PEER REVIEW HISTORY

ARTICLE DETAILS

TITLE (PROVISIONAL)	Reduced long-term care cost by social participation among older Japanese adult: A prospective follow-up study in JAGES
AUTHORS	Saito, Masashige; Aida, Jun; kondo, naoki; Saito, Junko; Kato, Hirotaka; Ota, Yasuhiro; Amemiya, Airi; Kondo, Katsunori

VERSION 1 – REVIEW

REVIEWER	Ross Wilkie & Yourah Uraiby Keele University, United Kingdom
REVIEW RETURNED	05-Jul-2018

GENERAL COMMENTS	This manuscript describes an observational study which evaluates differences in long term care insurance costs by level of social participation. The study topic is important; identifying if social participation should be a target for public health and clinical practice is important, particularly for people with impairments of activity limitation. However the manuscript requires greater detail to evaluate whether these findings can support the findings. Greater detail is also required to explain this work to the international readership of the journal and to enhance the generalisability of this work beyond Japan. Please consider the following points when revising the manuscript: Introduction 1.Explain what a healthy ageing society is; understanding of “healthy ageing” will vary. 2. Please include studies from additional countries to Japan on the benefits of social participation on health; this will outline the potential role of social participation beyond Japan and to this journal’s international readership. 3. Explain what collective, productive and political social participation are. 4. For an international audience, consider explaining how people obtain LTCI and use services. Explain who is eligible. Methods 1. Explain what a complete survey is? Should this be comprehensive or self - complete? 2. How do the 5483 responders differ to the 10274 enrolled? Is there non-response bias and how will this affect the results and generalisability? 3. Explain in greater detail how social participation was measured – how many items, phrasing of items. Also add support for the validity of these items and this approach. 4. Explain the selection of confounders – which impairments and comorbidities were included. Include as a limitation why some

	were not included. Include in the discussion why physical limitation and/or physical activity levels were not included. Could it be that it is general physical activity that is important and not social participation? Consider adjusting for this. 5. Where did you obtain the LTC costs from? Is this an acknowledged custodian of this data? 6. Add a sentence to explain why you have assumed that data is missing at random; often older adults missing data is linked to poor health. 7. Statistical analysis requires more detail; include assumptions for the analysis. 8. Explain what is meant by "the causal treatment effect from observational data". I don't feel this is correct. There is an association between levels of social participation and lower costs but I am not convinced and feel that it is inaccurate to state that social participation causes lower costs. Results 1. Table 1: Disease and/or impairment – please express as the number rather than binary (it is important to know which morbidities are present and how many; knowing that people have 1 morbidity is almost meaningless) 2. 27.2% have no health impairments or health conditions? Is this a healthy cohort? Please comment in the discussion. 3. Table 2: Give explanation for Care Lv2 and Care Lv4. This is not explained clearly in the methods. Why not present all levels? 4. Flowchart of respondent selection - please state the overall denominator population – what is the population size from which the 10,274 comes from and who was excluded before enrolment? – really important to interpret who the sample is representative of. 5. Results page 9, line 3 and 4. What proportion of the sample received LTCI. Is the average across the whole population or only those who claimed? 6. Was the distribution of the frequency of LTC normally distributed? 7. Page 9, last paragraph. As above, I am not convinced you can talk about treatment effects in an observational study; please revise. 8. The weighted model compared to the GLM estimations; add the interpretation of why the there are changes in significance but not model fit. Discussion 1. Discuss the role of physical activity and other potential confounders on the results. There is a lack of detail in the description of the methods which prevents a clear interpretation of results. Taking sport as an example, without knowing which sports are referred to it is difficult to interpret if social participation is the reason for the lower costs or if the reason that social participation is associated is that those who socially participate have less comorbidity, are healthier or are physically more active. The first section of the discussion highlights the link with physical disability – explain why social participation is different to physical limitation. Consider adding as a sensitivity analysis the link between physical activity and costs or include physical activity/disability in this analysis. 2. Page 11, line 13 – I not sure the study on tooth loss is relevant – again is this a sign of poor health rather than be linked to social participation. Again the literature to support the points being made need to be broader than from one country.

	3. Page 11, line 18 – is the role of social participation due to the ability to social participate than be the social participation itself –as above really important to explain/further adjust for health/comorbidity/physical function. 4. Explain why the study has high representativeness because public receipt data was used. 5. Page 12, line 24 – please clarify the points being made should you refer to measurement bias and validity of the measure of social participation. 6. Limitations: please see previous points with regards to confounding 7. Consider adding implications sections for practice and research.

