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QI-pathological constitution is associated with mental fatigue in class among university students: a cross-sectional study

Xinzhu Wang[1] and Xinyu He[2*]

Abstract

Background Mental fatigue in class is a common phenomenon among university students in China. However, there is limited research exploring the impact of QI-pathological constitution on mental fatigue in university students.

Methods We employed a convenience sampling method to survey 588 students aged 17 to 24 from a western university in China in May 2024. The study measured QI-pathological constitution and mental fatigue among these students. Additionally, diet quality, physical exercise, sleep quality, and academic pressure were assessed as controlled variables. Descriptive statistics, Pearson correlation, and structural equation modeling were utilized to analyze these cross-sectional data.

Results The results showed that university students experience low levels of mental fatigue in class ($M=2.41$, $SD=0.75$) and a slight QI-pathological constitution ($M=1.96$, $SD=0.71$ for QI stagnation and $M=2.41$, $SD=0.91$ for QI deficiency) on a 5-point Likert scale ranging from 1(never) to 5(often). Pearson correlation analysis revealed a weak positive association between QI-pathological constitution ($r=0.205$, $p<0.01$ for QI stagnation; and $r=0.256$, $p<0.01$ for QI deficiency) and mental fatigue in class. Controlling for diet quality, physical exercise, sleep quality, and academic pressure in the structural equation model showed that QI-pathological constitution has a significantly positive effect on mental fatigue in class ($\beta=0.228$, $p<0.01$).

Conclusion The study identified a low level of mental fatigue in class and a slight presence of QI-pathological constitution among university students. The QI-pathological constitution has a significantly positive impact on the level of mental fatigue experienced by university students in the classroom.

Keywords Mental fatigue, QI-pathological constitution, QI stagnation, QI deficiency, Chinses traditional medicine

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Introduction

Mental fatigue in class among Chinese university students has received much attention from scholars for many years. An earlier study indicated that approximately 20% of university students experienced falling asleep or dozing off in class, primarily due to fatigue and high academic pressure [1]. Mental fatigue including occasional difficulty concentrating during lectures and feeling mentally sluggish in class is a prevalent phenomenon among undergraduates in Chinese universities [2, 3]. Mental fatigue contributes to reduced learning efficiency and diminished academic performance [4–6].

Mental fatigue is defined as a diminished capacity to perform cognitive tasks due to an overload of mental activities [7]. It is typically characterized by a decline in cognitive functions, such as reduced visual search capabilities, impaired problem-solving skills, and diminished attention distribution, ultimately leading to decreased cognitive performance [8]. Furthermore, mental fatigue is often accompanied by feelings of tiredness, depletion, a lack of motivation for ongoing tasks, and a decrease in overall vitality. These factors can negatively impact both physical and mental health, ultimately resulting in reduced productivity in the workplace [8]. Research utilizing electroencephalography has demonstrated that mental fatigue is associated with atypical brain activity, including significant increases in theta activity in frontal, central, and posterior regions, as well as moderate changes in alpha activity in central and posterior areas [9].

There are numerous causes of mental fatigue, with work-related stress and workload being significant contributing factors. A study with a sample of 378 undergraduate students found that cognitive workload is a significant predictor of mental fatigue in online courses [10]. Sympathetic hyperactivity has been shown to be the mechanism underlying mental fatigue caused by prolonged cognitive load [11].

Unhealthy lifestyles can lead to mental fatigue. Firstly, diet quality is strongly associated with mental fatigue. A study involving healthy college students revealed that skipping breakfast and consuming meals irregularly are linked to the prevalence of both physical and mental fatigue [12]. Secondly, there is a significant correlation between physical activity and mental fatigue. An experimental study utilizing EEG techniques found that moderate physical activity, such as 15 min of exercise on an ergo-cycle, can effectively counteract mental fatigue [13]. A systematic review suggests that physical exercise, including bouts of physical activity, can enhance children's cognitive functioning in school [14]. Thirdly, sleep quality is a crucial factor contributing to mental fatigue. A study with a sample of 495 adults revealed that that, adjustment adjusting potential confounders, sleep quality was associated with both fatigue and physical energy [15]. In the society, sleep deprivation is a major contributor to mental fatigue [16].

Physical condition is considered an important factor contributing to mental fatigue. A study found that physical fitness—measured by grip strength, 6-meter walk time, and lung function—is positively associated with cognitive reserve [17]. Another study involving a group of 210 teenagers aged 11 to 15 years demonstrated that physical fitness (assessed through the horizontal jump test and the 5×10 m speed test) is positively correlated with their selective attention and concentration [18]. However, to date, limited research has examined the impact of QI-pathological constitution, a valid indicator of physical condition, on mental fatigue.

In traditional Chinese medicine (TCM), QI is considered a fundamental element of the human body, providing energy and vitality for both physical and mental functions. QI represents the refined nourishment and energy, along with their circulation and transformations, which are essential for human well-being [19]. A QI-pathological constitution refers to a bodily condition in which the QI deviates from an optimal healthy state, resulting in a sub-healthy state characterized by both QI deficiency—indicating an insufficiency or lack of QI—and QI stagnation, which denotes the slow or obstructed flow of QI in specific areas [20]. A QI-pathological constitution does not equate to a clinical disease state; however, it bears significantly on the degree of susceptibility to a range of related diseases, treatment efficacy, and prognosis [21] Long-term unhealthy lifestyles and negative moods are important factors contributing to a QI-pathological constitution [22, 23].

