

PEER REVIEW HISTORY

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ARTICLE DETAILS

TITLE (PROVISIONAL)	Independent and Combined Associations between Multiple Lifestyle Behaviors and Academic Grades of Inner Urban and Peri-Urban High School Students: A Cross-Sectional Study in Chongqing, China
AUTHORS	Cai, Zhengjie; Xian, Jin Li; Araujo, Camila; Zhang, Ziwei; Zhou, Hongyu; Peng, Huan; Sharma, Manoj; Zhao, Yong

VERSION 1 – REVIEW

REVIEWER	Asadpour, M Rafsanjan University of Medical Sciences, Health Education and Health Promotion
REVIEW RETURNED	02-Mar-2021

GENERAL COMMENTS	Worthwhile work has been done and I do not think there is a particular problem
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REVIEWER	Fan, Xiang Shanghai Jiao Tong University
REVIEW RETURNED	20-Apr-2021

GENERAL COMMENTS	<p>General comments: The current manuscript titled, “Independent and Combined Effects of Lifestyle Behaviors on Academic Grades of Inner Urban and Peri-Urban High School Students: A Cross-Sectional Study in Chongqing, China” utilizes 1481 of students from high schools to examine the independent and combined effects of multiple lifestyle behaviors on academic grades. The authors found that cumulative effects of healthy lifestyle behaviors have a stronger association with academic outcomes than the independent effects. Though I think that this manuscript has several strengths, including controlling for potentially relevant confounds, and the use of cumulative effects of healthy lifestyle behaviors I have several significant concerns related to selection of variables and cut points as well as novelty of the findings.</p> <p>Major comments:</p> <ol style="list-style-type: none">1) As a self-reported cross-sectional study, I have some reservations about whether this sample size can reflect the situation of one of the most important western cities in China.2) Academic grades are delineated by quartile and classified into low, moderate, and high. How were these cut-offs selected? Please provide justification for using this method of group creation
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since using cut points based on interquartile range can be somewhat arbitrary.

3) Though this is an interesting and important area of research, I am not sure how novel the findings are given existing research on associations between lifestyle behaviors and academic performance. No correlation between physical activity and performance was found in this study, which is different from previous studies and should be further discussed.

4) Though I appreciate the inclusion of relevant covariates, I have some concerns related to how these specific variables were chosen. Although some are intuitive, such as parental education level, authors should provide a rationale for the selection of each variable based on prior research. Please include within the introduction some background on included covariates, including why these specific lifestyle behaviors were chosen (e.g., average monthly living expenses) so it is clear to the readers why these specific variables, and not others, are most important to the research question. It is likely you can expand upon the points related to this in the discussion section and move to the introduction.

5) It is necessary to explain what subjects are included in academic grades, because prior research found that lifestyle behaviors have different influences on different subjects (such as language and mathematics).

6) This study used open-ended questions to assess physical activity levels. Were the reliability and validity of the questionnaire verified, and why the IPAQ questionnaire was not used?

Title

Generally, "effects of A on B" seems like a title of longitudinal study. Considering that the design of this manuscript is a cross-sectional study, a more accurate title would be "associations between ...".

Abstract

Line 79, 84, 93...: Please consider removing "might be" or "may be", unless that's what the references' meaning.

Line 24: Please consider removing "limited studies reported...", which should be background, not objectives.

Line 28: Please change to a complete sentence.

Line 29: Please consider to change "1,481 high school students were included" to "there are 1,481 students in this study" or correct this grammatical error.

Line 45: Please change "effects on" to "associations between".

Introduction

Line 74: The subject of the first half of the sentence is "high school", so "their" in the last sentence refers to "high schools' ", which is not your actual meaning. Please rephrase this sentence.

Line 78: "healthy dietary behaviors, sufficient physical activity..." belong to "healthy lifestyles", not contribute to. Please change to "healthy lifestyles including are associated with" or rewrite it.

Line 82: please change to "intake of certain micronutrients (i.e., iron)"

Line 104: Authors' last sentence of this paragraph emphasizes the importance of research in high school students, so this paragraph should describe why we should focus on high school samples instead of the limitations of current studies. Please rewrite this sentence.

Line 110: is there any reference related to "higher socioeconomic levels"?

Line 111: Please consider removing the first "may" in this sentence.

Line 112: is "may have different influences on students" your suspect or reference? If it comes from a reference, please add references.

Line 113: Suggesting change "effects on " to "association between"

Methods

Line 128: How to select these three high schools? random selection? step selection? Please specify.

Line 132: Please correct the grammatical errors in "The exclusion criteria were students... "

Line 134: "they" in the last half of this sentence refers to "investigators", but it is not your actual meaning. Please rewrite it.