REVIEWER	Nanako Tamiya University of Tsukuba
REVIEW RETURNED	24-Aug-2018

GENERAL COMMENTS	MAJOR REVISION Page 2 of 25, line 14 Some information of the participants is included in the setting. Please describe the participants in more detail. Page 2 of 25, line 14 As for the results part, because the objective mentions "differences", the results should address clearer what the objective is looking for in terms of actual differences: "The IPW……..to non-participants" It is unclear what 3500 USD and 6000 USD are supposed to mean, in relation to the objective of the study Page 5 of 25, line 4 The objectives are not clearly stated in the Introduction part of the article (page 5 line 4). A section should be included addressing the hypothesis or empirical aim of this study. It seems necessary to specify the direction of the relation of the independent variables and dependent variable you have hypothesized in a clear way. Page 6 of 25, line 3 Because the objectives are not clear, it is hard to tell if the results address them. Also, please explain in more detail Tab 2 What part of the objectives or research question it addresses. For the methods, please define clearly the sample at the in the Study design and improve the flow chart. Page 6 of 25, line 3 For the outcomes, in the subtitle: Explanatory variables: Social participation. It would be better to provide a definition of the 3 social groups: hobbies, sports and volunteering; there might be a confusion between hobbies and sports if not well defined, mention some question from the survey applied to the sample. Also, according to which criteria the authors and/or the researchers decided to choose as social participation variables: hobbies, sports and volunteering

	Page 7 of 25, line 7 It is not clear how you handle the fact that a given person can participate in more than one group for. social participation. If a person/many of them participate in all three groups, how can you isolate the effect or how do you handle the interaction effect between of having a more active social participation? MINOR REVISION Page 14 of 25, line 47 There is one spelling mistake in the reference N°25. “Generalized Linear Models” Page 13 of 25, line 29 It is not necessary to mention twice the Ethics in the article: Study design and in the Ethics approval part.

VERSION 1 – AUTHOR RESPONSE

Reviewer 1:
Introduction
1.Explain what a healthy ageing society is; understanding of “healthy ageing” will vary.
Response;
We added explanation about "healthy aging".
Introduction: (page 4, line 10)
Lowering these costs requires building a sustainable and healthy aging society which means developing and maintaining the functional ability that enables well-being in older age

2. Please include studies from additional countries to Japan on the benefits of social participation on health; this will outline the potential role of social participation beyond Japan and to this journal’s international readership.
Response;
We added more explanation about findings in previous systematic review.
Introduction: (page 4, line 25)
Several international systematic reviews and meta-analyses have reported on the physical, psychological, and social benefits of social participation among older people.5-10 For instance, meta-analysis across 148 articles mentioned active engagement in social activities could reduce risk for mortality. In particular, previous observational studies in Japan also found that .....

3. Explain what collective, productive and political social participation are.
Response;
We added brief explanation based on Bukov (2002).
Introduction: (page 4, line 18)
Although social participation is an ambiguous concept, Bukov (2002) distinguished three types of participation: collective, productive, and political.4 In this paper, we focused on involvement in collective activities in formal and informal societal groups at local community.

4. For an international audience, consider explaining how people obtain LTCI and use services. Explain who is eligible.
Response;

We added brief explanation about Japanese long-term care insurance system in introduction part.
Introduction: (page 5, line 4)
In addition, Japanese LTCI services are provided mainly when people aged 65 and over come to require care or support, based on investigation for certification and doctor's written opinion.

Methods
1. Explain what a complete survey is? Should this be comprehensive or self - complete?
Response;
Thank you for your comment. It was not correct expression. We used that in the meaning of a survey targetting on every member of a population in one municipality, NOT sample survey. We modified it to a "complete enumeration" in abstract, study design in maintext, and figure 1.
Abstract: (page 2, line 8)
Our baseline survey was conducted in March 2006 among people aged 65 or older who were not eligible for public LTCI benefits were selected using a complete enumeration in Tokoname City, Japan.
Method: (page 6, line 6)
... ... not eligible for public LTCI benefits were selected using a complete enumeration;
Figure 1:
Complete enumeration for functionally independent ... ...

