EFFECTS OF MUSIC COMBINED WITH SPORTS GAMES ON ENHANCING PSYCHOLOGICAL WELL-BEING AMONG ADOLESCENTS IN LANZHOU GANSU PROVINCE CHINA DURING COVID-19 PANDEMIC

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by

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LIST OF ABBREVIATIONS

AE	achievement Emotion
AE-P	achievement Emotion-positive
AEAL-P	Achievement Emotion Adjective List- Positive
AE-N	achievement Emotion-negative
AEAL-N	Achievement Emotion Adjective List- Negative
AME	athletic mental energy
MT	mental toughness
NMSC	Negative Mental States caused by COVID-19 (SAVE-6 combine FCV-19 measurement level)
PA	physical activity
PL	physical literacy

LIST OF APPENDICES

KESAN GABUNGAN MUZIK DENGAN PERMAINAN SUKAN TERHADAP PENINGKATAN KESEJAHTERAAN PSIKOLOGI DALAM KALANGAN REMAJA DI LANZHOU, WILAYAH GANSU, CHINA SEMASA PANDEMI COVID-19

ABSTRAK

Sejak Disember 2019, impak global COVID-19 menimbulkan kebimbangan dan tekanan psikologi meluas. Walaupun permainan sukan dan terapi muzik dapat mengurangkan tekanan remaja, keberkesanan gabungannya masih belum dikaji sepenuhnya. Di GanSu, China, kajian ini menyelidiki hubungan antara tekanan, kebimbangan, ketakutan terhadap COVID-19, tenaga mental atletik (AME), kegigihan mental (MT), literasi fizikal (PL), emosi pencapaian positif (AE-P), emosi pencapaian negatif (AE-N), dan impak muzik yang dikombinasikan dengan permainan sukan ke atas remaja sekolah menengah. Objektif khusus dibahagikan berdasarkan fasa kajian 1 dan 2. Fasa 1, Objektif 1 – 7: Menilai kebolehpercayaan dan ketepatan skala psikologi utama dalam versi Cina berkaitan wabak. Melalui persampelan kluster berperingkat, 729 peserta dilibatkan. CFA mengesahkan soal selidik, dan pengesahan kebolehulangan ujian melibatkan 72 peserta selepas tempoh 14 hari. Ukuran serentak seperti Gangguan Kecemasan Umum (GAD-7) dan petunjuk fisiologi (kortisol, HR, SpO2) dikumpulkan. Hasil menunjukkan kesesuaian model yang baik. Fasa 1, Objektif 8: Menilai faktor berkaitan dengan tekanan di kalangan 797 pelajar universiti Cina di GanSu. Statistik deskriptif, ujian sampel bebas, analisis regresi, SEM, dan Bootstrap mediation effect digunakan. Hasil menunjukkan bahawa PL mempengaruhi positif AE-P, MT, dan AME, sementara mempengaruhi negatif AE-N dan keadaan mental negatif yang disebabkan oleh COVID-19 (NMSC). Fasa 2, Objektif 9 & 10: Menilai

impak gabungan muzik dengan permainan sukan ke atas faktor-faktor berkaitan dengan tekanan di kalangan 200 remaja sekolah menengah di GanSu, China. Peserta dari Fasa 1 (n = 200) mendaftar dalam kajian intervensi, secara rawak ditugaskan ke dalam tiga kumpulan intervensi dan satu kumpulan kawalan menggunakan rawak blok. Hasil: Dalam SAVE-6, kesan utama yang signifikan terhadap kecemasan dan kesan interaksi dengan kumpulan ditemui ($p < 0.01$). Walau bagaimanapun, kesan utama kumpulan tidak signifikan ($p > 0.05$). Analisis kesan mudah seterusnya menunjukkan kesan individu yang signifikan bagi kumpulan dalam ujian selepas ($p < 0.05$). Begitu juga, untuk FCV-19, AE-P, AE-N, PPLA-Q, AMES, MTQ-48, kelembapan oksigen denyut, kadar jantung, dan kortisol serum, kesan utama masa dan kesan interaksi dengan kumpulan diperhatikan ($p < 0.05$ atau $p < 0.001$). Dalam kebanyakan kes, kesan utama kumpulan tidak signifikan ($p > 0.05$), sementara analisis kesan mudah seterusnya menunjukkan kesan individu yang signifikan bagi kumpulan dalam ujian selepas ($p < 0.05$). Kesimpulan utama yang ditarik dari kajian ini adalah: (1) SAVE-6, FCV-19, AMES, MTQ-48, PPLA-Q dan AEAL menunjukkan kebolehpercayaan dan ketepatan yang baik dan disyorkan untuk digunakan di kalangan pelajar universiti Cina. (2) Hubungan yang dikenalpasti: 1) PL mempunyai impak negatif langsung ke atas NMSC. 2) PL secara positif meramalkan AME, MT, dan AE-P. 3) AE-P memberi kesan negatif kepada NMSC. 4) AME, MT, dan AE-N secara langsung mempengaruhi NMSC. 5) AME, MT, AE-P dan AE-N, menjadi perantara kesan PL ke atas NMSC. Temuan ini menawarkan pandangan untuk intervensi yang ditargetkan untuk meningkatkan kesejahteraan keseluruhan pelajar. (3) Kesan intervensi muzik selama 8 minggu yang dikombinasikan dengan permainan sukan adalah lebih baik daripada kesan intervensi lain. Oleh itu, kami mencadangkan menggunakan pendekatan intervensi ini di kalangan remaja.