Line 158: Please change "grade" to "grades"

Line 159: For academic grades, options and categories are respectively delineated to top 25%, 25–50%, 50–75%, lowest 25%, good (top 50%) and poor (last 50%). How were the cut-offs selected? Please provide justification for using this method of group creation since using these cut points can be somewhat arbitrary.

Line 162: Please include within the introduction some background on included covariates, including why these specific lifestyle behaviors were chosen (e.g., being only child in family, boarding at school, average living expenses and parental education level) so it is clear to the reader why these specific variables, and not others, are most important to the research question.

Line 181: Suggesting change "number of behaviors" to "categories of behaviors".

Line 184: healthy lifestyle behaviors were divided into low, medium and high. As I said before, how were these cut-offs selected? Please provide justification for using this method of group creation since using these cut points can be somewhat arbitrary.

Results

Table 2: Please change "<0.000" to "<0.001"

Table 4: Suggesting change "number" to "categories"

Discussion

	<p>Page 21</p> <p>Line 6: positively or negatively associated with?</p> <p>Line 9: suggesting change "effects " to "association"</p> <p>Line 14: is "Lifestyle behaviors are closely..." your conclusion? if it is, please remove "health" because there are no results related to health in this study. If it comes from references, please add them here.</p> <p>Line 43: Regarding to the different results between IUHSSs and PUHSSs, I think the explanation of different education levels between them is necessary, of course you have described differences of teachers. But more importantly, there were also differences in students' achievement between IUHSSs and PUHSSs. For example, students with good grades in PUHSSs may be the last 50% of in IUHSSs. Please add more explanation about this difference.</p> <p>Line 53: I think one important reason of "insufficient sleep duration was associated with good academic performance among students from IUHSSs" is students with good academic performance spent more time on learning than those with poor students. Please consider adding and explaining it in details.</p> <p>Page 23-first paragraph</p> <p>Please specify why healthy dietary habits were associated with academic achievement. Like the mechanism on sufficient intake of nutrition can promote the cognitive development in children.</p> <p>Page 23-second paragraph</p> <p>Please consider add an important point you ignored before in the discussion section. Students with good academic achievement usually have better self-control, so they can stick to a healthy lifestyle.</p> <p>Ethics approval</p> <p>Page 26-Line 14: Please add the approval number of ethics.</p>
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REVIEWER	Buljan, Ivan Sveuciliste u Splitu Medicinski fakultet
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REVIEW RETURNED	14-Jul-2021
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GENERAL COMMENTS	<p>Thank you for the opportunity to review this paper. The study is very interesting, and will provide useful insight in the relation of lifestyle habits and academic success. However, I have performed statistical review only and in my opinion some things need to be refined before publication. In Data analysis section, please test numerical variables for normality, and if the distribution is not symmetrical, present results as medians with interquartile range. P values in tables cannot be <0.000, the lowest is the P<0.001, so that needs to be refined. The logistic regression should be done again. This time, all predictors should be entered at once, and variable (urban, periurban) should be one of the criteria. You should base your interpretation on adjusted regression only. Once again, thank you for the opportunity to review this manuscript.</p>
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VERSION 1 – AUTHOR RESPONSE

Reviewer: 1
Dr. M Asadpour, Rafsanjan University of Medical Sciences

Response: Thank you very much for your review.

Reviewer: 2

Dr. Xiang Fan, Shanghai Jiao Tong University

Comments to the Author:

** Please find additional comments from this reviewer in the attached file **

General comments: The current manuscript titled, "Independent and Combined Effects of Lifestyle Behaviors on Academic Grades of Inner Urban and Peri-Urban High School Students: A Cross-Sectional Study in Chongqing, China" utilizes 1481 of students from high schools to examine the independent and combined effects of multiple lifestyle behaviors on academic grades. The authors found that cumulative effects of healthy lifestyle behaviors have a stronger association with academic outcomes than the independent effects. Though I think that this manuscript has several strengths, including controlling for potentially relevant confounds, and the use of cumulative effects of healthy lifestyle behaviors I have several significant concerns related to selection of variables and cut points as well as novelty of the findings.

Major comments:

1) As a self-reported cross-sectional study, I have some reservations about whether this sample size can reflect the situation of one of the most important western cities in China.

Response: Thank you very much for the comments. Firstly, we added the sample size calculation in our revised manuscript, please see page 7, lines 149-153. According to the research of Yan et al.,³² nearly 48% of middle-school and high-school students reported having good grade rankings in their final examination.

According to the sample size calculation formula of the cross-sectional study , we

set $= 0.48$, $= 1 - = 0.52$, and margin of error $= 0.10 \times = 0.048$, $= 1.96$, the calculated sample size is 416. In the survey, the actual total sample size included 1481 individuals, which met the need for sample analysis.