2. How do the 5483 responders differ to the 10274 enrolled? Is there non-response bias and how will this affect the results and generalisability?
Response;
As we had mentioned in strengths and limitations, we thought it is one of limitations in this paper. However, we consider that the response rate (around 50%) is not necessarily fatally low in comparison to other questionnaire survey. Having this comment, we revised method and discussion (limitations). Then, figure 1 (flow chart) was also modified.
Method: (page 6, line 7)
... ... they live in the city of Tokoname in Aichi Prefecture (response rate=53.4%: 5,483 / 10,274)
Discussion: (page 13, line 24)
Third, generalizability might be limited by the fact that our study was conducted in one municipality, although the proportion of older adults and of certified LTC levels is roughly the same between the subject area and the national average. Selection bias might have occurred because the response rate in baseline survey was not high (53.4%).

3. Explain in greater detail how social participation was measured – how many items, phrasing of items. Also add support for the validity of these items and this approach.
Response;
Thank you for your comment. Same point was mentioned by reviewer 2 too. We added more explanation and theoretical background about indicators of social participation in method section, and added several paper at reference.
Method: (page 7, line 11)
The indicator of social participation was taken from the Japanese General Social Survey,25 and categorized organizations into following eight types: hobby activities group, sports group or club, volunteer group, neighborhood association, senior citizen club/fire-fighting team, religious group, political organization or group, industrial or trade association, and citizen or consumer group. We focused on the three groups/organizations previously identified as being associated with lower risks for functional disabilities; hobby activities group,17,26 sports group or club,15,26 and volunteer group.27,28 According to principal components analysis, these community activities were categorized to horizontal organizations.29,30 Respondents were asked how often they took part in these activities. We categorized them to the four frequencies, respectively; never; a few times a year; once or twice a month; and once a week or more.

Reference:
25. Osaka university commerce JGSS Research Center. Summary of Surveys. (http://jgss.daishodai.ac.jp/english/surveys/sur_top.html)
26. Ashida T., Kondo N., Kondo K. (2016) Social participation and the onset of functional disability by socioeconomic status and activity type: the JAGES cohort study. Prev Med, 89: 121-128.
27. Lum T.Y., & Lightfoot E. (2005) The effects of volunteering on the physical and menatl health of older people. Res Aging, 27(1): 31-55.
28. Musick M.A., & Wilson J. (2003) Volunteering and depression: the role of psychological and social resouces in different age group. Soc Sci Med, 56(2) 259-269.
29. Aida J., Hanibuchi T., & Nakade M., et al. (2009) The different effects of vertical social capital and horizontal social capital on dental status: a multilevel analysis. Soc Sci Med. 69(4): 512-518
30. Yazawa A., Inoue Y., & Fujiwara T., et al. (2016) Association between social participation and hypertension among older people in Japan: the JAGES Study. Hypertens Res. 39(11):818-824.

4. Explain the selection of confounders – which impairments and comorbidities were included. Include as a limitation why some were not included. Include in the discussion why physical limitation and/or physical activity levels were not included. Could it be that it is general physical activity that is important and not social participation? Consider adjusting for this.
Response;
As mentioned below, we excluded physically and cognitively dependent older adults at baseline survey from government database of public LTCI. We also have considered health condition and other factors at baseline. Strictly speaking, although we cannot deny the possibility of reverse causation, we have controlled major effect of physical limitation as far as possible. Having this comment, we modified method and discussion sections.
Method: (page 6, line 4)
In addition, our subjects were more healthy or active older adults at baseline, because Japanese LTCI certifies the people included mild care needs, not only severe care level.
Method: (page 7, line 23)
Demographic variables included sex, age, educational attainment, equivalent income (USD), marital status, and living situation at the baseline survey. Age was a continuous variable (73.4±6.2). Years of education was categorized as <6, 6-9, 10-12, and 13+. We equalized household income by the square root of the numbers and classified it as <20.0, 20.0-39.9, and 40.0+ thousand USD. Marital status consisted of married, widowed, divorced, and never married. Living situation was categorized as living alone, with one's spouse only, with a child, or with others such as grandchildren, siblings, and relatives.
In order to account for the health status at the baseline, the presence of disease or impairment and self-rated health were considered. The presence of disease or impairment was based on self-reported medical condition (no illness, having illness but need no treatment, having illness but discontinued treatment, and receiving some treatment). We dichotomized it; that is, no illness or not. We assessed self-rated health using four categories: excellent, good, fair, and poor.
Discussion: (page 12, line 2)
According to the 11-year prospective cohort study for Japanese healthy older adults, compared to non-participants, respondents who took part in the group for hobbies or sports once a week produced lower costs for LTCI services (approximately 3.5 and 6.1 thousand USD per person), even after demographic variables and health status at baseline were controlled.
Discussion: (page 13, line 20)
Second, we assessed social participation variables and covariates only at the baseline. Our study analyzed healthy older adults; we excluded those with physically and cognitively disabilities at baseline; we controlled for multiple health dimensions and other covariates, adopting several statistical techniques. However, we cannot deny the possibility of reverse causation.

