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A Study of the Relationship between Physical Activity and Anxiety and Depression in High Academic Pressure College Students

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Abstract: Objective: To investigate the relationship between physical activity and anxiety and depression among college students with high academic pressure. **Methods:** A stratified sampling method was used to obtain 1051 college students. The International Physical Activity Scale (IPAQ-SF), Generalized Anxiety Scale (GAD-7), and Symptom Self-assessment Scale (SCL-90) were used to measure their physical activity, anxiety, and depression respectively. The obtained data were also processed using SPSS 21.0 statistical analysis software. **Results:** (1) Physical activity was generally insufficient among college students with high academic pressure. The difference in physical activity by gender was significant ($p< 0.05$), with male

students having higher physical activity values than female students. (2) Anxiety was present in 73.7% of high academic pressure college students. The difference in the distribution of anxiety in terms of gender, whether they were only children and single-parent families was statistically significant ($p< 0.05$). (3) Depressive mood was present in 91% of high academic pressure college students. The difference in the distribution of depressive mood by gender was statistically significant ($p< 0.01$). (4) The difference in depressive mood among college students with high academic pressure was highly significant at different levels of physical activity ($p< 0.01$). There was a negative correlation between physical activity and depression (r=-0.062, $p< 0.05$), a significant positive correlation between anxiety and depression (r=0.608, $p< 0.01$), and a significant positive correlation between academic pressure and anxiety and depression (r=0.344, r=0.325, $p< 0.01$).

Conclusions: High academic pressure college students are physically inactive. Anxiety and depression were prevalent among high academic pressure college students. Although physical activity does not appear to reduce anxiety or academic pressure, it exhibits a significant effect in alleviating depressive symptoms, particularly with higher intensity levels.

Keywords: college students; physical activity; academic pressure; anxiety; depression

Introduction:

The university period represents a crucial juncture for the holistic development of college students, encompassing both physical and mental well-being. However, in recent times, various factors, including the impact of the COVID-19 pandemic, academic pressures, and the employment landscape, have exponentially intensified the pressure burdens borne by the college student populace, leading to various mental health concerns. Especially, academic pressure has become the primary source of psychological stress among college students (Gedam et al., 2020). College students face the double pressure of epidemic and academic pressure, many health problems cannot be ignored, such as insomnia, loss of appetite, and so on (Yang et al., 2023), but are also prone to anxiety, and depression, affecting their physical and mental health development (Caroppo et al., 2021).

Anxiety and depression are common mental health problems in the college student population, with high prevalence rates in recent years and an increasing trend year after year. Some studies have shown that the detection rate of mental health problems among college students has been on the rise after the epidemic (Meda et al., 2021). As many as 86.2% of the students showed varying degrees of anxiety and depression symptoms (Triastuti & Herawati, 2022). Anxiety is an unpleasant and complex emotional state of tension, uneasiness, worry, and annoyance that an individual experiences in response to an impending situation that may pose a danger or threat. Anxiety arises from people's vigilant attitude towards uncertain dangers and is accompanied by psychological states and emotional characteristics such as helplessness, uneasiness, nervousness, and apprehension (Freud, 2013). The World Health Organization (WHO) defines depressed mood as a psychological state characterized by low mood, usually accompanied by symptoms such as loss of interest, fatigue, sleep disturbances, and appetite

changes. This mood state may cause distress to an individual's daily life and work, and if not intervened promptly, it may develop into a depressive disorder in severe cases. College students suffering from anxiety, depression, and other mood symptoms usually have poor academic performance, poor interpersonal relationships, drug addiction, sleep disorders, and even suicide, and many other problems that seriously jeopardize their growth and development, which profoundly affect the academic progress and personal growth of college students (World Health, 2001b). Currently, most studies focus on adolescents and college students, and some studies focus on medical students graduate students, and other groups with higher academic pressure. Some studies have shown that the higher the sense of stress among college students, the more anxiety and depression are likely to be (Ramón-Arbués et al., 2020)The mental health of college students has always been an issue of great importance in the fields of medicine, psychology, and education around the world, and it is even more important to focus on and solve the problem for the group of college students with high academic pressure.