Research has indicated that the QI-pathological constitution may contribute to emotional disturbances and cognitive impairments. A study demonstrated that adults exhibiting symptoms of QI-pathological constitution particularly males with symptoms of QI deficiency, are more likely to experience severe major depression. Furthermore, both male and female adults displaying symptoms of QI deficiency tend to have a higher likelihood of suffering from anxiety disorders [24].

Another study in TCM indicated that individuals experiencing depression due to liver QI deficiency typically exhibit symptoms such as sluggish thinking and reduced cognitive function, including difficulty concentrating, delayed reaction times, learning difficulties, and poor language fluency, alongside low mood and diminished motivation [25]. An experimental study using rat models found that rats with mild QI deficiency, as indicated by heart function, exhibited a reduction in their ability to learn [26]. Furthermore, positive associations were observed between QI-pathological constitution and both physical and mental fatigue in nurses who worked

shifts; specifically, those with high levels of QI deficiency and QI stagnation tended to experience greater levels of fatigue [21].

In addition to lifestyle and cognitive workload, physical condition is recognized as a contributing factor to mental fatigue. However, limited research has investigated the association between QI-pathological constitution—an important indicator of physical condition in TCM—and mental fatigue among university students in class. This represents a significant gap in the literature concerning mental fatigue, which presents challenges for educators in addressing students' mental fatigue in school. Although university students are generally in the prime of their health throughout their lifespan [27], they often begin to exhibit various sub-healthy constitutional tendencies, including QI-pathological constitution [28]. This study aims to explore the relationship between mental fatigue experienced by university students in class and their QI-pathological constitution, with the goal of proposing strategies that can help reduce mental fatigue and enhance learning efficiency.

Research methods

Ethical statement

The present study was conducted in accordance with the principles of the Declaration of Helsinki and received approval from the Academic Committee of the School of Teacher Education at Xichang University (LG202406). Verbal informed consent was obtained from all participants prior to the formal investigation.

Sampling procedure

This study employed a convenience sampling method to collect cross-sectional data from a second-tier university located in a remote area of western China. The majority of students at this university come from families registered in rural regions. Prior to the survey, students were informed that the research was for scientific purposes and did not involve significant privacy concerns. The survey was conducted during daytime classes and evening self-study sessions from May 20 to May 28, 2024, with the assistance of two psychology students. Paper-and-pencil questionnaires were utilized for the survey. Upon submitting the questionnaire, participants were instructed to carefully review their completed forms to minimize instances of missing information.

In this study, a total of 25 variables are examined, including mental fatigue and QI-stagnation constitution, which consist of 4 and 12 items, respectively. Additionally, there are 4 control variables: diet quality, physical exercise, sleep quality, and academic pressure, as well as 5 participant characteristic variables (see Table 1). According to previous research, the recommended ratio for traditional multivariate statistics is 20 cases per measured variable. Therefore, this study requires an effective sample size of 500 participants. To account for the possibility of invalid questionnaires, the survey sample size is set at approximately 600 [29]. A total of 621 questionnaires were distributed. Participants who missed more than five items were excluded, resulting in 588 valid questionnaires, which corresponds to an effective response rate of 94.69%.

Table 1 The basic characteristics of sample ($N = 588$)

Variables	Levels	Frequency	Percent
Family Registered Areas	Rural	438	74.5
	Urban	150	25.5
Gender	Male	156	26.5
	Female	432	73.5
Ethnicity	Han	478	81.3
	Minority	110	18.7
Age	17–18	67	11.4
(M = 19.72, SD = 1.07)	19	185	31.5
	20	216	36.7
	21	92	15.6
	22–24	28	4.8
Major	Business administration	**140**	**23.8**
	English language	**130**	**22.1**
	Primary education	**126**	**21.4**
	Tourism management	**83**	**14.1**
	Animal science	**109**	**18.5**

Research instruments

QI-pathological constitution

The measurement of QI-pathological constitution comprised 12 items, with 6 items specifically designed to assess QI stagnation and another 6 items aimed at evaluating QI deficiency [30, 31]. Participants were instructed to recall their physical sensations over the past three months and respond to the 12 items using a 5-point Likert scale, ranging from 1 (never) to 5 (often). One item assessing QI stagnation states, "I sigh for no reason," while one item evaluating QI deficiency states, "I get tired easily." The Cronbach's alpha coefficients for QI stagnation and QI deficiency were 0.84 and 0.85, respectively, indicating high reliability. Elevated mean scores on the two sub-scales suggested high levels of QI-pathological constitution. In the present study, the measurement model of QI-pathological constitution demonstrated a good fit ($\chi^2/df = 3.83$, CFI = 0.95, AGFI = 0.97, TLI = 0.94, RMSEA = 0.069, 90% CI: 0.059, 0.080).

Mental fatigue

The four items used to assess mental fatigue in the classroom are adapted from the mental symptoms subscale of the 14-Item Fatigue Scale [32]. Participants were asked to evaluate their mental status in class over the past three months, focusing on aspects such as attention,

memory, interest in courses, and clarity of thought. All items were rated on a 5-point Likert scale, ranging from 1 (never) to 5 (often). One of the items states, "I have difficulty concentrating in class." The Cronbach's alpha coefficient for this scale was 0.85, indicating high reliability. Elevated composite mean scores reflected high levels of mental fatigue in class. In the present study, the measurement model for mental fatigue demonstrated a good fit ($\chi^2/df = 1.50$, CFI = 0.99, AGFI = 0.97, TLI = 0.99, RMSEA = 0.030, 90% CI: 0.000, 0.093).