5. Where did you obtain the LTC costs from? Is this an acknowledged custodian of this data?

Response;
We obtained it from LTC section in municipality as an insurer. As we mentioned in "ethics approval", this process was performed on the basis of collaborative research agreement between municipality and university. Having this comment, we modified method part.
Method: (page 6, line 10)
Afterward, we obtained receipt data on LTCI benefits over a period of 11 years after the baseline survey, from government database of public LTCI.

6. Add a sentence to explain why you have assumed that data is missing at random; often older adults missing data is linked to poor health.
Response;
We thought this comment is misunderstanding. "Missing at random" means that there might be systematic differences between the missing and observed data (please see, Bhaskaran et al. 2014). It is not missing COMPLETELY at random. We adopted multiple imputation, because we also thought older adults missing data is linked to poor health. Having this comment, we added explanation.
(ref.) Bhaskaran et al. (2014) What is the difference between missing completely at random and missing at random? International Journal of Epidemiology, 1336–1339
Method: (page 8, line 16)
Next, we performed a multiple imputation technique by chained equations under the missing at random assumption which means there might be systematic differences between the missing and observed values.

7. Statistical analysis requires more detail; include assumptions for the analysis.
Response;
We added brief explanation about statistical model.
Method: (page 8, line 8)
First, we adopted a classical linear regression (ordinary linear squares [OLS]) model, controlling covariates at baseline survey. We handled the missing value in each control variable as a dummy variable. Second, as one of robustness check, we predicted the marginal effects, adopting a generalized linear model (GLM)25 with Gamma distribution, as well as the log link and robust variance estimator, because our dependent variable (the cumulative cost of LTCI services) is not normally distributed. Next, we performed a multiple imputation technique by chained equations under the missing at random assumption, which means there might be systematic differences between the missing and observed values. We created twenty imputed datasets. Using each dataset, we first estimated the OLS model with the robust variance estimator. Finally, in order to estimate the potential outcomes after conditioning on the covariates, we adopted the inverse probability weighting (IPW) model26, 27 using the imputed data sets. We calculated the generalized propensity scores using multinomial regression analysis, employing all previously listed covariates.

8. Explain what is meant by “the causal treatment effect from observational data”. I don’t feel this is correct. There is an association between levels of social participation and lower costs but I am not convinced and feel that it is inaccurate to state that social participation causes lower costs.
Response;
Thank you for important suggestion. The expressions of "the causal treatment effect (from observational data)" or "average treatment effect" have been used in the inverse probability weighting (IPW estimation) methodology. However, to prevent misreading, we modified these expressions.
Method: (page 8, line 18)
Finally, in order to estimate the potential outcomes after conditioning on the covariates, we adopted the inverse probability weighting (IPW) model26, 27 using the imputed data sets.
Results: (page 10, line 25)
The estimations of IPW showed similar outcomes.

Results
1. Table 1: Disease and/or impairment – please express as the number rather than binary (it is important to know which morbidities are present and how many; knowing that people have 1 morbidity is almost meaningless)
Response;
We can assess the number of disease and/or impairment from 11 items: cancer, heart disease, stroke, high blood pressure, respiratory disease, mental disease, difficulty swallowing, impaired vision, impaired hearing, elimination problems, and undiagnosed illness. Distribution of that was as follows. However, we thought the continuous variable (count variable) is not necessarily appropriate in this paper, because our main subject is not exploration of threshold of that. We added brief explanation of this variable in method section.
(ref.) Distribution of disease and/or impairment at baseline survey
(n) %
None 1462 27.2
Presense 3471 64.6
Number of disease/impairment
One 1725 32.1
Two 817 15.2
Three 227 4.2
Four 73 1.4
Five 13 0.2
Six 12 0.2
Seven 2 0.0
Unknown 602 11.2
Missing 444 8.3
Total 5377 100.0

Method: (page 8, line 1)
In order to account for the health status at the baseline, the presence of disease or impairment and self-rated health were considered as covariates. The presence of disease or impairment was based on self-reported medical condition (no illness, having illness but need no treatment, having illness but discontinued treatment, and receiving some treatment). We dichotomized it; that is, no illness or not.