Physical activity (PA), also known as physical activity, refers to any physical activity caused by skeletal muscle contraction resulting in energy expenditure (Caspersen et al., 1985), which mainly includes four aspects work-based, domestic, transportation, and leisure physical activity (World Health, 2001a). In past research, scholars often take physical activity and physical activity as concepts. Still, in recent years, most of the studies have taken physical activity as a subordinate concept of physical activity. From the analysis of the idea of physical activity, it can also be found that physical activity includes almost all physical activity, sports exercise, and so on. There is a quantitative relationship between physical activity and health, and physical inactivity is one of the important independent risk factors for health (Booth et al., 2012). Physical activity or participation in physical activity has a positive impact on most studies, and physical activity can be used as a preventive and therapeutic tool for anxiety and depression (Fox, 1999). There is an association between physical activity and anxiety and depression (Elliot et al., 2012), which may be related to the reduction of anxiety and depression symptoms [14]. Combined with appropriate physical activity, it can play a role in preventing and intervening in psychological problems. However, some studies did not find a statistically significant effect of physical activity on mental health (Beard et al., 2007). In a study on an adolescent population, it was suggested that physical activity may not be a protective factor for adolescent mental health, which may be related to specific populations (Tao et al., 2007). For different groups, physical activity may have different effects on anxiety and depression. Therefore, it remains to be explored whether physical activity as an important intervention can prevent and reduce anxiety and depression for a group of college students with high academic pressure. In this study, a group of college students with high academic pressure was screened in a college in middle and high school, and the relationship between physical activity and anxiety and depression was explored by analyzing the current situation of physical activity, anxiety, and depression in college students with high academic pressure, to provide theoretical references for college students with high academic pressure to alleviate academic pressure and to improve and promote the development of physical and mental health.

In summary, we propose the following hypotheses: (1) high-academic-stress college

students are physically inactive; (2) high-academic-stress college students have serious mental health problems. Anxiety and depression are prevalent; (3) there is a negative correlation between the level of physical activity and depression among high academic pressure college students, and there is lower depression among college students with high levels of physical activity; and (4) there is a positive correlation between anxiety and depression and academic pressure among high academic pressure college students.

1 Objects and Methods

1.1 Objects

A stratified sampling method was used to administer an electronic questionnaire to students enrolled in a university in China. The subjects participated voluntarily. A total of 7039 questionnaires were collected, and 6427 questionnaires remained after excluding the responses that did not meet the statistical requirements. The effective recovery rate was 91.3%. 1051 (16.35%) college students with high academic pressure were screened. Among them, 571 (54.3%) were male and 480 (45.7%) were female; 441 (42%) were freshmen, 361 (34.3%) were sophomores, 170 (16.2%) were juniors, and 79 (7.5%) were seniors.

1.2 Measuring instruments

1.2.1 Basic information

The students' basic information mainly includes gender, grade, place of birth, whether they are single-parent families, whether they are only children, and whether they have had the experience of being left-behind children.

1.2.2 Academic pressure

The academic pressure subscale of the Chinese College Student Stress Scale was used for measurement. The scale has 30 entries and was compiled by Li Hong. The scale contains three parts: personal annoyance, study annoyance, and negative life events, with 16, 10, and 4 entries, respectively. In this study, the academic pressure subscale of the Chinese College Student Stress Scale was used to measure college students' academic pressure(Li, 2002). The scale consists of 10 questions and is scored on a 4-point scale of 0-3, with the options of "no stress", "mild stress", "moderate stress" and "severe stress". "Severe Stress". The total score on the scale ranges from 0-30, with higher scores indicating higher academic pressure(Li, 2002). In this study, a definitional criterion based on the mean academic pressure value (M) and standard deviation (SD) was used to classify students with academic pressure scores higher than one standard deviation (M+SD) above the mean academic pressure value as a high academic pressure population. The Cronbach's alpha coefficient for this scale was 0.950 in this measurement.

1.2.3 Physical Activity

Physical activity levels of college students with high academic pressure were measured using the International Physical Activity Scale Short Version (IPAQ-SF). The questionnaire has seven entries, six of which ask about an individual's physical activity. In the IPAQ short-form

survey respondents reviewed the amount of time spent walking, time spent in moderate-intensity physical activity, time spent in vigorous-intensity physical activity, and time spent sitting still during the week. For different types of activities, there are specific metabolic equivalent (MET) values to quantify(Noemi Ávila, 2023). Among them, the MET value for walking activity is 3.3, for moderate-intensity activity it is 4.0, and for high-intensity activity, it is 8.0(Noemi Ávila, 2023). Based on the responses provided in the questionnaire filled out by the participants, the physical activity levels of the respondents were calculated by assigning values to the selected options.