Sleep quality

Sleep quality is measured by a single item [33], which defines good sleep as follows: the ease of falling asleep when lying down, infrequent awakenings during the night, and feeling refreshed and restored upon waking in the morning. Participants were instructed to retrospectively evaluate their sleep quality over the past three months using a 5-point scale based on the criteria for good sleep, where "1" represents "very poor" and "5" signifies "very good."

Physical exercise

Physical exercise is assessed with a single item [34]. In this study, healthy physical exercise is defined as follows: Each session should last a minimum of 20 min and result in at least mild perspiration or breathlessness, and the forms of activities may include brisk walking, table tennis, basketball, badminton, football, running, skipping, dancing, swimming, etc. Participants were demanded to retrospectively assess their exercise activity over the past month and evaluate it using a 5-point scale, based on the criteria of healthy physical exercise: "1" means "Less than once a week", "2" means "1–2 times a week", "3" denotes "3–4 times a week", "4" indicates "5–6 times a week", and "5" means "almost every day".

Diet quality

The present study utilized a single item to evaluate diet quality and defined a healthy diet in this manner: In addition to staple foods, the daily diet should also include soy products (such as tofu), fruit, milk or other dairy products, eggs, meat (such as pork, chicken or beef), and seafood (such as fish and shrimp) [35]. The participants were instructed to assess their diet quality over the previous three months based on the aforementioned definition of a healthy diet, using a 5-point scale where "1" corresponds to "very poor" and "5" indicates "very good".

Academic pressure

This study utilized a single item to assess academic pressure. Participants were asked to evaluate their academic workload for the semester using a 5-point scale, where "1" represented "very light" and "5" represented "very heavy."

Other demographic variables

In this study, all participants were asked to report their major field of study at university.

Results

Descriptions of the sample

The fundamental characteristics of valid samples in this study are presented in Table 1.

Table 1 Indicates that in this study, 74.50% of the participants come from families registered in rural areas, while 26.50% of the sample consists of females. Additionally, only 18.70% of the sample represents minority groups.

Descriptive statistics and correlations

The descriptive statistics of key variables and correlations among them are presented in Table 2.

Drawing on a prior study on the 5-point scale [36], composite average scores ranging from 1.81 to 2.61 indicate a low level of mental fatigue, while scores between 2.62 and 3.42 suggest a moderate level. In the present study, the mean score for mental fatigue is 2.41, indicating that, on average, university students in this study experience a low level of mental fatigue in class.

The mean scores for QI stagnation and QI deficiency were 1.96 and 2.41 respectively. Overall, university students in this study exhibit a slight QI-pathological constitution.

Table 2 The descriptive statistics and correlations

	M	SD	MF	QS	QD	DQ	PE	SQ	AP
MF	2.41	0.75	1						
QS	1.96	0.71	0.205**	1					
QD	2.41	0.91	0.256**	0.758**	1				
DQ	3.41	0.82	-0.224**	-0.220**	-0.246**	1			
PE	2.05	0.95	-0.110**	-0.105*	-0.167**	0.058	1		
SQ	3.16	0.98	-0.194**	-0.293**	-0.273**	0.312**	0.123**	1	
AP	3.07	0.74	-0.026	0.128**	0.154**	-0.043	-0.041	-0.063	1

Note: ** denotes significance at the 0.01 level; * indicates significance at the 0.05 level. MF = mental fatigue, QS = QI stagnation, QD = QI deficiency, DQ = diet quality, PE = physical exercise, SQ = sleep quality, AP = academic pressure, QPC = QI-pathological constitution

The mean scores for diet quality, sleep quality, and physical exercise are 3.41, 3.16, and 2.05 respectively. Therefore, the sampled students exhibited moderate levels of both diet quality and sleep quality, as well as a low level of physical exercise. In addition, the mean value of academic pressure is 3.07, indicating a moderate level of academic pressure among these students.

Figure 1 illustrates the distributions of individual item scores and the mean values of the main variables in this study.

Correlation analysis revealed a positive association between mental fatigue and both QI depression ($r = 0.205$, $p < 0.01$) and QI deficiency ($r = 0.256$, $p < 0.01$). Conversely, there were significant negative correlations between mental fatigue and diet quality (r=-0.224, $p < 0.01$), physical exercise (r=-0.110, $p < 0.01$), and sleep quality (r=-0.194, $p < 0.01$). The correlation between academic pressure and mental fatigue is not significant(r=-0.026, $p > 0.05$).

Figure 2 illustrates the correlation between QI-pathological constitution and mental fatigue among university students.

Regression analysis

In this study, a structural equation model was utilized to examine the effect of QI-pathological constitution on mental fatigue in class. Diet quality, physical exercise, sleep quality, and academic pressure were included as control variables.

The results of the structural equation model are illustrated in Fig. 3.

The structural equation model demonstrated a good fit ($\chi^2/df = 1.64$, RMSEA = 0.033, 90% C.I.: 0.012, 0.051; CFI = 0.990, TLI = 0.984; SRMR = 0.019) (see Fig. 3).