2. 27.2% have no health impairments or health conditions? Is this a healthy cohort? Please comment in the discussion.
Response;
As shown in study design (method section), the subject of this paper was the people who were 65 years or older, physically and cognitively independent, and not eligible for public LTCI benefits in baseline survey. Moreover, they could respond a self-administered questionnaire (although this is one of limitaion). Therefore, it can say a comparatively healthy cohort. Having this comment, we revised method and discussion part.
Method: (page 6, line 7)
..... In addition, our subjects were more healthy or active older adults at baseline, because Japanese LTCI certifies the people included mild care needs, not only severe care level.
Discussion: (page 12, line 2)
According to the 11-year prospective cohort study for Japanese healthy older adults, compared to non-participants, respondents who took part in the group for hobbies or sports once a week produced lower costs for LTCI services (approximately 3.5 and 6.1 thousand USD per person), even after demographic variables and health status at baseline were controlled.

3. Table 2: Give explanation for Care Lv2 and Care Lv4. This is not explained clearly in the methods. Why not present all levels?

Response;
Having this comment, we added brief explanation in method section, and modified table 2 to show average duration of all care levels at follow-up period.
Method: (page 6, line 24)
As related variable, we calculated the average number of months at the follow-up period across the whole population, from care level 5 which signifies the highest level of requirement for LTC to any care or support level.
Table 2: Average duration of care giving at follow-up period by social participation
Care Lv1+ Care Lv3+ Care Lv5
n Mean (SD) Mean (SD) Mean (SD)
Hobby activities group
Never 2833 9.8 (21.4) 4.0 (12.5) 0.8 (4.6)
A few times a year 259 5.6 (15.7) 1.8 (6.4) 0.6 (4.1)
Once or twice a month 524 6.1 (16.6) 2.7 (10.2) 0.6 (3.7)
Once a week + 972 6.2 (16.6) 2.2 (9.3) 0.4 (3.0)
p <.001 p <.001 p =.026
Sports group or club
Never 3716 9.3 (20.7) 3.8 (12.1) 0.8 (4.6)
A few times a year 91 5.6 (18.4) 2.8 (12.0) 0.8 (5.0)
Once or twice a month 125 3.3 (13.4) 1.4 (6.9) 0.2 (1.4)
Once a week + 572 3.8 (12.8) 1.0 (5.4) 0.1 (1.0)
p <.001 p <.001 p =.005
Volunteer group
Never 3899 8.6 (20.0) 3.5 (11.6) 0.7 (4.3)
A few times a year 194 3.9 (12.8) 1.6 (8.3) 0.7 (5.6)
Once or twice a month 193 6.1 (17.0) 2.0 (8.9) 0.4 (2.7)
Once a week + 122 3.9 (12.4) 1.6 (6.9) 0.2 (1.5)
p <.001 p <.001 p =.165
Unit: month SD: Standard deviation

4. Flowchart of respondent selection - please state the overall denominator population – what is the population size from which the 10,274 comes from and who was excluded before enrolment? – really important to interpret who the sample is representative of.
Response;
As shown above, baseline survey was complete enumeration. Therefore, 10,274 is the overall denominator population, and does not include people who had used public LTCI benefits at the time. We revised figure 1 (flowchart).
Figure 1:
Complete enumeration for functionally independent older adults from government database of public LTCI

5. Results page 9, line 3 and 4. What proportion of the sample received LTCI. Is the average across the whole population or only those who claimed?
Response;
The average was calculated across the whole population. Then, we added the explanation in method and result.
Method: (page 6, line 24)
..... As closely related variable, we calculated the number of months which was eligible for LTCI benefit across the whole population, from care level 5 which signifies the highest level of requirement for LTC to any care or support level.
Results: (page 10, line 6)

There were significant differences in the average duration for the level of care required for social participation across the whole population during the follow-up period.

6. Was the distribution of the frequency of LTC normally distributed?
Response;
We added the distribution of that in RESULTS section.
Results: (page 10, line 4)
The distribution of that was skewed right.

7. Page 9, last paragraph. As above, I am not convinced you can talk about treatment effects in an observational study; please revise.
Response;
As mentioned above, we revised, as follows.
Results: (page 10, line 25)
The estimation of IPW showed similar outcomes.