According to the classification and guidelines established by the International Physical Activity Working Group for individual physical activity levels, the physical activity of college students under high academic pressure is categorized into three levels: high, medium, and low. In this study, the Cronbach's α coefficient for the scale used in this measurement was 0.677.

1.2.4 Anxiety

The Generalized Anxiety Scale (GAD-7) was used for measurement. The scale is used to assess the anxiety level of the general population, with a total of 7 items (Robert L Spitzer et al., 2006). The scale requires individuals to use 0-3 to assess the frequency of symptoms in the past two weeks. 0 represents "none at all", 1 represents "several days", 2 represents "more than a week", and 3 represents "almost every day". In the Spitzer version, the total score of 0-4 is classified as no anxiety, 5-9 as mild anxiety, 10-14 as moderate anxiety, and 15-21 as high anxiety (Robert L. Spitzer et al., 2006). In this study, the Cronbach's α coefficient for the scale used in this measurement was 0.931.

1.2.5 Depression

Depression was measured using the 90-item Symptom Checklist (SCL-90), also known as the Symptom Self-Rating Scale. The scale is composed of 90 items, covering a wide range of areas of psychiatric symptomatology, and uses 10 factors to reflect 10 aspects of psychological symptomatology (Wang, 1984). 1 represents "none", 2 represents "mild", 3 represents "moderate", 4 represents "relatively severe", and 5 represents "severe". In this study, we selected the depression dimension of the scale for assessment, which contains a total of 13 entries. The total points of the scale range from 0-65, and the raw score of depression is obtained by summing the scores of the 13 entries, and the level of the score directly reflects the severity of depression(Wang, 1984). To obtain a standardized depression score (denoted as i), the raw score was divided by 13, i.e., i = depression raw score/13. When i = 1, no depressive symptoms; when $1 < i \leq 2$, mild depression; when $2 < i \leq 3$, moderate depression; when $3 < i \leq 4$, severe depression; and when $4 < i \leq 5$, severe depression. The Cronbach's alpha coefficient for this scale was 0.924 in this measurement.

1.2.6 Statistical analysis

The questionnaires were screened and recovered, and the valid questionnaires were summarized using Excel and then imported into SPSS21.0. The data obtained were statistically

analyzed using SPSS. For the variables of physical activity, anxiety, and depressed mood, gender differences, differences in place of birth, and differences in family characteristics were analyzed using independent samples t-test; grade discrepancy was analyzed using one-way ANOVA; and then ANOVA was used to analyze the differences in anxiety and depressed mood among college students with high academic pressure at different levels of physical activity. Finally, Pearson correlation analysis was used to explore the correlation between physical activity level and anxiety, depression, and academic pressure.

2. Results

2.1 Common method test deviations

The sample was tested for common method bias using Harman's one-factor test. The results showed that the explanatory rate of the first factor was 32%, which is lower than the critical criterion of 40% (Podsakoff et al., 2003), indicating that the data of this study do not suffer from serious common method bias.

2.2 General demographic characteristics

6,427 valid questionnaires were collected and 1,051 (16.35%) college students with high academic pressure were screened. Among them, 571 (54.3%) were males and 480 (45.7%) were females; 441 (42%) were freshmen, 361 (34.3%) were sophomores, 170 (16.2%) were juniors, and 79 (7.5%) were seniors (Table 1).

2.3 Comparison of physical activity, anxiety, and depression among different groups of college students with high academic pressure

Based on the international classification standard for physical activity level levels, MET values were calculated for the collected data, and the screened college students with high academic pressure were categorized into low, medium, and high levels. Among them, 358 (34%) were included low-intensity physical activity group, 487 (46.2%) in the moderate-intensity physical activity group, and 207 (19.8%) in the high-intensity physical activity group. One may deduce that the greatest quantity of university students under significant academic strain participated in intermediate physical exertion during the preceding week, the smallest count of university students experiencing intense academic tension engaged in vigorous physical exertion, and the preponderance of them resided in intermediate and low levels of physical exertion. Among the study participants, 775 (73.7%) had anxious tendencies, 956 (91%) had depressive tendencies, and 740 (70.4%) had a combination of anxious and depressive tendencies. Therefore, hypotheses 1 and 2 were supported.