The structural equation model indicates that QI-pathological constitution significantly predicts mental fatigue in a positive direction ($\beta = 0.228$, $p < 0.01$).

Among the four control variables, diet quality had a significant impact on mental fatigue (β = -0.153, $p < 0.01$). In contrast, physical exercise (β = -0.065, $p > 0.05$), sleep quality (β = -0.087, $p > 0.05$), and academic pressure (β = -0.081, $p > 0.05$) did not show a significant effect on mental fatigue.

Last, diet quality (β = -0.267, $p < 0.01$), physical exercise (β = -0.167, $p < 0.01$), sleep quality (β = -0.312, $p < 0.01$), and academic pressure ($\beta = 0.164$, $p < 0.01$) all demonstrated a significant impact on QI-pathological constitution (see Fig. 3).

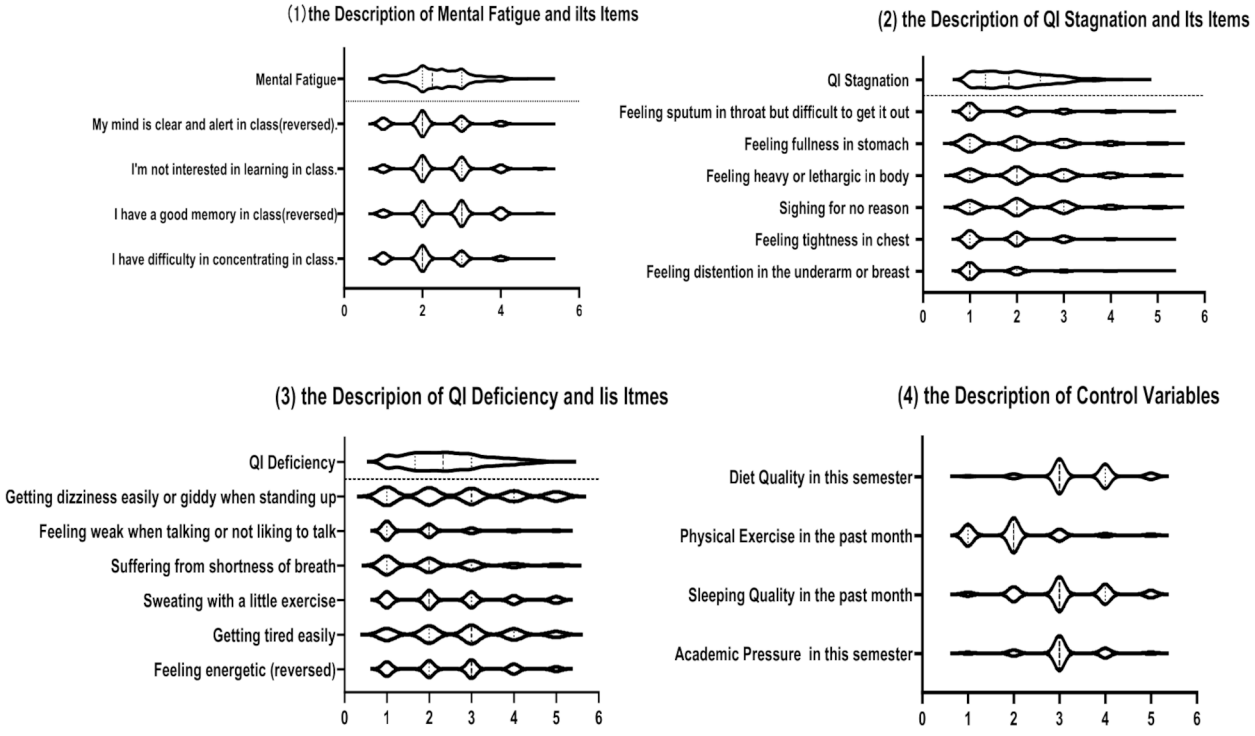

Fig. 1 The distributions of each item score and mean value in the main variables

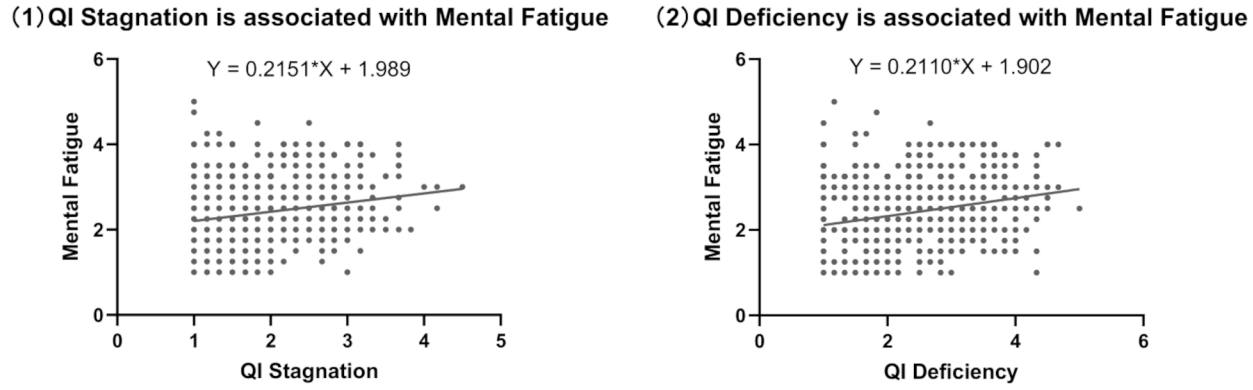

Fig. 2 The simple correlation between QPC and MF

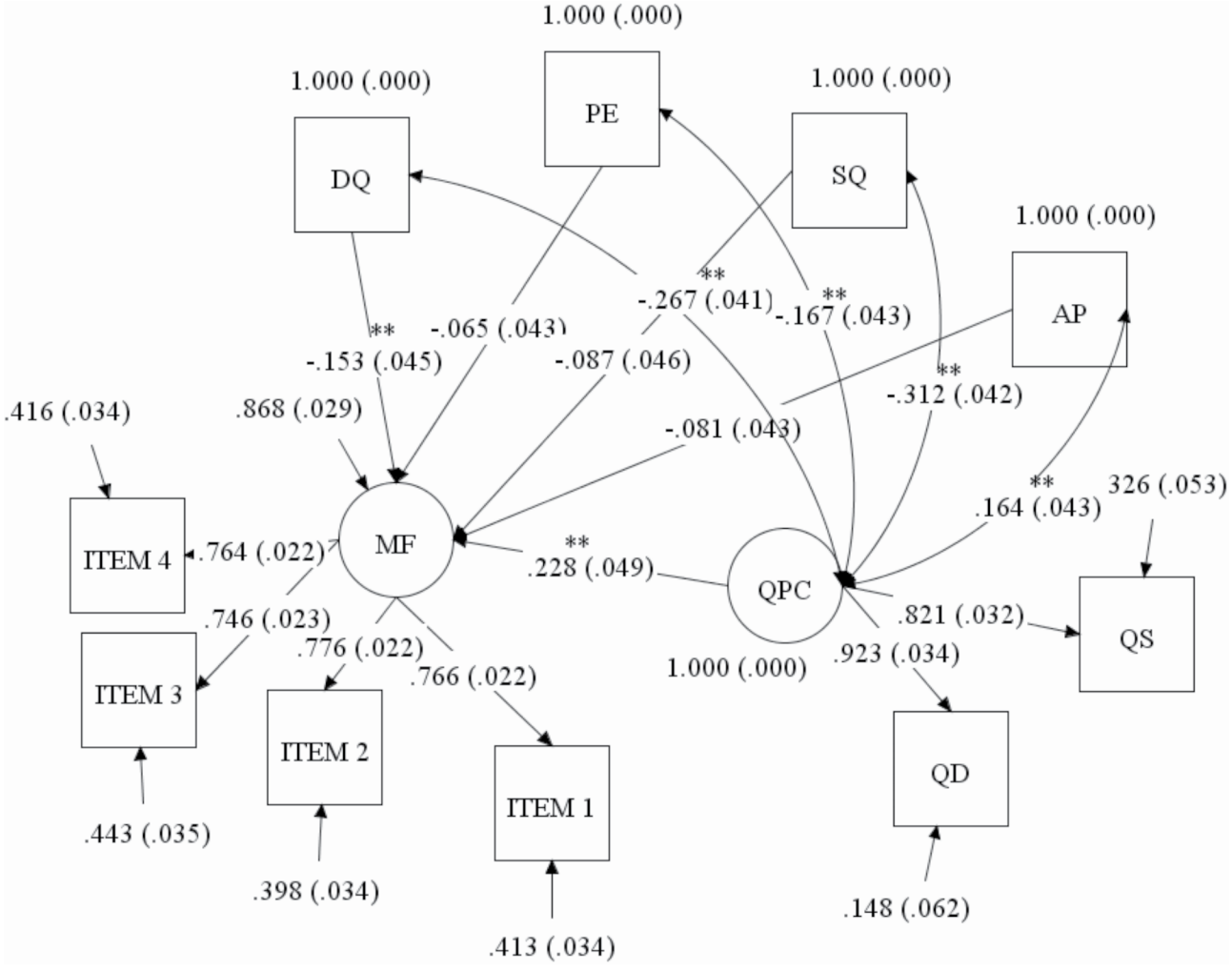

Fig. 3 Results of the structural equation model

Notes: Stdyx estimates are presented. MF = mental fatigue, QS = QI stagnation, QD = QI deficiency, DQ = diet quality, PE = physical exercise, SQ = sleep quality, AP = academic pressure, QPC = QI-pathological constitution. For brevity, the correlational paths between DQ, SQ, PE, and AP are omitted

Discussion

Descriptive statistics of the main variables

This study revealed that university students experience low levels of mental fatigue, which is manifested by occasional poor learning mindset in class including difficulty in concentrating, poor memory, lack of interest in learning, and unclear mind. These results align with the findings from a previous study which similarly observed low levels of fatigue among university students [2].

In this study, university students demonstrated low levels of QI stagnation and QI deficiency, suggesting that, overall, they exhibit a slight presence of a QI-pathological constitution. This finding is attributed to the fact that youth represents the healthiest phase of an individual's life [27], and their constitutional tendencies are still evolving.

This study also revealed that university students had a moderately healthy lifestyle. Specifically, their diet and sleep quality were rated as moderately healthy, while their physical exercise was limited to 1–2 times per week, with each session lasting at least 20 min. These results closely align with findings from other studies conducted in China. For instance, one study found that over 50% of university students exhibit unhealthy lifestyles characterized by poor sleep quality and insufficient physical activity [37]. Additionally, another survey indicated that university students often have an unreasonable dietary structure and an imbalanced nutrient intake [38].

