Author’s response to reviews

Title: The Associations of Multimorbidity with the Sum of Annual Medical and Long-Term Care Expenditures in Japan

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Dear Drs. Shuai Chen, Zhiguo Chen, and Xiaoyin Li,

On behalf of my co-authors, I would like to thank you for your time and effort in reviewing our manuscript and providing valuable comments. We have revised the manuscript to address the suggestions. Below, please find item-by-item responses to the comments. We hope that you will find the revised manuscript suitable for publication in BMC Geriatrics. Thank you again.

Reviewer reports:

Zhiguo Chen (Reviewer 1): This manuscript investigated the association between multimorbidity and medical expenditure, and concluded a positive relationship based on insurance data from a city in Japan for adults over 75 years old. Multimorbidity is appropriately measured by Charlson
Comobility Index, and medical expenditure data are well captured from insurance claims. Statistical method is used properly. Therefore, I support its publication with minor revisions and clarifications.

1. Last sentence of background at abstract, should specify cohort as "for older adults in Japan".

Response: Thank you for your suggestion. As suggested, “for older adults in Japan,” has been added to the abstract.

2. Result at abstract, every increase in one unit CCI was associated with 256,000…, but in table 3, it is 257,000. Please make it consistent. And it's of benefit to state every unit of CCI increase with long-term care expenditure here, as it is the novelty of this manuscript.

Response: Thank you for pointing this out. We confirmed “257,000” is correct. We agree with you that “it's of benefit to state every unit of CCI increase with long-term care expenditure here, as it is the novelty of this manuscript.” and appreciate your comment. However, due to the word limit, we have preferred not to include this.

3. Conclusion, first sentence at abstract, add "for older adults", because we have no information about this association for younger people.

Response: Thank you for this recommendation. As suggested, “for older adults” has been added.

4. Page 3, line 37, no need to state: "other than Japan", as these two references used data from UK and U.S, not every OECD country other than Japan is included.

Response: We appreciate this suggestion, and we have now removed, "other than Japan" from the revised manuscript.

5. Page 4, line 14, "used a single disease", better say "used selected diseases separately", because a couple of diseases were studied.

Response: Thank you for this feedback, we entirely agree with your comment and revised the text and “used a single disease” has been replaced with “studied the selected diseases separately.”

6. Page 5, line 34, any other variables used to merge two datasets besides ID number? Like date?
Response: Thank you for asking this question. The answer is no, only dummy ID numbers were used as a key variable to merge these two datasets.

7. Page 10 line 7, also states result of LTC coefficient to highlight its importance

Response: We appreciate your suggestion. We have replaced “each” with “medical and LTC” and also have added “therefore” for further clarification. We believe that putting the results of the sum of the expenditures would be sufficient in the main text.

Multiple generalized linear regressions showed that the CCI scores were associated with higher amounts of each expenditure, and therefore the sum of both types of expenditures (p < 0.001, Table 3; n = 29,915; Figure 1). For example, every increase in one unit of the CCI score (0, 1, 2, 3, 4, or ≥ 5) was associated with ¥256,000 ($2920) increase in the sum of both medical and LTC expenditures (95% CI [¥242,000, ¥271,000] or 95% CI [$2750, $3080]). (page 9 line 57-page 10 line 9)

8. Page 10, line 12. Is there any significant effect of covariates (age, gender, income level)? If yes, please add these covariates coefficient and p-values in table 3 total section.

Response: Thank you for raising this question. Yes, all of age, sex, and income level are statistically significant. The higher age group had $8550 higher (95% CI [$7860, $9230], p < 0.001), women had $460 higher (95% CI [$30, $900], p < 0.037), and higher income group had $3580 lower (95% CI [$3100, $4600], p < 0.001) sum of expenditures. We, however, prefer not to include these results. Conceptually, these variables function as covariates in the model, and it is our philosophy to keep the main text and table simple, so that our message can be directly and smoothly conveyed to the readers of the journal. Furthermore, the simple generalized linear regression without adjusting for these covariates did not result in change the conclusion. The results of this simple generalized linear regression have been added to the result section:

A simple generalized linear regression without adjusting for these covariates showed ¥261,000 ($2970) increase in the sum of the expenditures (95% CI [¥247,000, ¥275,000] or 95% CI [$2810, $3130], p <0.001). (page 10, line 9-16)

10. Figure 2 title should be "Predicted Probability" not "Frequency"

Response: Thank you for pointing this out. We have revised the title of the y axis in Figure 2 to “Predicted Probability”

11. Add a table of result for ordinal multiple logistic regression because level of LTC requirement is significant
Response: Thank you for your comment. However, we believe that Figure 2 sufficiently expresses the results of the ordinal multiple logistic regression. We would appreciate if you understand it is our philosophy to keep the table simple.

12. Page 11, line 41. Is higher level of LTC associated with higher expenditure? this may explain why there is an association with CCI, but no significance in each level of LTC as expenditure is same in each level?

Response: Thank you for raising this point. The answer is yes, a higher level of LTC is associated with higher LTC expenditure in this study. We have revised the manuscript to provide further clarification of this point (added in red):

Given that higher levels of LTC have higher limits for benefits paid for services per month (11), we concluded that greater comorbidity was associated with the higher level of LTC, leading to greater LTC expenditures. (We further explored and confirmed that a higher level of LTC was associated with higher LTC expenditures in this study (p < 0.001, data not shown.) (page 11, line 51-56)

13. Page 12, line 49, people with public assistance are also excluded, is there any common characteristics for them like illness, income, age?