EFFECTS OF MUSIC COMBINED WITH SPORTS GAMES ON ENHANCING PSYCHOLOGICAL WELL-BEING AMONG ADOLESCENTS IN LANZHOU GANSU PROVINCE CHINA DURING COVID-19 PANDEMIC

ABSTRACT

Since December 2019, global COVID-19 impact has caused widespread psychological distress. While sports games and music therapy alleviate adolescent stress, their combined effectiveness is underexplored. In GanSu, China, this study explores relationships between stress, anxiety, fear of COVID-19, athletic mental energy (AME), mental toughness (MT), physical literacy (PL), positive achievement emotion (AE-P), negative achievement emotion (AE-N), and the impact of music combined with sports games on secondary school-aged adolescents. The specific objectives are divided based on study's phase 1 and 2. Phase 1, Objective 1 – 7: This phase aimed to assess the reliability and validity of Chinese versions of key psychological scales related to epidemics. Through multistage cluster sampling, 729 participants were included. CFA validated the questionnaires, and test-retest reliability verification involved 72 participants after a 14-day interval. Concurrent measures like Generalized Anxiety Disorder (GAD-7) and physiological indicators (cortisol, HR, SpO2) were collected. Results indicated good model fit. Phase 1, Objective 8: This phase aimed to assess stress-related factors among 797 Chinese college students in GanSu province. Descriptive statistics, independent sample t - test, regression analysis, SEM, and Bootstrap mediation effect were employed. Results indicated that PL positively influenced AE-P, MT, and AME, while negatively affecting AE-N and COVID-19-induced negative mental state (NMSC). Phase 2, Objective 9 & 10: This phase aimed to assess the impact of combining music with sports games on stress-

related factors among 200 secondary school-aged adolescents in GanSu province, China. Participants from Phase 1 (n = 200) enrolled in the intervention study, randomly assigned into three intervention groups and one control group using block randomisation. Results: In the SAVE-6, a significant main effect of time on anxiety and interaction effect with groups were found ($p < 0.01$). However, the main effect of the group was not significant ($p > 0.05$). Further simple effect analysis revealed significant individual effects for groups in the post-test ($p < 0.05$). Similarly, for FCV-19, AEAL-Positive, AEAL-Negitive, PPLA-Q, AMES, MTQ-48, pulse oxygen saturation, heart rate, and serum cortisol, significant main effects of time and interaction effects with groups were observed ($p < 0.05$ or $p < 0.001$). In most cases, the main effect of the group was not significant ($p > 0.05$), while further simple effect analysis demonstrated significant individual effects for groups in the post-test ($p < 0.05$). The main conclusions drawn from the above research were as follows: (1) SAVE-6, FCV-19, AMES, MTQ-48, PPLA-Q and AEAL demonstrated good reliability and validity and were recommended for use among Chinese university students. (2) Relationships identified: 1) PL had a direct negative impact on NMSC. 2) PL positively predicted AME, MT and AE-P. 3) AE-P negatively affected NMSC. 4) AME, MT and AE-N, directly influenced NMSC. 5) AME, MT, AE-P and AE-N, mediated PL's impact on NMSC. These findings offer insights for targeted interventions to enhance students' overall well-being. (3) An 8-week music combine sports games intervention ‘s effect was better than other intervention’s effect. It might have a positive effect on NMSC, AME, MT, PL, AE-P and AE-N. Therefore, we recommended using this intervention approach in adolescents setting.

CHAPTER 1

INTRODUCTION

1.1 Background

Since the emergence of COVID-19 in December 2019, the virus has exhibited an exceptionally high transmission rate, leading to profound global repercussions. As of September 2022, the World Health Organization's (WHO) COVID-19 Dashboard reported that the cumulative number of confirmed cases worldwide had exceeded 600 million. The virus's persistent mutations have led to a continuous surge in confirmed and suspected cases, necessitating long-term adjustments to living with the virus. Consequently, this situation has induced significant psychological anxiety and stress, deeply affecting people's daily lives globally (Peteet, 2020).

Despite an overall decrease in the severity of COVID-19 and the implementation of improved prevention and control measures globally, the virus remains uneradicated and continues to pose a substantial threat to humanity (WHO, 2023). According to the latest official policy brief from the World Health Organization, the pandemic appears to be transitioning after more than three years. However, it's vital to acknowledge that COVID-19 remains an urgent global emergency due to the potential for new variants to emerge and trigger future surges (WHO, 2023). Vigilance and ongoing efforts are essential to effectively address the persistent challenges posed by the pandemic and safeguard public health worldwide.

As of June 7, 2023, based on the latest data from the WHO's (2023) COVID-19 Dashboard, the global death toll from COVID-19 has reached 6,941,095, with a total of 767,750,853 confirmed cases reported worldwide. Throughout the pandemic's course, the WHO's Coronavirus (COVID-19) Dashboard has documented

unpredictable fluctuations in the number of confirmed cases on a weekly basis since its initial outbreak. Remarkably, the most recent significant surge occurred in December 2022, resulting in a staggering increase of 97,976,070 cases within just four weeks (WHO, 2023). These statistics underscore the ongoing volatility of the pandemic and the importance of sustained vigilance and preparedness in addressing the virus's global impact.

