, enabling valid comparisons of latent mean scores between male and female students. This is particularly important for interpreting gender differences in academic burnout levels. Finally, the demonstration of strict invariance, with equivalent residual variances across genders, provides the strongest evidence for measurement equivalence and allows for unbiased comparisons of observed scores between male and female students.

The establishment of measurement invariance across genders is a significant contribution to the literature on academic burnout in Chinese higher education. Previous studies using the LBSU have often assumed measurement equivalence without explicitly testing for it (Gao et al., 2018; Wang, 2017). The findings provide empirical support for this assumption and strengthen the validity of gender comparisons in academic burnout research using the LBSU. Moreover, the demonstration of measurement invariance addresses a gap in the literature, where the limited exploration of the LBSU's measurement invariance across genders was found (Tang et al., 2021; Yu et al., 2020). By establishing measurement invariance, the study provides a solid methodological foundation for future research investigating gender differences in academic burnout among Chinese undergraduate students.

Gender Differences in Academic Burnout

The results regarding gender differences in academic burnout present a nuanced picture. The study found no significant differences between male and female students in overall academic burnout levels and two of the three subscales (Low Mood and Low Sense of Accomplishment). However, a significant gender difference was observed in the "Inappropriate behavior" subscale. These findings, combined with the established measurement invariance across gender, provide a complex understanding of the relationship between gender and academic burnout in the Chinese undergraduate context.

The lack of significant gender differences in overall academic burnout and two of the subscales aligns with some previous studies using the LBSU (Liu et al., 2016) and the meta-

analysis by Yu et al. (2020), which found no statistically significant gender differences in learning burnout scores among Chinese undergraduate students. However, the finding of a gender difference in the "Inappropriate behavior" subscale adds nuance to this picture and suggests that while overall burnout levels may be similar, there may be specific aspects of burnout that manifest differently between genders.

These results highlight the importance of considering both overall burnout scores and individual subscale scores when examining gender differences. The complex pattern of findings underscores the need for a multidimensional approach to understanding academic burnout and its relationship with gender. The findings that male students reported higher levels of inappropriate behavior related to their studies compared to their female counterparts may be due to the different expectations of gender roles in traditional Chinese culture. Compared with boys, girls are more reserved and introverted, so even if they have academic burnout problems, they may not show it in their behavior, which may cause boys' inappropriate behavior at a higher level. However, this needs to be further examined in empirical research.

Last but not least, the complex relationships found between gender and academic burnout in the Chinese undergraduate context are in line with the conflicting findings in the literature using MBI-SS (Aguayo et al., 2019; Backović et al., 2012; Cabras et al., 2023), highlighting the complex nature of the relationship between gender and academic burnout. The specific characteristics of the sample, such as academic discipline, year of study, cultural background, gender roles and expectations may contribute to these complex or even conflicting results. The use of a gender-invariant instrument (LBSU) in the current study ensures that the observed complex results regarding gender differences are not due to measurement bias, lending credibility to the findings, which has important implications for understanding the universality of academic burnout experiences and for developing interventions that can be effective across gender groups.

Levels of Academic Burnout

The present study revealed moderate levels of academic burnout among the participants, which aligns with findings from previous research using the LBSU in various Chinese university settings in recent years (Yu et al., 2020). This observation warrants careful consideration and highlights the ongoing challenges faced by Chinese undergraduate students in managing academic stress and maintaining well-being.

Several factors may contribute to these moderate burnout levels. Firstly, the intense academic pressure in Chinese higher education, characterized by high-stakes examinations and fierce competition for employment opportunities, may contribute to sustained stress and eventual burnout (Lin & Huang, 2014). Secondly, the transition to university life, involving new responsibilities, independence, and social adjustments, can be emotionally taxing for many students (Van Doren et al., 2021). Thirdly, concerns about future career prospects and the pressure to succeed academically to secure better job opportunities may exacerbate burnout symptoms (Liu et al., 2023; Mannerström et al., 2024). Lastly, the data collection occurred just after the COVID-19 pandemic, the disruptions to traditional learning environments and increased reliance on remote learning may have heightened stress levels and contribute to burnout (Duarte et al., 2022; Gundogan, 2023; Sveinsdóttir et al., 2021).