However, according to the 2020 Statistical Bulletin on Chongqing's National Economic and Social Development [Chongqing Municipal People's Government. 2020 Statistical Bulletin on Chongqing's National Economic and Social Development. http://www.cq.gov.cn/zwgk/zfxxgkz/fdzdgknr/tjxx/tjgb/202103/t20210318_9009790.html], there are 626,300 high school students at schools in Chongqing. The sample size of 1481 in this study could only reflect the situation of high school students in Chongqing to a certain extent, and cannot be generalizable to all high school students across China. This is one limitation in this study, we have added this limitation in the revised manuscript. Please see page 26, line 403-405.

"Fifthly, the participants who were investigated in this study could only reflect the situation of high school students in Chongqing to a certain extent, and cannot be generalizable to all high school students across China. Further nationally representative studies are warranted."

Reference:

32. Yan H, Zhang R, Oniffrey TM, et al. Associations among Screen Time and Unhealthy Behaviors, Academic Performance, and Well-Being in Chinese Adolescents. *International journal of environmental research and public health* 2017;14(6):596.

2) Academic grades are delineated by quartile and classified into low, moderate, and high. How were these cut-offs selected? Please provide justification for using this method of group creation since using cut points based on interquartile range can be somewhat arbitrary.

Response: Thank you very much for the comments. Academic grades were approximately assessed based on the students' self-reported ranking in the last cumulative examination in their grades. The options setting and cut-offs selection are similar to the previous studies,^{4 32} academic grades were dichotomized into good (top 50%) and poor (last 50%) for statistical analyses. We have added the related references in our manuscript, please see page 8, lines 176-177.

Reference:

4 Stea TH, Knutsen T, Torstveit MK. Association between short time in bed, health-risk behaviors and poor academic achievement among Norwegian adolescents. *Sleep Med.* 2014 Jun;15(6):666-71. doi: 10.1016/j.sleep.2014.01.019. Epub 2014 Mar 25. PMID: 24767727.

32 Yan H, Zhang R, Oniffrey TM, et al. Associations among Screen Time and Unhealthy Behaviors, Academic Performance, and Well-Being in Chinese Adolescents. *International journal of environmental research and public health* 2017;14(6):596.

3) Though this is an interesting and important area of research, I am not sure how novel the findings are given existing research on associations between lifestyle behaviors and academic performance. No correlation between physical activity and performance was found in this study, which is different from previous studies and should be further discussed.

Response: Thank you very much for the comments. Firstly, most previous studies mainly explored the association between a single lifestyle factor and the academic grades of students, limited studies have investigated the independent and combined associations between multiple lifestyle behaviors and students' academic grades, especially for Chinese high school students, their academic grades are so important as they need to prepare for the National College Entrance Examination. In addition, inner urban and peri-urban

high school students were selected for a stratified analysis to discuss the difference in the associations. Therefore, this research is innovative to some degree. The innovativeness of this article was provided in the introduction section.

Secondly, no correlation between physical activity and performance was found in this study, and it is inconsistent with some studies. Hence, in the fifth paragraph of the discussion section, we focused on the possible reasons for the insignificant correlation, which is mainly from the following aspects: the curvilinear relationship between physical activity and academic achievement, characteristics of Chinese high school students, the applicability of cut-off value and the assessment tool for physical activity. Please see pages 23-24, lines 340-363.

"In this study, no association was found between physical activity before or after school or on weekends, physical activity at school, and academic grades in IUHSSs and PUHSSs. Most laboratory trials, cohort-based or cross-sectional studies have demonstrated the positive effect of physical activity on cognitive function,⁴⁵⁻⁴⁸ while, studies on physical activity and academic grades have produced mixed results.^{49 50} A previous study found an inverse U-shaped curvilinear association between physical activity and academic achievement, thereby indicating that too little physical activity might impair the positive effects of physical activity on students' cognitive function and top sports students may have additional extracurricular physical activity that displaced the time spent on academics.⁵¹ Moreover, under the social, cultural, and educational background of China, many schools have reduced the physical education curriculum to maximize the study time on subjects important for exams.¹⁸ This phenomenon is particularly prominent in high schools, as high school students need to prepare for the National College Entrance Examination.¹ The results of this study showed that only 5.6% of the students before or after school or on weekends, and 19.5% of the students at school have more than 1 hour of physical activity. Considering these factors, the cut-off values of the recommendation for physical activity may be inappropriate to assess the association between physical activity and academic grades of high school students, and this could be the reason for the lack of significant association between physical activity and academic grades in IUHSSs and PUHSSs. This was also mentioned in a previous study targeting the association between physical activity and academic achievement among elementary school students.²³ In addition, the questionnaire used for assessing the level of physical activity was not evaluated for its reliability and validity, the limited information provided by the questionnaire could be another reason for the lack of association. Choosing the appropriate method to assess the physical activity of high school students still needs to be explored in future studies, thereby to better explore its association with academic performance."