Response: Thank you for asking this interesting question. In this sample, those who received public welfare usually belonged to the low-income group. To address this point, we have revised the manuscript to add further details at the end of the Limitations in the Discussion section.

Finally, we did not include those who received public welfare due to the unavailability of the data, which likely led to an underrepresentation of the low-income group. (page 13, line 14-19)

Xiaoyin Li, Ph.D. (Reviewer 2): This study was aimed to examine the association between the multimorbidity and the sum of medical and (long-term care) LTC expenditure. The author also introduced the medical insurance system and different levels of LTC in Japan. The main findings indicate better ways to evaluate the economic burden caused by multimorbidity on a rapidly aging society. The manuscript is well-written and this reviewer only has the following concerns:

1. First paragraph: Please spell out OECD in the first sentence, so people will know what is OECD countries.

Response: Thank you for pointing this out. OECD has now been spelled out when it is first mentioned in the first paragraph.
2. On page 5, the "overview of healthcare and long-term care insurance systems" should be moved ahead to the introduction session.

Response: Thank you for this recommendation. Based on your feedback, we have moved the "Overview of healthcare and long-term care insurance systems" subsection to be included in the Introduction section.

3. On page 8, why age was dichotomized into two categories? Why age 86 is the cutoff age? Why examine household income? How to define low-income v.s. middle-to-high income group? Rationales for examining age and household income need to be introduced.

Response: The Joint Committee of Japan Gerontological Society and the Japan Geriatrics Society proposed that those who are aged 75-89 are defined as being “old” and those who are aged 90 or older are defined as “super-old” (1). In this dataset, participant age was indicated by a 5-year age ranges based on birth years, we divided into two category by putting birthyear 1925-29 (ages 82-86 as of January 1, 2012) and later as the younger group and birthyear 1920-24 (ages 87-91 as of January 1, 2012) and earlier as the older group. The study period was between April 2012 to September 2013.


With regard to participant of income level, we have explained as follows in the main text:

As a proxy for socioeconomic status, we used the LTC insurance premiums categories, which were based on household income. The premiums categories were divided into two groups, a low-income group for those participants (along with their family members) who were exempt from residents’ taxation and a middle-to-high income group for the remaining participants (25). (page 8, line 31-41)

Because conceptually, age, sex, and income level could function as confounding factors in the analysis, we included these demographic characteristics as covariates. Furthermore, as stated in our response to Reviewer #1’s Comment 8:

A simple generalized linear regression without adjusting for these covariates showed ¥261,000 ($2970) increase in the sum of the expenditures (95% CI [ ¥247,000, ¥275,000] or 95% CI [$2810, $3130]' p <0.001). (page 10, line 9-16)

4. On page 9, "The mean medical expenditures, LTC expenditures, and the sum of these expenditures for 12 months were ¥1,086,000 ($12,340), ¥ 716,000 ($8140), and ¥370,000 ($4200), respectively (n=30,042; Figure 1, Table 2)." First of all, the order for the mean
expenditures is incorrect. This sentence is redundant because the statistics were reported in table 2.

Response: Thank you for your suggestions. The order of this sentence has been revised, so that it can be read as “The mean medical expenditures, LTC expenditures, and the sum of these expenditures for 12 months were ¥ 716,000 ($8140), ¥370,000 ($4200), and ¥1,086,000 ($12,340), respectively.” (page 9, line 47-52)

While we appreciate your feedback, we have elected to keep this statement in place, as we believe that the key findings of the study can be mentioned in the main text in addition to the table.

5. For the majority of participants (even when they have CCI score of 5 or higher), LTC was not required. This issue raises some questions. For example, who and how were levels of LTC evaluated and designated?

Response: Thank you for asking this important question. The process of the initial evaluation of LTC services in Japan is quite complicated. As it is beyond the scope of the current paper, we have added the following explanation and cited a previous study in the main text to help the reader find an explicit and detailed explanation of the process.

For greater detail on the evaluation process for LTC services in Japan, please see Tamiya and colleagues (11). (page 5, line 21-24)


Is there any evaluating scale in addition to CCI? Maybe the occurrence of multimorbidity is not the best way to determine medical expenditures. The severity of chronic diseases should also be considered.

Response: We fully agree with your point! These are important factors to be discussed. In response to your feedback, we have included the following sentence as a part of the discussion regarding the limitation of our study.

Secondly, CCI scores did not fully assess the severity of the participants’ chronic diseases, which may play an important role in the expenditures. (page 12, line 43-48)

6. For the analysis examining the association between CCI scores and 7 levels of LTC, the outcome is zero-inflated. Zero-inflated Poisson regression might be a better approach.
Response: Thank you for suggesting this analysis. In our understanding, a zero-inflated poisson regression is typically used for count data with excess zeros and over dispersion. Our analysis that examined the association between CCI scores and the 7 levels of LTC was not based on count data. Therefore, based on our understanding of this analysis, we do not believe that zero-inflated poisson regression would be applicable to our data.

7. In the discussion session, it will be helpful to know whether there is any debate on whether LTC is beneficial to society and whether it should be introduced to other countries.

Response: We agree with you that the benefits of LTC is a discussion that would be useful to a society. We, however, are afraid such content would be beyond the scope of this manuscript, as well as divert the reader from key points of our findings, so we would prefer not to include this debate in this manuscript.

8. Please double check the number in table 2 the US dollars for inpatient care and outpatient care don’t add up to 8140.

Response: Thank you for your careful review. You are entirely correct, and we apologize for this oversight. For inpatient care, US$ 3660 (not 3650) is correct. We have revised Table 2 accordingly, and now the sum of inpatient and outpatient care equal the total medical expenditure.