The findings unequivocally underscore the persistent threat of COVID-19 to human health. In anticipation of potential future outbreaks, it is imperative to gain a comprehensive understanding of the diverse psychological impacts of COVID-19 on individuals and formulate effective response strategies. Numerous studies have delved into the psychological repercussions of the viral outbreak at personal, national, and global levels (Fawaz et al., 2023). At the personal level, individuals may grapple with the fear of falling ill or facing mortality, feelings of helplessness, and the weight of societal stigmatization (Salari et al., 2020). The pandemic has inflicted substantial consequences on mental health, affecting both healthcare professionals and the general populace (Chakraborty & Chatterjee, 2020; Chen et al., 2022; Khatatbeh et al., 2021).

Healthcare workers, in particular, have been thrust into an environment of heightened work-related stress due to the sudden surge in their workload (Tabur et al., 2022). The constant risk of infection has further exacerbated their mental well-being (Wu et al., 2020), and witnessing the suffering and death of patients has left profound imprints on their mental health (Mosheva et al., 2021). Moreover, the pandemic's ever-evolving circumstances have necessitated continuous adaptation, resulting in increased anxiety levels (Deliktas et al., 2021).

For the general population, COVID-19 has triggered health-related anxiety and panic, leading to the over-interpretation of common physiological responses as potential symptoms (Marra et al., 2020). The fear of infection has culminated in reduced human interaction, contributing to feelings of depression and anxiety (Haider et al., 2020; Wu et al., 2023). Financial and work-related stressors have also taken a toll on mental health (Halliburton et al., 2021). According to the World Health Organization (WHO, 2022), the COVID-19 pandemic has culminated in a 25% increase in the global prevalence of anxiety and depression.

For society as a whole, the pervading anxiety and stress stemming from the COVID-19 pandemic can give rise to panic and unhealthy behaviors. These, in turn, may have adverse effects on the progression of the disease, its ultimate outcome, and even lead to social unrest. This underscores the paramount significance of tending to the mental health of the population, not only for maintaining social stability but also for ensuring the overall well-being of the people.

In the realm of healthcare, professionals wield a wealth of medical knowledge and skills. However, owing to the unique nature of their profession, their conduct, words, and psychological well-being during an epidemic can directly influence the mental health of those in their proximity, particularly the general public's response to the crisis. Early in the epidemic, the focus of scholarly attention was often directed towards the epidemiology of the outbreak and the mental health of specific professional groups, such as healthcare workers. As the COVID-19 virus continues to evolve, the likelihood of effective drugs becoming available in the near future remains uncertain. Thus, the question of how humanity will adapt to the long-term coexistence

with this infectious disease, along with the associated public psychological challenges, looms large and necessitates thorough exploration.

While our understanding of COVID-19 has grown, and knowledge and concepts have improved, the impact of the psychological state of healthcare workers on the general population has gradually become less pronounced. Consequently, more research has begun to focus on the mental health of the general adult population. However, insufficient attention has been directed towards the mental health of adolescents, especially those in secondary school. These adolescents, aged 14 to 17 years old, typically possess fewer years of formal education and less general health knowledge, rendering them among the segments of the population with relatively lower “health literacy”. If their psychological well-being is neglected, the persistent feelings of insecurity and psychological suboptimal health are likely to exert a detrimental influence on their future development.

1.2 Problem statement & Study rationale

Since the advent of the pandemic, there has been a palpable shift in the global mental states, marked by a significant increase in negative mental states such as stress, anxiety, fear, anger, and depression. Happiness, on the other hand, has witnessed a considerable decline. Simultaneously, there has been a remarkable surge in people's feelings of powerlessness, accompanied by a notable loss of self-confidence. Hence, there exists an urgent imperative for research on profoundly relevant subjects, such as the mental well-being of individuals and their coping strategies amidst sudden public health crises.

Upon conducting a comprehensive review and comparison of the psychometric questionnaires currently in circulation, it becomes evident that most of the available

mental health scales are suited for assessing individuals' mental states in general circumstances. Only a few, however, are designed for the specific evaluation of mental health within particular occupational contexts influenced by epidemics. Among these, the Stress and Anxiety to Viral Epidemics-6 items (SAVE-6) questionnaire stands as a notable exception. It has been employed to gauge psychological anxiety in the general population during the COVID-19 pandemic and has exhibited robust reliability and validity in international studies. Regrettably, no analogous studies have been conducted in China. In this research endeavor, we place a primary focus on measuring and analyzing the prevailing mental health conditions of secondary school adolescents during the COVID-19 pandemic. This study is intended to serve as a vital reference point for future investigations into the mental health of secondary school adolescents in the context of public health emergencies.

Existing research has underscored the potential of sports games in alleviating negative emotion, mitigating psychological tension, and reducing anxiety among adolescents. sports are regarded as having therapeutic effects (Zhang & Zhang, 2013). Likewise, music therapy has demonstrated effectiveness in alleviating and diminishing anxiety and stress (Standley, 1995). However, there remains a dearth of research on the combined use of music and physical activity games to reduce stress and anxiety. Consequently, it remains uncertain whether the simultaneous utilisation of music and physical activity games yields more pronounced benefits in mitigating stress and anxiety compared to single-mode interventions. This research project is dedicated to investigating the effects and underlying mechanisms of merging music and sports games in the treatment of stress and anxiety among secondary school-aged adolescents, typically aged between 14 and 17 years old. Its findings aim to provide valuable

insights for future research endeavors focused on stress and anxiety interventions for this demographic.

1.3 Research questions, research hypothesis, objective

Research questions, research hypotheses, objectives were divided into Phase 1 and Phase 2 based on the sequences of the study.