8. The weighted model compared to the GLM estimations; add the interpretation of why the there are changes in significance but not model fit.
Response;
In the study of medical expenditures, it is proposed that GLM estimation is one of appropriate method, if an outcome variable (cost) is not normal distribution (ex. Buntin et al. 2004). Then, we adopted it as a robustness check in this paper. On the other hand, Buntin et al. (2004) also mentioned, a potential disadvantage of the GLM approach is that GLM estimation can be less efficient than OLS, a natural consequence of its weaker model assumptions. Therefore, it seems naturally that confidential interval in GLM showed broader in our results. We thought the most important thing is the major results and trends were similar between OLS and GLM, as suggesting a robustness of our results.
(ref.) Buntin et al. (2004) Too much ado about two-part models and transformation? Comparing methods of modeling medicare expenditures. Journal of Health Economics, 23: 525-542

Discussion
1. Discuss the role of physical activity and other potential confounders on the results. There is a lack of detail in the description of the methods which prevents a clear interpretation of results. Taking sport as an example, without knowing which sports are referred to it is difficult to interpret if social participation is the reason for the lower costs or if the reason that social participation is associated is that those who socially participate have less comorbidity, are healthier or are physically more active. The first section of the discussion highlights the link with physical disability – explain why social participation is different to physical limitation. Consider adding as a sensitivity analysis the link between physical activity and costs or include physical activity/disability in this analysis.
Response;
This is very important point of this paper. But I'm afraid there are some misunderstandings.
As shown in method part, the subject of this paper was physically and cognitively independent, from government database of public LTCI at baseline survey. It can also say our subjects were healthy or active older adults at baseline, because Japanese LTCI certifies the people included mild care needs, not only severe care level. Moreover, we have already considered presence of disease and/or impairment, self-rated health, sex, age, educational attainment, equivalent income (USD), marital status, and living situation at baseline survey. Additionally, we adopted the inverse probability weighting estimation with multiple-imputation in order to control individual characteristics of usability or accessibility to participate three activities from observational data as far as possible. However, strictly speaking, we can not deny the possibility of reverse causation.
As shown in introduction part, several previous papers based on prospective cohort study and intervention study have showed social participation might decrease the risk of incident functional disability. In this context, we also confirmed that the average duration of care giving at follow-up

period was shorter among respondents who participated in social activities than non-participants (Table 2). We thought additional analysis which reviewer mentioned is outside the scope of this paper.
Considering the above, we revised discussion and method part to avoid misunderstanding to readers.
Method: (page 6, line 7)
..... In addition, our subjects were more healthy or active older adults at baseline, because Japanese LTCI certifies the people included mild care needs, not only severe care level.
Discussion: (page 12, line 2)
According to the 11-year prospective cohort study for Japanese healthy older adults, compared to non-participants, respondents who took part in the group for hobbies or sports once a week produced lower costs for LTCI services (approximately 3.5 and 6.1 thousand USD per person), even after demographic variables and health status at baseline were controlled.
Discussion: (page 13, line 20)
..... Second, we assessed social participation variables and covariates only at the baseline. Our study analyzed healthy older adults; we excluded those with physically and cognitively disabilities at baseline; we controlled for multiple health dimensions and other covariates, adopting several statistical techniques. However, we cannot deny the possibility of reverse causation.

2. Page 11, line 13 – I not sure the study on tooth loss is relevant – again is this a sign of poor health rather than be linked to social participation. Again the literature to support the points being made need to be broader than from one country.
Response;
Thank you for important suggestion. We deleted two papers concerning tooth loss, and added previous findings based on longitudinal study except Japan. Thus, reference part was revised.
Discussion: (page 12, line 7)
These findings are consistent with those of previous research. Several longitudinal studies showed that older adults who participate in social activities have lower risks of disability,34 functional decline,35,36 and mobility decline.37,38 Moreover, it has been suggested that participation to hobby groups, sports club, and volunteer group might contribute to reduce the incidence of physical disability risk.15,17,26-28 In an intervention study examining the effect of community salons in Japan, among the participants, the incidence of physical disability risk fell by 51% over five years;39 cognitive disability risk also declined by around 30% over seven years.40 Several trajectory analyses showed that attending leisurely activities is related to “functional maintenance,”41 while a low frequency of going out was related to being “persistently disabled.”42
References:
34. Mendes de Leon C.F., Glass T.A., Berkman L.F. (2003) Social engagement and disability in a community population of older adults: the New Haven EPESE. Am J Epidemiol. 157(7): 633-642.
35. James B.D., Boyle P.A., Buchman A.S., et al. (2011) Relation of late-life social activity with incident disability among community-dwelling older adults. J Gerontol A Biol Sci Med Sci, 66A(4):467-473
36. Thomas PA. (2011) Trajectories of social engagement and limitations in late life. J Health Soc Behav, 52(4): 430-443.
37. Avlund K., Vass M., & Hendriksen C. (2003) Onset of mobility disability among community-dwelling old men and women: the role of tiredness in daily activities. Age Ageing 32(6): 579-584
38. Buchman A.S., Boyle P.A., & Wilson R.S., et al. (2009) Association between late-life social activity and motor decline in older adults. Arch Intern Med, 169(12): 1139-1146.