4) Though I appreciate the inclusion of relevant covariates, I have some concerns related to how these specific variables were chosen. Although some are intuitive, such as parental education level, authors should provide a rationale for the selection of each variable based on prior research. Please include within the introduction some background on included covariates, including why these specific lifestyle behaviors were chosen (e.g., average monthly living expenses) so it is clear to the readers why these specific variables, and not others, are most important to the research question. It is likely you can expand upon the points related to this in the discussion section and move to the introduction.

Response: Thank you very much for your comments. Many of the previous studies on lifestyle behaviors and academic grades have not controlled for known covariates. This issue was addressed in the present study. The selection of these factors as covariates were based on prior researches, we have added the reasons and corresponding references for choosing these factors as confounding variables for adjustment in our revised manuscript. Please see pages 5-6, lines 107-117.

"Previous studies have demonstrated that there were some factors related to students' academic grades, lifestyle behaviors or both.^{9 23-28} Faught et al. found that girls had a stronger association with the likelihood of meeting expectations for academic achievement in reading and writing than boys, and the area

of residence was associated with students' academic achievement in mathematics.²³ Some researchers found that students with higher parental education levels were more likely to obtain better academic achievement.^{9 23} Li's research showed that boarding school students were more likely to obtain better academic grades than those students who did not board at school.²⁶ In addition, Pan et al. found that students' monthly living expenses were negatively correlated with academic performance, also, whether the student was an only child influenced academic performance.²⁷ These factors were also the possible influencing factors of students' lifestyle behaviors.^{23-25 28} Therefore, the above factors were adjusted as potential confounders in this study."

Reference:

9. Burrows T, Goldman S, Olson RK, et al. Associations between selected dietary behaviours and academic achievement: A study of Australian school aged children. *Appetite* 2017;116:372-80.

23. Faught EL, Ekwaru JP, Gleddie D, et al. The combined impact of diet, physical activity, sleep and screen time on academic achievement: a prospective study of elementary school students in Nova Scotia, Canada. *Int J Behav Nutr Phys Act* 2017;14(1):29.

24. Chortatos A, Terragni L, Henjum S, et al. Consumption habits of school canteen and non-canteen users among Norwegian young adolescents: a mixed method analysis. *BMC pediatrics* 2018;18(1):328-28.

25. Ragelienė T, Grønhøj A. The influence of peers' and siblings' on children's and adolescents' healthy eating behavior. A systematic literature review. *Appetite* 2020;148:104592.

26. Li D. The study about the grade and Psychological health of the boarders and day students—For example Shandong Experimental High School. Shandong Normal University, 2007.

27. Pan XD, Guan NN. Analysis of the Relationship between Mental Health Status and Academic Performance of Medical Students. *Medical Education Research and Practice* 2019

28. Haddad MR, Sarti FM. Sociodemographic determinants of health behaviors among Brazilian adolescents: Trends in physical activity and food consumption, 2009-2015. *Appetite* 2020;144:104454.

5) It is necessary to explain what subjects are included in academic grades, because prior research found that lifestyle behaviors have different influences on different subjects (such as language and mathematics).

Response: Thank you very much for your comments. Firstly, academic grades were approximately assessed based on the students' self-reported ranking in the last cumulative examination in their grades, which is a comprehensive ranking of all compulsory subjects (including Chinese, English, mathematics, physics, chemistry, biology, geography, history and politics). Generally, Chinese high schools have a formal examination once a month, and then a ranking will be carried out.

And we agree with you, lifestyle behaviors could have different influences on different subjects, this is one limitation in this study, the independent and combined associations between multiple lifestyle behaviors and academic grades among Chinese high school students need to be explored in further studies according to the classification of students (liberal arts or science), as well as the classification of subjects (Chinese, English, mathematics, physics, chemistry, biology, geography, history or politics), we have added it to the limitations in our revised manuscript. Please see page 26, lines 390-395.

"Academic grades in this study is a comprehensive ranking of all compulsory subjects, however, students' lifestyle behaviors could have different influences on different subjects,²³ the independent and combined associations between multiple lifestyle behaviors and academic grades among Chinese high school students could be explored in further studies according to the classification of students (science or liberal students), as well as the classification of subjects (Chinese, English, mathematics, physics, chemistry, biology, geography, history or politics)"

Reference:

23. Fought EL, Ekwaru JP, Gleddie D, et al. The combined impact of diet, physical activity, sleep and screen time on academic achievement: a prospective study of elementary school students in Nova Scotia, Canada. *Int J Behav Nutr Phys Act* 2017;14(1):29.

6) This study used open-ended questions to assess physical activity levels. Were the reliability and validity of the questionnaire verified, and why the IPAQ questionnaire was not used?

Response: Thank you very much for your comments. Firstly, in this study, the open-ended questions for assessing physical activity were designed with reference to the questionnaire of China Health and Nutrition Survey, however, the use of unvalidated questionnaires was a limitation in this study.