1.3.1 Research questions

Phase 1:

1. Are the Stress and Anxiety to Viral Epidemics-6 items (SAVE-6), Fear of COVID-19 Scale (FCV-19), Athletic Mental Energy Scale (AMES), Mental Toughness Questionnaire-48 (MTQ-48), Portuguese Physical Literacy Assessment Questionnaire (PPLA-Q), Achievement Emotion Adjective List (AEAL)， suitable for translation into Chinese?
2. Are the Chinese translated Negative Mental States caused by COVID-19 (NMSC), which is combination of SAVE-6 and FCV-19; AMES; MTQ-48, PPLA-Q, AEAL questionnaires valid and reliable by using confirmatory factor analysis (CFA)?
3. Are the Chinese versions of NMSC, AMES, MTQ-48, PPLA-Q and AEAL valid based on convergent validity?
4. Are the Chinese versions of NMSC, AMES, MTQ-48, PPLA-Q and AEAL stable across two time points based on test-retest reliability?
5. What are the levels of negative mental states caused by COVID-19, athletic mental energy (AME), mental toughness (MT), physical literacy (PL) and achievement emotion (AE) among secondary school-aged adolescents in GanSu province China?

6. Is there any mean differences between gender, age groups, grade, and schools in negative mental states caused by COVID-19, AME, MT, PL and AE among secondary school-aged adolescents in GanSu province China?
7. Are there any relationships between negative mental states caused by COVID-19, AME, MT, PL and AE among secondary school-aged adolescents in GanSu province China?
8. Is there a significant correlation among NMSC, AME, MT, PL, and AE among adolescents in GanSu Province?

Phase 2:

9. How to develop a set of music combined with sports games for middle school adolescents.
10. Are there any effects of music combined with sports games intervention in reducing negative mental states caused by COVID-19, AME, MT, PL and AE among secondary school-aged adolescents in GanSu province China?

1.3.2 Research hypotheses

Phase 1:

1. The Chinese translated NMSC, AMES, MTQ-48, PPLA-Q, AEAL questionnaires are valid and reliable by using CFA.
2. The Chinese versions of NMSC, AMES, MTQ, PPLA-Q and AEAL are valid based on CFA.
3. The Chinese versions of NMSC, AMES, MTQ, PPLA-Q and AEAL are valid based on convergent validity.
4. The Chinese versions of NMSC, AMES, MTQ, PPLA-Q and AEAL are reliable based on test-retest, intraclass correlation analysis.

5. The levels of NMSC, AME, MT, PL and AE among secondary school-aged adolescents in GanSu province China can be determined.
6. There are significant mean differences between gender, age groups, grade, and schools in negative mental states caused by COVID-19, AME, MT, PL and AE among secondary school-aged adolescents among secondary school-aged adolescents in GanSu province China?
7. To determine the association between NMSC, AME, MT, PL, and AE among secondary school-aged adolescents in Gansu Province due to the COVID-19 by using linear regression analysis.
8. There is a significant relationship between negative mental states caused by COVID-19, AME, MT, PL and AE among secondary school-aged adolescents among secondary school-aged adolescents in GanSu province China.

Phase 2:

9 & 10. There is a significant effect of music combined with sports games intervention in negative mental states caused by COVID-19, AME, MT, PL and AE among secondary school-aged adolescents among secondary school-aged adolescents in GanSu province China.

1.3.3 General objective

The aim of this study is to investigate the effects of music combined with sports games intervention for enhancing psychological well-being (NMSC, AMES, MTQ-48, PPLA-Q and AEAL) among secondary school-aged adolescents in GanSu province China during COVID-19 pandemic. The specific objectives are divided based on study's phase 1 and 2.

1.3.4 Specific objectives

Phase 1:

1. To translate the English version questionnaires of NMSC, AMES, MTQ-48, PPLA-Q and AEAL into Chinese version.
2. To validate the Chinese version questionnaires of NMSC, AMES, MTQ-48, PPLA-Q and AEAL by using CFA.
3. To examine the convergent validity of the Chinese version questionnaires (NMSC, AMES, MTQ-48, PPLA-Q, and AEAL) by comparing them with the Generalized Anxiety Disorder 7-Item (GAD-7) and other physiological measures - serum cortisol (SCC), heart rate (HR), and pulse oxygen saturation (SpO_2).
4. To examine the test-retest reliability of the Chinese version questionnaires of NMSC, AMES, MTQ-48, PPLA-Q and AEAL.
5. To determine the levels of NMSC, AME, MT, PL and AE among secondary school-aged adolescents in GanSu province China.
6. To determine the mean differences in NMSC, AME, MT, PL, and AE levels among secondary school-aged adolescents in GanSu Province during COVID-19 with respect to gender, age groups, grades, and schools.
7. To determine the association between NMSC, AME, MT, PL, and AE among secondary school-aged adolescents in GanSu Province due to the COVID-19 by using linear regression analysis.
8. To examine the inter-relationships between NMSC, AME, MT, PL, and AE among secondary school-aged adolescents in GanSu province China by using structural equation modelling.

Phase 2:

9. To develop a music combine sports games program for the secondary school-aged adolescents.
10. To examine the time effects (within groups), group effects (between groups) and interaction effects (within-beween groups) of music combined with sports games on NMSC, AME, MT, PL, and AE among secondary school-aged adolescents in GanSu province China.