3. Page 11, line 18 – is the role of social participation due to the ability to social participate than be the social participation itself –as above really important to explain/further adjust for health/comorbidity/physical function.
Response;

As mentioned above, we have considered the individual characteristics of usability or accessibility to participate three activities as far as possible from observational study. Likewise, we added some explanations as follows.
Discussion: (page 12, line 2)
According to the 11-year prospective cohort study for Japanese healthy older adults, compared to non-participants, respondents who took part in the group for hobbies or sports once a week produced lower costs for LTCI services (approximately 3.5 and 6.1 thousand USD per person), even after demographic variables and health status at baseline were controlled.
Discussion: (page 13, line 20)
..... Second, we assessed social participation variables and covariates only at the baseline. Our study analyzed healthy older adults; we excluded those with physically and cognitively disabilities at baseline; we controlled for multiple health dimensions and other covariates, adopting several statistical techniques. However, we cannot deny the possibility of reverse causation.

4. Explain why the study has high representativeness because public receipt data was used.
Response;
It was not appropriate expression. We deleted expression concerning high representativeness.
Discussion: (page 13, line 24)
Third, generalizability might be limited by the fact that our study was conducted in one municipality, although the proportion of older adults and of certified LTC levels is roughly the same between the subject area and the national average. Selection bias might have occurred because the response rate in baseline survey was not high (53.4%). However, there was important meanings to analyze the merged individual data from a questionnaire concerning social life and a public receipt data concerning LTC services.

5. Page 12, line 24 – please clarify the points being made should you refer to measurement bias and validity of the measure of social participation.
Response;
We can not deny the possibility of measurement bias about social participation in baseline survey, although our indicators have been often used in previous self-reported questionnaire. We modified limitation part as follows.
Discussion: (page 13, line 30)
Fourth, there might be measurement bias about social participation because it derived from the self-reported questionnaire. Although our indicators have been often used in previous survey, it is possible that it does not reflect actual activities correctly since the self-reported one. To assess the frequency and role of these groups, future research should examine interactions among participating members using objective indicators.

6. Limitations: please see previous points with regards to confounding
Response;
We added the possibility of reverse causation in discussion as one of limitations.
Discussion: (page 13, line 20)
... ... Second, we assessed social participation variables and covariates only at the baseline. Our study analyzed healthy older adults; we excluded those with physically and cognitively disabilities at baseline; we controlled for multiple health dimensions and other covariates, adopting several statistical techniques. However, we cannot deny the possibility of reverse causation. Third, ...

7. Consider adding implications sections for practice and research.
Response;
I'm sorry, I couldn't understand this suggestion correctly. We had described public health implications of this paper in discussion section (page 13, line 3). That is, we mentioned that our results suggest

promoting participation in community activities might have a non-ignorable cost containment effect. Does that mean that it is inappropriate?

Reviewer 2:
MAJOR REVISION
1. Some information of the participants is included in the setting. Please describe the participants in more detail. (Page 2 of 25, line 14)
Response;
We revised the participants of ABSTRACT, as follows.
Participants: Functionally independent 5,377 older adults.

2. As for the results part, because the objective mentions “differences”, the results should address clearer what the objective is looking for in terms of actual differences: “The IPW……..to non-participants” It is unclear what 3500 USD and 6000 USD are supposed to mean, in relation to the objective of the study (Page 2 of 25, line 14)
Response;
We thank this reviewer for pointing this out. We revised the results of ABSTRACT, as follows.
Results: .....The IPW model showed that respondents who participated in hobby activities once a week or more, the cumulative cost of LTCI services for 11 years was lower approximately 3,500 USD per person, in comparison to non-participants. Similary, that in respondents who participated in sports group or clubs was lower approximately 6,000 USD than non-participants.

3. The objectives are not clearly stated in the Introduction part of the article (page 5 line 4). A section should be included addressing the hypothesis or empirical aim of this study. It seems necessary to specify the direction of the relation of the independent variables and dependent variable you have hypothesized in a clear way (Page 5 of 25, line 4)
Response;
Thank you for important suggestion. We revised the hypothesis and purpose of this paper in introduction section.
Introduction: (page 5, line 1)
We hypothesize that if social participation extends healthy life expectancy and reduces the time spent in intensive nursing care, then the cumulative cost of LTCI services might be lower among the participants; however, to our knowledge, there is no evidence that social participation lessens it.
Introduction: (page 5, line 10)
In this paper, using data from a follow-up study that took place over a period of 11 years and tracked older Japanese adults, we assessed the differences of the duration period of requiring care level and of the cumulative cost of LTCI services by frequency of social participation in baseline survey.