Secondly, the IPAQ is widely used to assess physical activity, with two versions available: the 31 items long-form (IPAQ-LF) and the 9 items short-form (IPAQ-SF), each item has 1 or 2 questions. As this study aims to collect the information for a wide range of lifestyle behaviors of high school students (physical activity, sleep time, screen time, diet behaviors), and being an exploratory study, shorter questions adapted from the children questionnaire of China Health and Nutrition Survey were used and have good feasibility. However, unvalidated measures in the questionnaire may raise potential issues related to reliability, further studies should consider using the verified questionnaire for assessing lifestyle behaviors. We have added this limitation in our manuscript. Please see page 26, lines 396-402.

"Being an exploratory study, questions on physical activity, sleep duration, and screen time were adapted from the China Health and Nutrition Survey,⁵⁷ and questions on dietary behaviors were adapted from Chinese Dietary Guideline 2016.³⁴ Additionally, expert review and a pilot study were done before implementation. However, the questionnaire was not evaluated for its reliability and validity, and the unvalidated measures in the questionnaire designed to measure the lifestyle behaviors and academic grades may raise potential issues related to reliability. Further studies should consider using a verified questionnaire or validating the questionnaire before administration."

Reference:

34. Chinese Nutrition Society. Dietary Guidelines for Chinese School-age Children 2016; People's Medical Publishing House: Beijing, China, 2016. <http://dg.cnsoc.org/article/04/8a2389fd575f695101577a545b0102db.html>. Accessed 3 August 2020.

57. China Health and Nutrition Survey. <https://www.cpc.unc.edu/projects/china>. Accessed 3 April 2020.

Response to the additional comments

Title

Generally, "effects of A on B" seems like a title of longitudinal study. Considering that the design of this manuscript is a cross-sectional study, a more accurate title would be "associations between ...".

Response: Thank you very much for the comments. We have revised the title of our manuscript according to your suggestions, and changed it to "Independent and Combined Associations between Multiple Lifestyle Behaviors and Academic Grades of Inner Urban and Peri-Urban High School Students: A Cross-Sectional Study in Chongqing, China". Please see page 1, lines 1-3. This expression has also been revised throughout the manuscript.

Abstract

Line 79, 84, 93...: Please consider removing "might be" or "may be", unless that's what the references' meaning.

Response: Thank you very much for the suggestion. After carefully reviewing the corresponding references, some expressions have been modified. Please see page 4, lines 76-77, lines 79-82 and lines 88-91.

"Healthy lifestyles, including healthy dietary behaviors, sufficient physical activity and sleep, minimal screen time, etc., are positively associated with students' academic performance.²⁻⁴"

"Intake of certain micronutrients (i.e., iron), high frequency of fruit and vegetable consumption, low consumption of energy-dense and nutrient-poor food, and regular breakfast consumption all predict the likelihood of good academic grades.^{5 7-9}"

"Studies on the correlation between students' screen time and their academic performance have shown that spending considerable time on television, videos or social networking sites appears to be negatively associated with academic grades.^{16 17}"

Line 24: Please consider removing "limited studies reported...", which should be background, not objectives.

Response: Thank you very much for the suggestion. We have removed this sentence. Please see page 2, lines 24-26.

Line 28: Please change to a complete sentence.

Response: Thank you very much for the suggestion. We have revised this sentence, and changed it to "A cross-sectional study was conducted". Please see page 2, line 27.

Line 29: Please consider to change "1,481 high school students were included" to "there are 1,481 students in this study" or correct this grammatical error.

Response: Thank you very much for the comments. Sorry for our carelessness, we have revised this sentence, and changed it to "There are 1,481 high school students (49.9% boys) in this study, who were enrolled from one inner urban and two peri-urban districts in Chongqing, China". Please see page 2, lines 28-29.

Line 45: Please change "effects on" to "associations between".

Response: Thank you very much for the suggestion. We have changed "effects on" to "associations between", please see page 3, line 44.

Introduction

Line 74: The subject of the first half of the sentence is "high school", so "their" in the last sentence refers to "high schools", which is not your actual meaning. Please rephrase this sentence.

Response: Thank you very much for the comments. We have changed this sentence to "High school is a key stage in students' transition to college, academic grades of high school students are closely related to college or university admission, even their future careers and health in adulthood". Please see page 4, lines 71-73.

Line 78: "healthy dietary behaviors, sufficient physical activity..." belong to "healthy lifestyles", not contribute to. Please change to "healthy lifestyles including are associated with" or rewrite it.

Response: Thank you very much for the comments. We have changed this sentence to "Healthy lifestyles, including healthy dietary behaviors, sufficient physical activity and sleep, minimal screen time, etc., are positively associated with students' academic performance". Please see page 4, lines 76-77.