The outcomes of the t-test and ANOVA performed revealed that the difference in the distribution of physical activity values of college students with high academic pressure by gender was statistically significant ($p<0.01$), and the results of post-hoc test results showed that the difference in physical activity scores was of statistical significance ($p<0.05$) between freshman and junior years (Table 1).

Differences in the distribution of anxiety scores of college students with high academic

pressure by gender, whether they were only children and single-parent families were statistically significant ($p < 0.05$).

The disparity in the allocation of depression scores across genders was found to be statistically significant. ($p<0.01$).

Table 1 Describe the analysis.

Demographic variables		PA		Anxiety		Depression	
		Mean	*Sd*	*Mean*	*Sd*	*Mean*	*Sd*
Sex	Male (n=571)	1666.82	1872.52	6.91	4.89	2.4	0.85
	Female (n=480)	1310.23	1790.1	7.88	4.89	2.6	0.75
t		3.138**		-3.202***		-4.027***	
Year of Study	1 (n=441)	1637.68	2126.41	7.29	5.04	2.06	0.74
	2 (n=361)	1470.06	1689.07	7.32	4.82	2.08	0.72
	3 (n=170)	1277.00	1358.97	7.5	4.79	2.1	0.77
	4 (n=79)	1400.82	1679.87	7.53	4.96	2.03	0.75
F		1.760		0.114		0.194	
Place of origin	Rural (n=676)	1452.34	1956.92	7.17	4.75	2.48	0.82
	Urban (n=375)	1597.01	1616.02	7.68	5.19	2.52	0.81
t		-1.219		-1.625		-0.828	
Only child	Yes (n=229)	1399.01	1453.22	8	5.06	2.47	0.78
	No (n=822)	1533.2	1937.51	7.17	4.86	2.5	0.82
t		-0.974		2.276*		-0.579	
Experience of being a left-behind child	Yes (n=273)	1527.97	2312.33	7.33	5.05	2.56	0.8
	No (n=778)	1495.54	1648.74	7.36	4.87	2.47	0.82
t		0.25		-0.087		1.465	

Single parent family	Yes (n=94)	1725.07	2597.41	8.54	5.48	2.55	0.86
	No (n=957)	1482.24	1751.93	7.24	4.84	2.49	0.81
t		1.219		2.47*		0.73	

Note: *p≤0.05，**p≤0.01，***p≤0.001

2.4 Differential analysis of different physical activity levels of anxiety and depression in high academic pressure college students

The results of conducting one-way ANOVA showed that the difference in the distribution of anxiety across physical activity levels among college students with high academic pressure was not statistically significant (p>0.05). The results of the post-hoc test showed that there was a borderline significance (p=0.07) between the anxiety scores of the high physical activity level group and the low physical activity group, as shown by the fact that the anxiety in the high physical activity level group was significantly lower than that in the low physical activity level group. The difference in the distribution of depression across physical activity levels was statistically significant (p<0.01), as evidenced by the fact that depression scores were significantly lower in the high physical activity group than in the medium and low physical activity level groups. The difference in the distribution of academic pressure across physical activity levels was not statistically significant (p>0.05).

Table 2 Differences in anxiety, depression, and academic pressure across physical activity levels among high academic pressure college students

	PA level					
	Low (n=358)	Medium (n=487)	High (n=206)	*F*	*p*	*Post-hoc*
Anxiety	7.58 ± 4.74	7.43 ± 4.92	6.8 ± 5.18	1.728	0.178	High < Low
Depression	2.08 ± 0.72	2.14 ± 0.73	1.91 ± 0.77	6.624	0.001	High < Low High < Middle
Academic Pressure	21.62 ± 3.59	21.38 ± 3.29	21.55 ± 3.6	0.516	0.597	-

2.5 Correlation analysis of physical activity with anxiety, depression, and academic pressure

The results of conducting Pearson correlation analysis showed that there was a negative correlation between physical activity and depression (r=-0.062, $p<0.05$); a significant positive correlation between anxiety and depression (r=0.608, $p<0.01$); and a significant positive correlation between academic pressure and anxiety and depression (r=0.344, r=0.325, $p<0.01$). Therefore, hypotheses 3 and 4 were supported (Table 3).