Lastly, this study revealed that the students experience a moderate level of academic pressure. The university of the study sample is a second-tier university located in a remote area of western China, and its academic demands placed on students are relatively low, resulting in a moderate level of academic pressure among its students.

The association between QI-pathological constitution and mental fatigue in class

Pearson correlation analysis indicated that both QI stagnation and QI deficiency are significantly and positively associated with mental fatigue in class. The structural equation model demonstrates that QI-pathological constitution has a significantly positive effect on mental fatigue, even when controlling for other variables. This suggests that individuals with higher levels of QI-pathological constitution tend to experience greater mental fatigue in class. This finding closely aligns with results from previous studies. For example, one study found a positive association between QI-pathological constitution and mental fatigue among nurses working shifts [21]. Additionally, another experimental study showed that mice with mild QI deficiency, as indicated by heart function, exhibited signs of mental fatigue, evidenced by a reduction in their learning ability [26].

Current medical research indicates that the concept of QI in TCM essentially describes the metabolic processes and functional activities of the human body [39]. Individuals with QI deficiency and QI stagnation are more susceptible to experiencing both physical and psychological fatigue. This susceptibility is attributed to impaired metabolic function and inadequate energy supply within the body. For instance, a prior study demonstrated a significant correlation between QI deficiency and chronic fatigue syndrome [40]. Additionally, Qi stagnation can lead to a decline in physiological function and may ultimately result in clinical conditions, including cognitive impairment [41]. Furthermore, both QI deficiency and QI stagnation may contribute to the development of depression and anxiety [24],, which can, in turn, manifest as psychological fatigue characterized by impaired concentration and memory [42, 43].

The foundation for QI-pathological constitution may start developing as early as adolescence or even childhood [44]. Although college students represent a healthy population and are generally in the prime of their physical health throughout their lifespan, they exhibit variations in QI-pathological constitution. Consequently, the impact of QI-pathological constitution on mental fatigue in class can be observed among university students.

Additional analysis

Among the control variables, diet quality revealed a significant effect on mental fatigue in class among university students, inconsistent with the results in a previous study revealed a negative association between diet quality and mental fatigue in college students [45].

None of the factors related to physical exercise, sleep quality, or academic pressure have a significant effect on mental fatigue in the classroom. This contradicts the findings of previous studies [10, 13, 46]. The reason may be that each of these three variables is measured using a single item, which could result in low validity.

In addition, diet quality, sleep quality, physical exercise all have positive impact on QI-pathological constitution. Academic pressure has negative effect on QI-pathological constitution. All these results are aligned with the theory of TCM, which posits that unhealthy life styles contributes to QI-stagnation and QI-deficiency [22, 23].

Research implications

Theoretically, this study provides support for the TCM notion that QI provides energy and power for mental activities, meaning that QI serves as the substance foundation of healthy mental function. TCM clinical investigations using samples of clinical patients have demonstrated that QI-pathological status in patients can result in a compromised state of mental functioning, characterized by noticeable cognitive deterioration[25]

and emotional disorders [24]. Using a sample of university students, this study has revealed that QI-pathological constitution can exert a significant impact on mental function, leading to symptoms of mental fatigue in class.

The present study has practical implications for addressing mental fatigue in university. It suggests that regulating the QI-pathological constitution can help alleviate the mental fatigue experienced by students. According to TCM, a healthy lifestyle that includes regular physical activity, quality sleep, and a healthy diet is beneficial for maintaining a healthy state of QI in the body [22]. Both simple correlations and structural equation modeling in this study demonstrate a significant association between lifestyle choices and the QI-pathological constitution. Therefore, university students should be encouraged to adopt healthier lifestyles as a strategy to reduce their mental fatigue in the classroom. Additionally, TCM therapies such as Qigong practice, Tuina massage, and acupuncture can be employed to adjust the QI-pathological constitution, as these therapies are effective in regulating and replenishing QI in the body [22, 47].

Strengths and limitations

The strengths of this study are twofold. Firstly, it integrates QI stagnation and QI deficiency into a comprehensive model of QI-pathological constitution, exploring their combined effects on mental state. This approach differs from previous studies that typically examined these effects on mental function separately [21, 48]. Secondly, this study adopts a TCM perspective to investigate students' mental fatigue in class, revealing that QI-pathological constitution significantly influences mental fatigue during class. This perspective offers a novel approach compared to prior research on mental fatigue [9, 49].

This study has three notable limitations. First, the sample consists solely of students from a second-tier university, which does not represent the entire population of university students in China; thus, the external validity of the research is compromised. Second, the use of cross-sectional data in this study only allows for correlational conclusions rather than establishing a definitive causal relationship between QI-pathological constitution and mental fatigue in class. Future studies should employ cross-lag analysis to address this deficiency. Third, the control variables, including physical exercise, sleep quality, diet quality, and academic pressure, are all assessed using a single item. This approach may lead to significant measurement error, thereby decreasing the internal validity of the study. In future research, we will address these limitations to conduct a more comprehensive investigation into the relationship between QI-pathological constitution and mental fatigue in class.

Conclusions

Based on the principles of TCM, this study employed cross-sectional data to examine the relationship between QI-pathological constitution and mental fatigue among university students. By controlling for variables such as diet quality, sleep quality, physical activity, and academic pressure, structural equation modeling demonstrated that QI-pathological constitution has a significant positive effect on mental fatigue in class. This research contributes to a deeper understanding of the connection between physical constitution in TCM and mental fatigue.