Line 82: please change to "intake of certain micronutrients (i.e., iron)"

Response: Thank you very much for the comments. We have changed "intake of certain micronutrients (such as iron)" to "intake of certain micronutrients (i.e., iron)". Please see page 4, lines 79-80.

Line 104: Authors' last sentence of this paragraph emphasizes the importance of research in high school students, so this paragraph should describe why we should focus on high school samples instead of the limitations of current studies. Please rewrite this sentence.

Response: Thank you very much for the comments. Firstly, we have moved the limitations of previous studies to the last paragraph, please see page 6, lines 124-125. And the importance of high school students' academic grades and modifiable factors have been emphasized in the first paragraph. In addition, according to your suggestions, we have added the reasons for choosing high school students. Please see page 5, lines 101-106.

"With the social, cultural, and educational context of China, the heavy burden of study for Chinese high school students is so common, and maintaining a healthy lifestyle could be ignored. However, having a healthy lifestyle is one of the most important modifiable factors for students' academic grades. Given the importance of academic grades for high school students, the independent and combined associations between lifestyle behaviors and academic grades targeting this population need to be investigated."

Line 110: is there any reference related to "higher socioeconomic levels"?

Response: Thank you very much for the comments. We have added the corresponding reference. Please see reference 30.

Reference:

30. Run J, Sun Q. The Spatio-temporal Evolution of the County Economic Disparity in Chongqing City Since Its Municipality. *Journal of Southwest University (Natural Science Edition)* 2020;42(8):106-16.

Line 111: Please consider removing the first "may" in this sentence.

Response: Thank you very much for the comments. We have removed the first "may" in this sentence. Please see page 6, line 122.

Line 112: is "may have different influences on students" your suspect or reference? If it comes from a reference, please add references.

Response: Thank you for your careful review, this is our suspect.

Line 113: Suggesting change "effects on " to "association between"

Response: Thank you very much for the comments. We have revised this sentence. Please see pages 6 and 7, lines 124-136.

Methods

Line 128: How to select these three high schools? random selection? step selection? Please specify.

Response: Thank you for your careful review, we have added relevant information, which is "one high school was randomly selected from each designated district". Please see page 7, line 142.

Line 132: Please correct the grammatical errors in "The exclusion criteria were students... "

Response: Thank you for your careful review, and we are sorry for the incorrect expression, we have changed this sentence into "Students who have a history of major diseases, chronic health conditions, or mental trauma were excluded in this study". Please see page 7, lines 145-146.

Line 134: "they" in the last half of this sentence refers to "investigators", but it is not your actual meaning. Please rewrite it.

Response: We are sorry for the incorrect expression, we have changed "they" to "students". Please see page 7, line 147.

Line 158: Please change "grade" to "grades"

Response: We are sorry for the incorrect expression, we have changed "grade" to "grades". Please see page 8, line 175.

Line 159: For academic grades, options and categories are respectively delineated to top 25%, 25–50%, 50–75%, lowest 25%, good (top 50%) and poor (last 50%). How were the cut-offs selected? Please provide justification for using this method of group creation since using these cut points can be somewhat arbitrary.

Response: Thank you very much for the comments. Academic grades were approximately assessed based on the students' self-reported ranking in the last cumulative examination in their grades. The options setting and cut-offs selection are similar to the previous studies,^{4,32} academic grades were dichotomized into good (top 50%) and poor (last 50%) for statistical analyses. We have added the related references in our manuscript, please see page 8, lines 176-177.

Reference:

4 Stea TH, Knutsen T, Torstveit MK. Association between short time in bed, health-risk behaviors and poor academic achievement among Norwegian adolescents. *Sleep Med.* 2014 Jun;15(6):666-71. doi: 10.1016/j.sleep.2014.01.019. Epub 2014 Mar 25. PMID: 24767727.

32 Yan H, Zhang R, Oniffrey TM, et al. Associations among Screen Time and Unhealthy Behaviors, Academic Performance, and Well-Being in Chinese Adolescents. *International journal of environmental research and public health* 2017;14(6):596.

Line 162: Please include within the introduction some background on included covariates, including why these specific lifestyle behaviors were chosen (e.g., being only child in family, boarding at school, average living expenses and parental education level) so it is clear to the reader why these specific variables, and not others, are most important to the research question.

Response: Thank you very much for your comments. Many of the previous studies on lifestyle behaviors and academic grades have not controlled for known covariates. This issue was addressed in the present study. The selection of these factors as covariates were based on prior researches, we have added the reasons and corresponding references for choosing these factors as confounding variables for adjustment in our revised manuscript. Please see pages 5-6, lines 107-117.