1.4 Operational definition

1.4.1 Confirmatory factor analysis (CFA)

CFA is a type of structural equation modelling that manages specially the measurement models, which is, the relationships between observed variables or indicators (items, test scores, social perception appraisals) and latent variables or factors (Hoyle, 2012). It gives a more miserly comprehension of the covariation among a number of indicators on the grounds that the quantity of factors is not exactly the quantity of measured variables.

1.4.2 Structural Equation Modelling (SEM)

SEM is a combination of factor analysis and multiple regression analysis that used to analyse the structural relationship between measured variables and latent constructs (Kline, 2023). SEM is adopted to see the structural relationship between stress, anxiety, fear of COVID-19, athletic mental energy, mental toughness, physical literacy and achievement emotion.

1.4.3 Negative mental state caused by COVID-19 (NMSC)

Common negative mental states often include stress, anxiety, and fear (Lovibond & Lovibond, 1995). In this study, we have chosen to employ stress, anxiety,

and fear as representative indicators of NMSC in adolescents. However, presently, there is a dearth of existing survey questionnaires that encompass all three of these dimensions induced by COVID-19. Therefore, in this research, we intend to utilize two distinct scales, the SAVE-6 and the FCV-19, to collectively assess and measure data related to these three dimensions. This approach will enable us to effectively capture and evaluate the NMSC in adolescents.

In this study, the levels of stress and anxiety are assessed using the SAVE-6 questionnaire. The SAVE-6 is a unidimensional questionnaire developed by South Korean researchers Chung et al. (2021). This questionnaire is specifically designed to evaluate the stress and anxiety responses of the general population in the context of the COVID-19 pandemic. Furthermore, the extent of fear related to COVID-19 is quantified through the utilization of the FCV-19. The FCV-19, created by Ahorsu et al. (2022), is also a unidimensional questionnaire. It is tailored to measure the fear experienced by the general public in response to the COVID-19 pandemic. These two instruments serve as valuable tools in assessing the key dimensions of stress, anxiety, and fear within the context of the COVID-19 pandemic, enabling a comprehensive evaluation of NMSC in the study.

1.4.4 Athletic mental energy

In this study, the level of variable athletic mental energy is measured by the AMES. AMES is a six factors questionnaire developed by Lu et al. (2018) which is specially used to measure athletic mental energy. The six factors included in the questionnaire were Vigor (VIG), Confidence (COF), Motivation (MOT), Concentration (CON), Tireless (TIR) and Calm (CAL).

1.4.5 Mental toughness

In this study, the level of variable mental toughness is measured by the MTQ-48. MTQ-48 is a six factors questionnaire developed by Clough et al. (2002) which is specially used to measure MT. The six factors included in the questionnaire were Challenge, Commitment, Control emotion, Control life, Confidence Abilities and Confidence Interpersonal.

1.4.6 Physical literacy

In this study, the level of variable PL is measured by the PPLA-Q. PPLA-Q is a four factors questionnaire developed by Mota et al. (2021) which can used to measure PL. The four factors included in the questionnaire were Motivation, Confidence, emotional Regulation and Physical Regulation.

1.4.7 Achievement emotion

In this study, the level of variable achievement emotion is measured by the AEAL. AEAL is a ten factors questionnaire developed by Raccanello et al. (2022) which can used to measure achievement emotion. The ten factors included in the questionnaire can fall into two categories AE-P and AE-N.

CHAPTER 2

LITERATURE REVIEW

2.1 The definition of stress and anxiety

Stress, as described in contemporary scientific literature, can be summarised in three ways depending on the definition and perspective (Rice, 1999). Firstly, stress refers to external events or environmental stimuli that are considered stressful (Gatersleben & Griffin, 2017). Secondly, stress is a subjective psychological state characterised by internal tension (Hoge et al., 2013). It represents an internal psychological response within an individual, serving as an explanatory, emotional, and defensive coping mechanism, ultimately leading to the experience of psychological tension. Lastly, stress can be viewed as a physiological response of the body to the intrusion of a need or threat (Brosschot et al., 2006). It involves an increase in the body's natural arousal levels to support heightened activity. These physiological responses are instrumental in facilitating behavioural and psychological coping efforts. However, it's worth noting that prolonged exposure to high levels of stress can have adverse effects, potentially leading to mental illness, physical health problems, and unhealthy social behaviours (Boullier & Blair, 2018). In summary, stress is both a physiological and psychological state that arises within the body due to external environmental stimuli. While it can be beneficial to a certain extent, contributing to personal growth and professional development, prolonged high levels of stress can lead to negative outcomes, including mental health issues, physical ailments, and unhealthy social behaviour.

Anxiety is an unpleasant emotional response to both external environmental factors and internal thoughts and feelings (Krug et al., 2002). In its most severe forms, anxiety can manifest as sudden episodes of intense apprehension, fear, or even a sense

of impending doom (Rice, 1999). In normal circumstances, anxiety represents a realistic and adaptive reaction to situations or events that an individual perceives as beyond their control. The intensity of anxiety typically corresponds to the level of the perceived threat – the greater the threat, the higher the anxiety levels. Importantly, when the real or potential threat diminishes or is resolved, the individual's anxiety levels tend to decrease or disappear.

In conclusion, anxiety represents an undesirable psychological state in the human body. It's important to note that there exists no rigid boundary between the definitions of stress and anxiety. Both can be understood as subjective psychological responses to environmental stressors. Alternatively, anxiety can be categorized as a negative psychological state that emerges from prolonged exposure to external environmental factors or events, during which an individual experiences a heightened state of stress over which they have little or no control.