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Author contributions

Xinzhu Wang---conceptulization, writing and data processing； Xinyu He---investigation, review and revision.

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Data availability

The raw data for this study is available at https://www.scidb.cn/en/anonymous/MlVCellm.

Declarations

Ethics approval and consent to participate

The present study was carried out in compliance with the principles of the Declaration of Helsinki and received approval from the Academic Committee of the School of Teacher Education at Xichang University (LG202406). Verbal informed consent was obtained from all the participants prior to the formal investigation.

Consent for publication

Not Applicable.

Competing interests

The authors declare no competing interests.

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References

1. Juan L, Liangqing L. Sleeping in classroom circumstance of undergraduates with different genders and grades. China J Health Psychol. 2012;20(04):593–4.
2. Chunyu C, Shuailei L, Chen Y, Zongkui Z. Effect of mobile phone addiction on college students' depression: mediation and moderation analyses. Chin J Clin Psychol. 2019;27(04):746–9.
3. Yajing W. Reclaiming space, challenging norms, and Establishing routines: the integration of mobile phones in college students' classrooms. Chin Youth Stud. 2023;26(03):90–9.
4. Wang X, He X, Fu K. Mental fatigue mediates the relationship between Qi deficiency and academic performance among fifth-grade students aged 10–13 years. Front Psychol. 2024;15:1369611.