"Previous studies have demonstrated that there were some factors related to students' academic grades, lifestyle behaviors or both.^{9,23-28} Faught et al. found that girls had a stronger association with the

likelihood of meeting expectations for academic achievement in reading and writing than boys, and the area of residence was associated with students' academic achievement in mathematics.²³ Some researchers found that students with higher parental education levels were more likely to obtain better academic achievement.^{9 23} Li's research showed that boarding school students were more likely to obtain better academic grades than those students who did not board at school.²⁶ In addition, Pan et al. found that students' monthly living expenses were negatively correlated with academic performance, also, whether the student was an only child influenced academic performance.²⁷ These factors were also the possible influencing factors of students' lifestyle behaviors.^{23-25 28} Therefore, the above factors were adjusted as potential confounders in this study."

Reference:

9. Burrows T, Goldman S, Olson RK, et al. Associations between selected dietary behaviours and academic achievement: A study of Australian school aged children. *Appetite* 2017;116:372-80.
23. Faught EL, Ekwaru JP, Gleddie D, et al. The combined impact of diet, physical activity, sleep and screen time on academic achievement: a prospective study of elementary school students in Nova Scotia, Canada. *Int J Behav Nutr Phys Act* 2017;14(1):29.
24. Chortatos A, Terragni L, Henjum S, et al. Consumption habits of school canteen and non-canteen users among Norwegian young adolescents: a mixed method analysis. *BMC pediatrics* 2018;18(1):328-28.
25. Ragelienė T, Grønhøj A. The influence of peers' and siblings' on children's and adolescents' healthy eating behavior. A systematic literature review. *Appetite* 2020;148:104592.
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Line 181: Suggesting change "number of behaviors" to "categories of behaviors".

Response: Thanks for your suggestions. We have changed "number of behaviors" to "categories of behaviors", and adjusted the order of sentences appropriately. Please see page 10, lines 202-206.

Line 184: healthy lifestyle behaviors were divided into low, medium and high. As I said before, how were these cut-offs selected? Please provide justification for using this method of group creation since using these cut points can be somewhat arbitrary.

Response: Thank you very much for your comments. Firstly, different studies might include different types of lifestyle behaviors, the calculated number of lifestyles behaviors could be different, and no standards for the cut-offs were found.

Secondly, the categories of healthy lifestyle behaviors in this study were constructed by tri-sector methods, which were in accordance with the frequency distribution of the number of healthy lifestyle behaviors, the cut-off used in order to have a similar proportion in each category. The total number of healthy lifestyle behaviors ranged from 1 to 13, accounted for 0.2%, 0.14%, 2.30%, 6.21%, 12.36%, 18.84%, 21.88%, 16.88%, 12.63%, 6.01%, 1.62%, 0.81% and 0.14%, respectively. Hence, three categories of healthy lifestyle behaviors were constructed low (1–6 healthy lifestyle behaviors, 40.0%), medium (7–8 healthy lifestyle behaviors, 38.8%), and high (9–13 healthy lifestyle behaviors, 21.2%). Similar tri-sector methods were also mentioned in one previous study [Bai L, Cai Z, Lv Y, Wu T, Sharma M, Shi Z, Hou X, Zhao Y. Personal Involvement Moderates Message Framing Effects on Food Safety Education among

Medical University Students in Chongqing, China. *Int J Environ Res Public Health*. 2018 Sep 19;15(9):2059. doi: 10.3390/ijerph15092059. PMID: 30235903; PMCID: PMC6164898.].

Results

Table 2: Please change "<0.000" to "<0.001"

Response: Thank you very much for your comments. We are sorry for our carelessness and we have changed "<0.000" to "<0.001". Please see Table 2 on pages 12-14.

Table 4: Suggesting change "number" to "categories"

Response: Thanks for your suggestions. We have changed "number" to "categories". Please see page 20, Table 4.

Discussion

Page 21

Line 6: positively or negatively associated with?

Response: Thanks for your suggestions. We have revised this sentence in our revised manuscript. Please see page 21, line 282.

Line 9: suggesting change "effects " to "association"

Response: Thanks for your suggestions. We have changed "effects " to "association". Please see page 21, line 290.

Line 14: is "Lifestyle behaviors are closely..." your conclusion? if it is, please remove "health" because there are no results related to health in this study. If it comes from references, please add them here.

Response: Thank you very much for your comments. We agree with your opinion and have removed "health". Please see page 21, line 281.

Line 43: Regarding to the different results between IUHSSs and PUHSSs, I think the explanation of different education levels between them is necessary, of course you have described differences of teachers. But more importantly, there were also differences in students' achievement between IUHSSs and PUHSSs. For example, students with good grades in PUHSSs may be the last 50% of in IUHSSs. Please add more explanation about this difference.

Response: Thank you very much for your comments. Firstly, to be clear, the objectives of the present study were to assess the independent and combined associations between multiple lifestyle behaviors and academic grades of inner urban high school students (IUHSSs) and peri-urban high school students (PUHSSs). Therefore, we didn't compare the difference in academic grades between IUHSSs and PUHSSs in the study.