2.2 Studies on stress and anxiety during epidemic

The COVID-19 pandemic has persisted for four years, leading to widespread outbreaks across the globe. In response, countries have implemented various policies to combat the virus, including workplace closures, production disruptions, school shutdowns, travel restrictions, and protective measures (Khalifa et al., 2020). These measures, though necessary, have significantly disrupted people's lives. As the pandemic continues unabated, individuals are compelled to coexist with the virus for an extended period, creating a prolonged and often precarious environment that gives rise to substantial psychological anxiety and stress, ultimately leading to feelings of anxiety and fear (Joshi, 2021). Currently, the severity of COVID-19 seems to have diminished, and the pandemic appears to be entering a transitional phase after more

than three years. However, it is essential to recognize that COVID-19 remains a pressing global emergency due to the ongoing possibility of new variants emerging and triggering future surges (WHO, 2023). Given the continuous evolution of the COVID-19 virus, the likelihood of obtaining effective drugs in the near future remains uncertain. Consequently, humanity must prepare for the long-term coexistence with the virus, with the ever-present possibility of new outbreaks, which continues to evoke anxiety and fear among the populace (Wang et al., 2022).

Investigations into the mental well-being of different population groups during COVID-19 can be categorized into three main areas. These encompass studies focused on the mental health of healthcare workers, examinations of college students' mental states, and analyses of the psychological conditions of the general adult population.

2.2.1 The impact of COVID-19 on the mental state of medical workers

A large number of studies have shown that the outbreak of COVID-19 has had a great negative impact on the mental state of medical workers. One study showed that fear of COVID-19 among frontline nurses in the Philippines led to lower job satisfaction and increased intention to leave (Labrague & Santos, 2021). Similarly, a study of 441 health care workers in Saudi Arabia found that the prevalence of anxiety among health care workers increased to 33.3 per cent, with mild anxiety accounting for 27 per cent of the total; Moderate depression 13.2%; Severe anxiety accounted for 7.9% (Alzaid et al., 2020). In a survey among 365 health care workers in Jordan in August 2020, the researchers found increased fear of the COVID-19 pandemic among the health care workers surveyed. The participants presented with extremely severe depression (40%), extremely severe anxiety (60%), and severely distressed (35%) (Alnazly et al., 2021). Similarly, a study of 1,106 Israeli doctors found a significant increase in anxiety levels (Mosheva et al., 2020) during the Covid-19 pandemic. In a

survey of 1,416 frontline health care workers in 75 countries, two-thirds of them showed varying degrees of anxiety (Cag et al., 2021).

Numerous studies have documented an increased psychological stress among health care workers during the COVID-19 pandemic, with symptoms of anxiety and depression (Magnavita et al., 2020). This is likely related to the nature of their profession. By the nature of their work, health care workers have to come into direct contact with COVID-19 patients, which greatly increases their risk of contracting, and the increase number of patients may lead to increased workloads and longer working hours for health care workers. Lack of access to adequate rest may also be a contributing factor to their psychological stress.

2.2.2 The impact of COVID-19 on the mental state of general adults

A multitude of studies examining the mental well-being of ordinary adults during the COVID-19 pandemic have consistently demonstrated its detrimental effects on their mental health. For instance, Rosen et al. (2020) conducted a survey of U.S. residents during the initial community quarantines and found a substantial increase in negative mental states, often accompanied by poor sleep quality. In the UK, where COVID-19 had a significant impact, Dawson and Golijani-Moghaddam (2020) conducted a survey among adults, revealing that nearly 41% of participants met criteria for anxiety and/or depression, with over a fifth meeting criteria for both. Furthermore, one-third of the population reported elevated anxiety levels. In Turkey, Mustafa, (2020) surveyed 1,130 respondents during the COVID-19 pandemic and discovered that more than half of the participants exhibited moderate to severe psychological issues (52.7%). Additionally, nearly one in five participants displayed moderate to severe depressive symptoms (18.6%), while approximately a third showed moderate to severe anxiety

symptoms (26.5%). Cénat et al. (2021) conducted a comprehensive analysis of 55 COVID-19-related surveys, revealing an increased incidence of symptoms such as depression, anxiety, insomnia, post-traumatic stress disorder, and psychological distress during the pandemic, compared to other periods.

In summary, various studies conducted by scholars from different countries have consistently shown that the existence of COVID-19 has led to an upsurge in adverse psychological states among individuals across different nations and professions. This collective evidence underscores the pandemic's role in heightening psychological stress and anxiety on a global scale.

2.2.3 The impact of COVID-19 on the psychological status of students

The psychological well-being of college students has been a focal point of research during the COVID-19 pandemic. College students constitute a distinct demographic. They possess higher levels of education, but due to their youth, limited life experiences, and the added pressures of both academics and employment, their mental states are more susceptible to external influences compared to the general adult population (Son et al., 2020). Numerous studies have provided compelling evidence of the detrimental impact of the COVID-19 spread on the psychological health of college students.