5. Smith AP. Cognitive fatigue and the well-being and academic attainment of university students. *Journal of Education, Society and Behavioral Science* 2018.
6. Sievertsen HH, Gino F, Piovesan M. Cognitive fatigue influences students' performance on standardized tests. Proc Natl Acad Sci. 2016;113(10):2621–4.
7. Lambert A, Soni A, Soukane A, Cherif AR, Rabat A. Artificial intelligence modelling human mental fatigue: A comprehensive survey. Neurocomputing. 2024;567:126999.
8. Brazaitis M, Satas A. Regular short-duration breaks do not prevent mental fatigue and decline in cognitive efficiency in healthy young men during an office-like simulated mental working day: an EEG study. Int J Psychophysiol. 2023;188:33–46.
9. Tran Y, Craig A, Craig R, Chai R, Nguyen H. The influence of mental fatigue on brain activity: evidence from a systematic review with meta-analyses. Psychophysiology. 2020;57(5):e13554.
10. Alleyne Bayne G, Inan FA. Development of the online course overload indicator and the student mental fatigue survey. Int Rev Res Open Distrib Learn. 2022;23(4):74–92.
11. Mizuno K, Tanaka M, Yamaguti K, Kajimoto O, Kuratsune H, Watanabe Y. Mental fatigue caused by prolonged cognitive load associated with sympathetic hyperactivity. Behav Brain Funct. 2011;7(1):17.
12. Tanaka M, Mizuno K, Fukuda S, Shigihara Y, Watanabe Y. Relationships between dietary habits and the prevalence of fatigue in medical students. Nutrition. 2008;24(10):985–9.
13. Jacquet T, Poulin-Charronnat B, Bard P, Perra J, Lepers R. Physical activity and music to counteract mental fatigue. Neuroscience. 2021;478:75–88.
14. Donnelly JE, Hillman CH, Castelli D, Etnier JL, Lee S, Tomporowski P, Lambourne K, Szabo-Reed AN. Physical activity, fitness, cognitive function, and academic achievement in children: A systematic review. Med Sci Sports Exerc. 2016;48(6):1197–222.
15. Pastier N, Jansen E, Boolani A. Sleep quality in relation to trait energy and fatigue: an exploratory study of healthy young adults. Sleep Sci. 2022;15(Spec 2):375.
16. Kayser KC, Puig VA, Estepp JR. Predicting and mitigating fatigue effects due to sleep deprivation: A review. Front NeuroSci. 2022;16:930280.
17. Deary IJ, Whalley LJ, Batty GD, Starr JM. Physical fitness and lifetime cognitive change. Neurology. 2006;67(7):1195–200.
18. Reigal RE, Moral-Campillo L, de Mier RJ-R, Morillo-Baro JP, Morales-Sánchez V, Pastrana JL, Hernández-Mendo A. Physical Fitness Level Is Related to Attention and Concentration in Adolescents. In: *Frontiers in psychology.* vol. 11; 2020: 110.
19. Korngold E, Beinfield H. Chinese medicine and the Mind. Explore: J Sci Healing. 2006;2(4):321–33.
20. Sun Y, Zhao Y, Xue SA, Chen J. The theory development of traditional Chinese medicine constitution: a review. J Traditional Chin Med Sci. 2018;5(1):16–28.
21. Wang Z, Hohashi N, Wu X. Chinese medicine constitution that influences sleep quality and fatigue among Chinese nurses working in shifts in Japan and China. J Rural Community Nurs Pract. 2023;1(2):124–44.
22. Wang Q, Bai M, Yang Y, Liang X, Sun P, Han J, Fan T, Yuan C. Application of TCM constitution in lifetime health maintenance. J Traditional Chin Med Sci. 2018;5(1):6–15.
23. Jiang Q-Y, Li J, Zheng L, Wang G-H, Wang J. Constitution of traditional Chinese medicine and related factors in women of childbearing age. J Chin Med Association. 2018;81(4):358–65.
24. Kondo T, Tokunaga S, Sugahara H, Yoshimasu K, Akamine M, Kanemitsu Y, Fujisawa K, Masuda Y, Kubo C. Qi-deficiency, Qi-stagnation, Qi-flowback, blood deficiency, and fluid retention in patients with depression, psychiatric disorders, or psychosomatic disorders. Psychology. 2011;2(06):643.
25. Ming S, Jiaxu C, Yajing H, Fangfang W. Relationship between depression and liver Yang Qi deficiency. J Beijing Univ Traditional Chin Med. 2016;39(09):720–3.
26. Jiu-lin C, Zhi-hua Y. Changes of Learning - Memory and Amyloid-beta protein in rats with Heart-qi deficiency. Chin J Alzheimer's Disease Relat Disorders. 2018;1(02):143–7.
27. Hopman WM, Harrison MB, Coo H, Friedberg E, Buchanan M, VanDenKerkhof EG. Associations between chronic disease, age and physical and mental health status. Chronic Dis Can. 2009;29(3):108–16.
28. Yap SY, Ng FL, Subramaniam M, Lim YM, Foo CN. Traditional Chinese medicine body constitutions as predictors for depression: A systematic review and Meta-Analysis. Behav Sci (Basel Switzerland) 2022, 12(11).
29. Kyriazos TA. Applied psychometrics: sample size and sample power considerations in factor analysis (EFA, CFA) and SEM in general. Psychology. 2018;09(8):2207–30.
30. Chiang Huichu Y, Sutso L, KoChen H, Poyu H, Mutsu C, Henhong. From theory to clinic: key components of Qi deficiency in traditional Chinese medicine. Altern Ther Health Med. 2012;18(6):28–36.
31. Kim J, Ku B, Kim KH. Validation of the Qi blood Yin Yang deficiency questionnaire on chronic fatigue. Chin Med. 2016;11:1–11.
32. Chalder T, Berelowitz G, Pawlikowska T, Watts L, Wessely S, Wright D, Wallace EP. Development of a fatigue scale. J Psychosom Res. 1993;37(2):147–53.
33. Snyder E, Cai B, DeMuro C, Morrison MF, Ball W. A new single-item sleep quality scale: results of psychometric evaluation in patients with chronic primary insomnia and depression. J Clin Sleep Med. 2018;14(11):1849–57.
34. Milton K, Bull FC, Bauman A. Reliability and validity testing of a single-item physical activity measure. Br J Sports Med. 2011;45(3):203–8.
35. Gago CM, Lopez-Cepero A, O'Neill J, Tamez M, Tucker K, Orengo JFR, Mattei J. Association of a single-item self-rated diet construct with diet quality measured with the alternate healthy eating index. Front Nutr. 2021;8:646694.
36. Alkharusi H. A descriptive analysis and interpretation of data from likert scales in educational and psychological research. Indian J Psychol Educ. 2022;12(2):13–6.
37. Yaru L. Influence of different ways of life on physical health of college students. J Shaoguan Univ ·Natural Sci. 2018;39(06):81–5.
38. Guoyu D, Bing A, Qingwu S. An analysis of health condition and dietary nutrition of college students. Health Med Res Pract. 2010;7(02):62–4.
39. Zhang Y. The essence of human Qi is metabolism. Chin J Basic Med Chin Med. 2000;6(5):5.
40. Shin S, Park SJ, Hwang M. Effectiveness a herbal medicine (Sipjeondaebotang) on adults with chronic fatigue syndrome: A randomized, double-blind, placebo-controlled trial. Integr Med Res. 2021;10(2):100664.
41. Chen Shengliang. New clinical thinking of TCM and Western medicine in psychosomatic Gastrointestinal disease. Chin J Integr Traditional Western Med Digestion. 2023;31(1):1–5.
42. Baune BT, Miller R, McAfoose J, Johnson M, Quirk F, Mitchell D. The role of cognitive impairment in general functioning in major depression. Psychiatry Res. 2010;176(2–3):183–9.
43. Leonard K, Abramovitch A. Cognitive functions in young adults with generalized anxiety disorder. Eur Psychiatry. 2019;56(1):1–7.
44. Jun Z, Zhenying W. Whelan Fan: Research on traditional Chinese medicine constitution type of healthy children. China J Traditional Chin Med Pharm 2000(2):41–2.
45. Park SY, You JS, Chang KJ. Relationship Among Self-Reported Fatigue, Dietary Taurine Intake, and Dietary Habits in Korean College Students. In: *Taurine 8: 2013// 2013; New York, NY.*: Springer New York; 2013: 259–265.
46. Pastier N, Jansen E, Boolani A. Sleep quality in relation to trait energy and fatigue: an exploratory study of healthy young adults. Sleep Sci. 2022;15(S 02):375–9.
47. Bao GC. The idealist and pragmatist view of Qi in Tai Chi and Qigong: a narrative commentary and review. J Integr Med. 2020;18(5):363–8.
48. Chen S-L, Liu Y-T, Hsueh K-C, Tang P-L. Body constitution of traditional Chinese medicine caused a significant effect on depression in adult women. Complement Ther Clin Pract. 2021;42:101288.
49. Ishii A, Tanaka M, Watanabe Y. Neural mechanisms of mental fatigue. Rev Neurosci. 2014;25(4):469–79.

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