The moderate burnout levels observed in this study underscore the need for continued attention to student well-being and the implementation of effective support strategies within Chinese higher education institutions.

Implications, Limitations and Recommendations

The findings of this study have several important implications for research, practice, and policy in Chinese higher education by contributing to the methodological rigor of academic burnout research in several ways. Firstly, the validation of the LBSU's measurement invariance across genders provides researchers and practitioners with a reliable tool for assessing academic burnout in diverse student populations. This enhances the validity of gender-based comparisons and allows for more accurate identification of at-risk students. Secondly, the complex pattern of gender differences observed suggests that interventions and support strategies may need to be tailored to address specific aspects of burnout that may manifest differently between male and female students, particularly in relation to "Inappropriate behavior." Thirdly, the moderate levels of burnout observed across the sample highlight the need for Chinese universities to prioritize student well-being and implement proactive measures to prevent and address academic burnout. The findings have the potential to inform both future research directions and practical interventions aimed at mitigating the growing challenge of academic burnout among undergraduate students. Fourthly, the validated LBSU can be used as a screening tool to identify students at risk of burnout early, enabling timely interventions and support.

Despite its contributions, this study has several limitations that should be acknowledged. The cross-sectional design limits the ability to draw causal conclusions or examine the development of academic burnout over time. Future longitudinal studies could provide valuable insights into the trajectory of burnout and its relationship with gender across students' academic careers. The reliance on self-report measures may introduce common method bias and social desirability effects. Future research could incorporate objective measures of stress and burnout to complement self-report data. The study was conducted at three universities, potentially limiting the generalizability of findings to other educational contexts or cultural settings within China. Multi-site studies across different regions of China could enhance the generalizability of results. While the study focused on gender differences, other potential contributors to academic burnout (e.g., academic major, year of study, family background) were not examined. Future research could explore how these factors interact with gender to influence burnout levels.

Based on these limitations and the findings, several recommendations for future research are proposed. Conduct longitudinal investigations to examine the trajectory of academic burnout over time and identify critical periods for intervention among Chinese undergraduate students. Incorporate qualitative methods to gain deeper insights into students' lived experiences of academic burnout and the factors that contribute to or mitigate it within the Chinese cultural context. Investigate the role of various personal, academic, and environmental factors in the development of academic burnout among Chinese students, including personality traits, coping strategies, and institutional characteristics. Develop and evaluate targeted interventions to prevent and address academic burnout in Chinese universities, considering the findings on gender invariance and the specific gender difference observed in the "Inappropriate behavior" subscale and moderate burnout levels. Explore the

impact of technology use, digital learning environments, and social media on academic burnout among Chinese undergraduate students, particularly in light of the increasing digitalization of education. Investigate how the intersection of gender with other demographic factors (e.g., rural/urban background, socioeconomic status) may influence the experience of academic burnout in the Chinese higher education context. Broader sample diversity: Extend the research to multiple institutions to enhance the generalizability of findings and explore potential differences in academic burnout. Incorporate objective measures of stress and burnout, such as cortisol levels or heart rate variability, to complement self-report data and provide a more comprehensive understanding of academic burnout.

Conclusions

This study provides valuable insights into the measurement and manifestation of academic burnout among Chinese undergraduate students. The psychometric properties of the three-factor structure LBSU were found to be robust in the current study, demonstrating good internal consistency reliability and construct validity. Measurement invariance for the LBSU across gender groups was established, indicating that the instrument measures academic burnout equivalently for male and female students, and provides a foundation for meaningful comparisons between gender groups. The complex pattern of gender differences observed, coupled with the moderate levels of burnout across the sample, highlights the nuanced nature of this challenge in Chinese higher education and the urgency of tailored effective interventions.

By systematically examining the measurement invariance across gender, the study makes a crucial contribution to the cross-gender academic burnout measurement. Theoretically, the research extends our understanding of academic burnout by demonstrating the nuanced ways in which burnout experiences may differ between male and female students. Practically, the validation of the LBSU provides a robust, gender-sensitive tool that enhances the precision of burnout research, offering researchers and educational practitioners a more refined instrument for identifying and addressing student psychological challenges. Moreover, the study contributes to the broader theoretical framework of educational psychology by highlighting the importance of contextual and gender-specific factors in understanding academic burnout.

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