2.2.3(a) Research on psychological state of medical college students

Studies have shown that in the early days of the COVID-19 outbreak, when the United States suspended clinical rotations for all students while moving offline classes to an online model, medical students also reported higher levels of anxiety, stress and exhaustion than ordinary students, with female students in a worse psychological state (Mittal et al., 2021). In one medical school in Saudi Arabia, 234 medical students were

emotionally isolated from others due to the pandemic, and their work performance and study hours decreased; The results also showed that a quarter of these felt depressed during their isolation (Meo et al., 2020). In a similar study, 217 undergraduate medical students at a medical school in Chennai, India, experienced a significant increase in the prevalence and severity of anxiety and stress during COVID-19 (Saraswathi et al., 2020). In a study in Indonesia, researchers investigated and analyzed the mental state of 1027 medical students during COVID-19, and found that nearly half of them felt stressed or anxious (44.6%, 47.8%), and 18.6% felt depressed (Natalia & Syakurah, 2021).

2.2.3(b) Research on psychological state of general students

During the COVID-19 epidemic, the mental well-being of students, both medical and non-medical, has been a focal point of research. Studies conducted among various student populations worldwide have consistently shown that the prevalence of depression, anxiety, and stress reached significantly higher levels during the pandemic compared to pre-pandemic times. For instance, research involving Bangladeshi university students aged 18 to 29 revealed a marked increase in depression, anxiety, and stress levels (Islam et al., 2020). Similarly, cross-sectional surveys in Jordan found elevated anxiety levels, particularly among college students, with a heightened risk of depression (Naser et al., 2020). A study conducted in France among 69,054 secondary school students reported a significant rise in symptoms like suicidal thoughts, severe distress, high perceived stress, severe depression, and high anxiety levels during COVID-19 (Wathelet et al., 2020). Additionally, a study involving 1,224 students in Brazil indicated a substantial prevalence of depression (60.5%), anxiety (52.5%), and stress (57.5%) symptoms during the pandemic (Lopes & Nihei, 2021). Likewise, research conducted in Russia emphasized the increased psychological stress among

college students during the COVID-19 pandemic. It highlighted that isolation measures could exacerbate mood disorders, leading to symptoms such as depression, irritability, and insomnia, while also negatively impacting overall health and mental well-being (Gritsenko et al., 2021).

In summary, scholars from diverse backgrounds have extensively explored the mental health of students during the COVID-19 pandemic. The collective findings underscore the pandemic's toll on students' mental health, with clear evidence of heightened psychological stress and anxiety levels among students worldwide.

2.3 Solutions and impacts of students' stress and anxiety during COVID-19

The study focus on the solutions and impacts of students' anxiety during COVID-19. Due toonly few studies on secondary school students, the inclusion criteria were relaxed to include college students. As mentioned above, the student group is a relatively special group. As a small group of the public, it has its vulnerability. In the face of Stress and Anxiety, they show emotional instability. Studies have shown that the psychological characteristics of students are different from ordinary adults or even ordinary young people. Usually, students are high-risk groups prone to psychological problems. Under the influence of external environment, they are more likely to have a series of psychological problems such as stress, anxiety and depression (Bruffaerts et al., 2018).

For students' anxiety and stress caused by the COVID-19 pandemic, some researchers are trying to use different methods to relieve it. Through the summary and collation of relevant literature, this study found that the main methods to reduce the stress and anxiety caused by COVID-19 include: using students' religious beliefs, conducting relevant psychological counselling, letting students learn more knowledge

related to COVID-19 through media, mindfulness online courses, increasing sleep quality and physical exercise; Among the most effective interventions: watching brief behavioural therapy (DBT) skills videos, regular web-based physical education, enhancing students' knowledge of COVID-19 through social media, and physical activity of about 2,500 METs per week. (Deng et al., 2020; Kheirallah et al., 2021; Rizvi et al., 2022; Zhang et al., 2020). The improved interventions in some studies were not significant, but they played a role as effective mediators. These include: middle-distance running, increasing distance learning satisfaction, increasing mental resilience, enhancing social support, improving sleep quality, reducing smartphone misuse, and increasing academic satisfaction (Franzen et al., 2021; Gabrovec et al., 2022; Li et al., 2022; Lin et al., 2021; Liu et al., 2021; Song et al., 2022). There are two intervention methods with good intervention effect, and the intervention effect is better than traditional psychotherapy: behavioural therapy intervention and online mindfulness program intervention. (Liang et al., 2021; Simonsson et al., 2021). Other studies have shown that positive coping strategies are more effective at relieving stress and anxiety in the face of COVID-19 than negative avoidant coping strategies. (Banstola et al., 2021; Chan et al., 2022).

2.3.1 Highly effective interventions in existing researches

In existing researches, four studies indicated that the interventions they used had a significant impact on student stress and anxiety during COVID-19 (Deng et al., 2020; Kheirallah et al., 2021; Rizvi et al., 2022; Zhang et al., 2020). One of the studies, involving 153 undergraduate students at a public university in the United States, completed three stages of pre-assessment, intervention, and post-assessment over six weeks during COVID-19. Participants were asked to receive animated videos of DBT skills for 14 consecutive days during the intervention. All participants underwent

ecological instant assessments of mood, emotion management self-efficacy, and emotional tolerance four times a day. By comparison, the researchers found that participants' negative emotion significantly decreased and positive emotion significantly increased after watching the videos. There is a significant interaction between time and condition in emotional tolerance. At the end of the intervention, compared to the state before the intervention, participants in the control group felt their mood had gotten worse, but participants in the intervention group did not perceive their mood as having gotten worse (Rizvi et al., 2022). The research proves that DBT technology can effectively improve the mental health state of college students.