Secondly, line 43: the reason we discussed the differences of education levels or teachers is to emphasize the stricter rules, tighter schedules and less sleep time adherence to the recommendation of inner urban high school compared with peri-urban high school, which could lead to the inconsistent associations between sleep duration adherence and academic grades among IUHSSs and PUHSSs. We focus on the distribution of each student's academic grades in their own district, and this is one of the reasons why we conducted a stratified analysis, we divided the students into two groups (IUHSSs and

PUHSSs) to discuss the independent and combined associations between multiple lifestyle behaviors and academic grades.

Line 53: I think one important reason of "insufficient sleep duration was associated with good academic performance among students from IUHSSs" is students with good academic performance spent more time on learning than those with poor students. Please consider adding and explaining it in details.

Response: Thank you very much for your comments. We agree with your opinion and have added this explanation in our revised manuscript. Please see lines 298-300 on pages 21-22.

"In addition, IUHSSs with good academic grades may spend more time in learning than those with poor academic grades, which could be another possible explanation for the negative association between insufficient sleep time on weekdays and good academic grades among IUHSSs."

Page 23-first paragraph

Please specify why healthy dietary habits were associated with academic achievement. Like the mechanism on sufficient intake of nutrition can promote the cognitive development in children.

Response: Thank you very much for your comments. We agree with your opinion and have added the possible mechanism discussion in our revised manuscript. Please see lines 377-385 on page 25.

"Regarding the potential mechanisms on the associations between lifestyle behaviors and academic grades, a previous study showed that adolescence is a critical period in which there is considerable re-organisation and growth of many brain structures, including the hippocampus related to learning and memory.⁵² Increasingly evidence demonstrates that the hippocampus is particularly responsive to the lifestyle influences during adolescence, previous studies showed that unhealthy diet and decreased exercise levels have been associated with decreased hippocampal neurogenesis and cognitive performance in rodent models.⁵³⁻⁵⁵ And the BDNF (brain-derived neurotrophic factor) system appears to be a major mechanism underlying the effects of exercise and diet on neurogenesis and cognitive function.⁵²
56"

Page 23-second paragraph

Please consider add an important point you ignored before in the discussion section. Students with good academic achievement usually have better self-control, so they can stick to a healthy lifestyle.

Response: Thank you very much for your comments. We agree with your opinion and have added this point in our revised manuscript. Please see page 25, lines 368-371.

"Overall, one possible explanation for the positive association between multiple lifestyle behaviors and academic grades is that high school students with good academic grades usually have better self-control, which could contribute to high adherence to a healthy lifestyle"

Ethics approval

Page 26-Line 14: Please add the approval number of ethics.

Response: Thank you very much for your comments. We have added the approval number of ethics in the revised manuscript. Please see page 27, lines 418-419.

Reviewer: 3

Dr. Ivan Buljan, Sveuciliste u Splitu Medicinski fakultet

Comments to the Author:

Thank you for the opportunity to review this paper.

The study is very interesting, and will provide useful insight in the relation of lifestyle habits and academic success.

However, I have performed statistical review only and in my opinion some things need to be refined before publication.

1. In Data analysis section, please test numerical variables for normality, and if the distribution is not symmetrical, present results as medians with interquartile range.

Response: Thank you very much for your comments. We agree with you, it is necessary to test numerical variables for normality. In this study, all variables are categorical variables except age. We have provided relevant information on whether "age" is normally distributed in the revised manuscript, and we have corrected the corresponding statistical expression in the revised manuscript. Please see lines 187-189 on page 9, and Table 1 on page 10.

"The categorical variables were described using frequency and percentiles, and owing to the non-normal distribution of age, we described age using median and Inter-Quartile Range (IQR)."

2. P values in tables cannot be <0.000 , the lowest is the $P<0.001$, so that needs to be refined.

Response: Thank you very much for your comments. We are sorry for our carelessness and we have changed " <0.000 " to " <0.001 ". Please see Table 2 on pages 12-14.

3. The logistic regression should be done again. This time, all predictors should be entered at once, and variable (urban, periurban) should be one of the criteria. You should base your interpretation on adjusted regression only.

Response: Thank you very much for your comments. Firstly, we have done the logistic regression again, all predictors were entered at once (including the variable "school areas" (urban, peri-urban). We have added the corresponding contents in the method section and added the data in the results, please see lines 194-197 on page 9, and Table 3 and Table 4 on pages 17-20.

Secondly, we agree with you, we should only make explanations on adjusted regression results, changes have been made in our revised manuscript. Please see lines 237-265 on pages 14-16.

VERSION 2 – REVIEW

REVIEWER	Buljan, Ivan Sveuciliste u Splitu Medicinski fakultet
REVIEW RETURNED	24-Aug-2021
GENERAL COMMENTS	I have no additional comments for the authors.