Table 3 Correlation analysis of physical activity with anxiety, depression, and academic pressure in high academic-pressure college students

	Physical Activity	Anxiety	Depression	Academic-pressure
Physical Activity	1			
Anxiety	r=-0.053	1		
Depression	r=-0.062*	r=0.608**	1	
Academic-pressure	r=-0.012	r=0.344**	r=0.325**	1

Note: *$p\leq0.05$，**$p\leq0.01$，***$p\leq0.001$

3. Discussion

3.1 Physical activity, anxiety, and depression status of high academic pressure college students

The results of this study show that physical inactivity among college students is more pronounced in the group of high academic pressure college students. Only 19.6% of college students engaged in vigorous physical activity when academic pressure was at a high level. This is consistent with other scholars' studies that academic pressure varies among different grades and that college students are sedentary and physically inactive due to heavy academics (Kohl III & Cook, 2013). Hypothesis 1 is verified: there is a significant difference in the physical activity value of college students with high academic pressure in terms of gender, which is manifested in the fact that the physical activity value of male students is significantly higher than that of female students. This is consistent with the findings of other scholars (Klomsten et al., 2005; Molina et al., 2012), which may be caused by the difference between male and female majors. Some scholars suggested that science and engineering subjects need to move around, while most of the subjects studied by female students are liberal arts majors, which may have a

longer sedentary time every day, so male students may produce more energy consumption than female students, which produces gender differences in physical activity values (Klomsten et al., 2005). Physical activities available to college students during their school years include soccer, basketball, volleyball, table tennis, badminton, tennis, running, jumping rope, and so on. Due to boys' and girls' physical abilities and interests, boys perform more confrontational physical activities such as basketball and soccer, while girls may prefer moderate and light-intensity physical activities such as badminton, jumping rope, and walking, which can also lead to gender differences in physical activity values between boys and girls (Li et al., 2021). The results of the study also showed that there is a difference in physical activity values between freshman and junior years, which is reflected in the fact that freshman-year physical activity values are higher than those of junior year. This may be because the third year of college is close to graduation, internship and employment pressure, and heavy study tasks, resulting in a long sedentary time every day and no time for medium and high-intensity physical activity.

In this study, 73.3% of high-academic-stress college students had an anxiety tendency and 91% had a depression tendency. It indicates that high academic pressure college students have more serious mental health problems. Hypothesis 2 was verified. The results of the study showed that both anxiety and depression of college students with high academic pressure were affected by gender**.** Female students scored significantly higher than male students in anxiety and depression scores. This may be due to the influence of physiological and psychological differences between male and female students. When faced with academic pressure, male students will be more inclined to proactively seek help to relieve the stress and generally do not develop depression; female students show more anxiety and may develop depression in severe cases (Li et al., 2021). It may also be because estrogen and progesterone are subject to large changes in the physiological cycle of female college students, making girls more susceptible to mental health problems (Maske et al., 2016). Anxiety among high academic-stress college students differed in terms of whether they were only children or single parents. Only child anxiety scores were higher than those of non-only children. One study showed that the anxiety scores of only children were higher than those of the Chinese norm (Cheng et al., 2020). This may be because parents are too spoiled, students lack the opportunity to experience and grow independently and are prone to poor social adaptability as well as psychological tolerance. At the same time, only a child carries more hope in the family compared to a non-only child, and the pressure in various aspects such as academics and employment will be greater, and it is easier to produce negative emotions. Meanwhile, the results show that the anxiety scores of students from single-parent families are higher than those of students from non-single-parent families. Mental health problems of college students from single-parent families are common (HOU et al., 2024), students from single-parent families are emotionally more sensitive because of their special family relationships and living environments and are easily affected by negative information, resulting in negative emotions such as low self-esteem, anxiety, etc. (HOU et al.,

2024). Meanwhile, students from single-parent families are prone to loneliness, and the more serious the loneliness is, the more likely it is to lead to mental health problems.