Another Chinese study that showed better intervention results included 1,607 college students in Wuhan, China, whose mental health and sports-related lifestyle were studied. The study assessed their mental health using the Depression, Anxiety and Stress Scale (DASS-21). The results showed that lower DASS-21 scores were significantly associated with regular exercise, maintaining exercise habits during the COVID-19 pandemic, exercising more than 1-2 times per week, exercising for $\geqslant$ 1 hour, and taking $\geqslant$ 2000 steps (Deng et al., 2020). It proved that the quality of mental state was significantly correlated with regular weekly exercise and sufficient weekly exercise time. A similar study came to a similar conclusion. In this paper, 66 Chinese college students were surveyed during the peak of COVID-19 in China. The results showed that COVID-19 had a direct negative impact on overall sleep quality. In contrast, COVID-19 mediated general negative emotion, stress, anxiety, and sleep quality. In addition, intervention through physical activity can directly alleviate general negative emotion, and the effect is greatest when physical activity is about 2,500 METs per week (Zhang et al., 2020).

Also reporting a significant effect of the intervention was a survey of all medical students in Jordan, which showed that participants self-reported increased levels of negative emotion (such as anxiety) and decreased levels of positive emotion during COVID-19. Nearly half of the participants used social media as their primary source of COVID-19 information and experienced a significant reduction in emotional distress after prolonged use of social media for COVID-19 information (Kheirallah et al., 2021). It is proved that more COVID-19 related information and better understanding of COVID-19 through social media channels can play a potentially positive role in alleviating negative emotion.

2.3.2 Additional effective interventions

Of all the relevant studies reviewed, three identified improved sleep quality as an intervention to indirectly improve students' stress and anxiety during COVID-19 (Liu et al., 2021; Song et al., 2022; Zhang et al., 2020). To demonstrate the mediating role of insomnia in the relationship between perceived stress and depression among medical students during the COVID-19 pandemic, researchers used the Perceived Stress Scale (PSS), Insomnia Severity Index (ISI), and Patient Health Questionnaire 9 (PHQ-9) to measure perceived stress, insomnia, and depression levels. The results showed that perceived stress was significantly correlated with depression; Insomnia mediates between perceived stress and depression; Moreover, insomnia has a significant indirect effect on perceived stress (Liu et al., 2021). Therefore, we can assume that the depression of medical students can be effectively reduced by improving the quality of sleep. Similarly, in a survey of 666 medical students, researchers found that anxiety among students during the COVID-19 pandemic was significantly associated with excessive smartphone use and sleep disturbances. Excessive smartphone use not only directly affects anxiety, but also has a significant

indirect effect on anxiety by causing sleep disturbances. Using sleep disorders as a mediator, the researchers observed that prolonged smartphone use resulted in a significant reduction in the path coefficient of anxiety. Demonstrates the importance of sleep health in reducing anxiety (Song et al., 2022).

Some other studies believe that our fear and anxiety about COVID-19 are rooted in the unknown, HP Lovecraft, in “Supernatural Horror in Literature” (1927), H.P. Lovecraft wrote: "The oldest and strongest emotion of mankind is fear, and the oldest and strongest kind of fear is fear of the unknown"(Joshi & Schultz, 2001). Therefore, in order to eliminate this negative impact, we should actively face COVID-19, increase the understanding of COVID-19 in various ways, and help relieve students' pressure and anxiety through deeper understanding (Banstola et al., 2021; Chan et al., 2022). A study evaluated the mental health status of 202 medical students and found that different stress coping strategies would affect mental health status: Medical students who adopted the approach strategy had better mental health status than those who adopted the avoidance strategy, indicating that the approach strategy was more effective than the avoidance strategy in stress management (Chan et al., 2022). Similarly, Banstola et al. (2021) suggest that more proactive adaptive coping strategies could better reduce pandemic-related mental health problems.

To sum up, the intervention effect of receiving animated videos of DBT skills is very significant. Likewise, the PA of 2,500 METs per week is also considered an effective intervention. In addition to improving students' sleep quality is also a way to improve their mental state an effective way.

2.4 Studies of exercise intervention on mental illness

Exercise is a physical activity that promotes health, a set of rules involving physical strength and skill, a behavioural activity governed by habit, and often competitive in nature. Numerous studies have demonstrated that long-term participation in sport can improve participants' physical fitness, such as skeletal and muscular, cardiovascular, respiratory and neurological functions, in varying degrees of targeted enhancement (Kargarfard et al., 2013; Saraví & Sayegh, 2013; Shenoy et al., 2013; Stolzenberg et al., 2013).

In recent years, more and more research has focused on the effects of physical activity on interventions for mental illness. Studies have shown that multiple forms of exercise or physical activity based on skeletal muscle contractile activity have a positive preventive effect on many neurological disorders, including depression, more so than psychological interventions or medication alone (Blumenthal et al., 2012). Some studies suggest that exercise-induced peripheral metabolic adaptations and endocrine signaling in muscle and adipose tissue have a positive effect on the brain, and that exercise integration biology suggests that in response to exercise challenges, the body establishes a new dynamic equilibrium to increase muscle energy and oxygen supply, and that this disturbance and remodeling of systemic homeostasis not only benefits skeletal muscle itself, but also has positive effects on the brain and neurocentral system; depression The book quality of life assessment: International Perspectives also states that exercise interventions not only help to It also helps to alleviate psychological problems such as fatigue, stress, anxiety and depression, thus effectively improving the treatment outcome of patients, promoting physical and psychological recovery and reducing the mortality rate of various diseases (Orley & Kuyken, 1994). In a review article on the effectiveness of treatment for 26 common