3.2 Relationship between physical activity and anxiety and depression

The results of the study showed that the correlation coefficient between physical activity level and anxiety was not statistically significant. The results of ANOVA showed that there was a borderline significant difference between anxiety in the high physical activity level group and anxiety in the low physical activity level group. The results of several studies suggest that there is an association between physical activity and anxiety (Ströhle, 2009). Therefore, this study hypothesized that it may be because high academic pressure college students, as a special group of college students, have severe anxiety, and performing high-intensity physical activity will consume a lot of energy and energy, and may take up study time, exacerbate negative emotions, and not necessarily be able to alleviate anxiety well, which makes the effect of high levels of physical activity on anxiety not significant. At this point, other effective measures may be needed to prevent and intervene in the anxiety of high academic pressure college students, such as psychological interventions and relaxation techniques.

This also suggests that the relationship between physical activity levels and anxiety in the high academic-stress college student population deserves further attention and research to explore the relationship between them more deeply.

There is a negative correlation between physical activity level and depressed mood. Meanwhile, the ANOVA results showed that the score of depression in the high physical activity level group was significantly lower than the other two groups, which suggests that depression may be reduced as the level of physical activity increases, which is consistent with the findings of other scholars. In the past, some studies have shown an association between physical activity and depressive symptoms, and an association between physical activity and depressive symptoms, with higher physical activity associated with lower depressive symptoms (Azevedo Da Silva et al., 2012; Harbour et al., 2008). It has also been suggested that an increase in the amount of moderate to high-intensity physical activity is effective in alleviating the onset of depression. The antidepressant effect of moderate to high-intensity aerobic exercise combined with resistance training and a variety of coordinated exercises is better than the antidepressant effect of a single low-intensity aerobic exercise (Li et al., 2024). Therefore, physical activity negatively predicts high academic pressure and university depression. And high-intensity physical activity level is more effective in alleviating depression. Hypothesis 3 was verified.

Also, the results of the correlation analysis showed that anxiety, depression, and academic pressure are positively correlated with each other, which is consistent with the results of other scholars' studies (Zhang et al., 2022). Hypothesis 4 was supported. Academic pressure is the most important stressor for college students during school, and it is also the main cause of anxiety, tension, burnout, and other mental health problems among college students (Gedam et al., 2020). High academic pressure college students group, they will spend most of the time and energy invested in learning life, often have less time to engage in physical activities, and sedentary time is long, whether physical or mental is prone to problems, more prone to anxiety,

depression, and even develop into depression. At the same time, the emergence of anxiety, and depression is often accompanied by insomnia, lethargy, mental instability, and other symptoms, resulting in a decline in academic performance, which may exacerbate academic pressure. The results of the study showed that the correlation coefficients between physical activity and academic pressure were not statistically significant, and from the results of the ANOVA, it can be observed that the academic pressure of the students in the group with high levels of physical activity was significantly lower than that of the other two groups. This may be influenced by other variables and subsequent more in-depth studies are needed to explore the relationship between physical activity and academic pressure. It also suggests that we need to pay attention to the physical and mental health problems of the high academic-stress college student group and take active measures to intervene when one of these mental health problems occurs to prevent the emergence of other mental health problems.

This study has some limitations, and the scope of the survey is only undergraduate students in a university in China, which may impose some limitations on the representativeness of the sample. Different regions and different institutions should be considered in the future. Secondly, this study used a questionnaire survey, and social expectations and recall bias may have some impact on the results of the study.

At the same time, the influence of related confounding factors was fully considered, to better elucidate their associations, explore the internal mechanisms, and provide a reference for college students' mental health. In summary, this study found that high academic pressure college students were physically inactive. Anxiety and depression were prevalent. Physical activity cannot reduce the anxiety and academic pressure of high academic pressure college students. Still, it has an obvious effect on relieving depression, and high-intensity physical activity has a better effect.

Declarations

Author contributions:

C.Y. conceived the study, participated in the screening process and data extraction, and drafted the manuscript; J.L. formulated the standards for manuscript review and helped revise the manuscript. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest:

All authors do not have conflict of interest.

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Not applicable. Our study did not require an ethical board approval because it did not contain human or animal trials.

Data Availability Statement:
The data presented in this study are available on request from the corresponding author.
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