4. Because the objectives are not clear, it is hard to tell if the results address them. Also, please explain in more detail Tab 2 What part of the objectives or research question it addresses. For the methods, please define clearly the sample at the in the Study design and improve the flow chart (Page 6 of 25, line 3)
Response;
We thank reviewer for suggesting this. We revised method and results sections, and figure 1 (flow chart) in order to clarify aim of this analysis.
Method: (page 6, line 19)
Primary outcome variable is the cumlative cost of LTCI services at follow-up period. We obtained the LTC costs of insured services across forty-four points every three months (April, July, October, January) over a period of 11 years. We summed them up after tripling these monthly costs in order to calculate an approximate value of the overall cost for the follow-up period. We used the currency exchange rate of 100JPY to 1USD. As closely related variable, we calculated the number of months

which was eligible for LTCI benefit across the whole population, from care level 5 which signifies the highest level of requirement for LTC to any care or support level.
Results: (page 10, line 8)
Non-participants in groups for hobbies, sports, and volunteering had a longer duration of certification for LTC at all care levels. For example, among participants who took part in the group for hobbies, the average duration for non-participants was 14.1 (standard deviation [SD]=25.8) months, whereas that of those who participated “once a week or more” was 10.6 (SD=21.6) months.

5. For the outcomes, in the subtitle: Explanatory variables: Social participation. It would be better to provide a definition of the 3 social groups: hobbies, sports and volunteering; there might be a confusion between hobbies and sports if not well defined, mention some question from the survey applied to the sample. Also, according to which criteria the authors and/or the researchers decided to choose as social participation variables: hobbies, sports and volunteering (Page 6 of 25, line 3)
Response;
Thank you for your comment. Same point was mentioned by Reviewer 1 too. We added more explanation and theoretical background about indicators of social participation in method section, and added several paper at reference.
Method: (page 7, line 11)
The indicator of social participation was taken from the Japanese General Social Survey,25 and categorized organizations into following eight types: hobby activities group, sports group or club, volunteer group, neighborhood association, senior citizen club/fire-fighting team, religious group, political organization or group, industrial or trade association, and citizen or consumer group. We focused on the three groups/organizations previously identified as being associated with lower risks for functional disabilities; hobby activities group,17,26 sports group or club,15,26 and volunteer group.27,28 According to principal components analysis, these community activities were categorized to horizontal organizations.29,30 Respondents were asked how often they took part in these activities. We categorized them to the four frequencies, respectively; never; a few times a year; once or twice a month; and once a week or more.
Reference:
25. Osaka university commerce JGSS Research Center. Summary of Surveys. (http://jgss.daishodai.ac.jp/english/surveys/sur_top.html)
26. Ashida T., Kondo N., Kondo K. (2016) Social participation and the onset of functional disability by socioeconomic status and activity type: the JAGES cohort study. Prev Med, 89: 121-128.
27. Lum T.Y., & Lightfoot E. (2005) The effects of volunteering on the physical and menatl health of older people. Res Aging, 27(1): 31-55.
28. Musick M.A., & Wilson J. (2003) Volunteering and depression: the role of psychological and social resouces in different age group. Soc Sci Med, 56(2) 259-269.
29. Aida J., Hanibuchi T., & Nakade M., et al. (2009) The different effects of vertical social capital and horizontal social capital on dental status: a multilevel analysis. Soc Sci Med. 69(4): 512-518
30. Yazawa A., Inoue Y., & Fujiwara T., et al. (2016) Association between social participation and hypertension among older people in Japan: the JAGES Study. Hypertens Res. 39(11):818-824.

6. It is not clear how you handle the fact that a given person can participate in more than one group for. social participation. If a person/many of them participate in all three groups, how can you isolate the effect or how do you handle the interaction effect between of having a more active social participation? (Page 7 of 25, line 7)
Response;
In this paper, we analyzed three social participation indicators separately. We don't perform to calculate integrated score or interaction effect, because distribution and meanings of each activities qualitatively differed. As shown in table 3, the effect of frequency of participation to volunteer group has different trend from other two variables. Therefore, we thought it is not suitable to sum up our three social participation variables. We modified in method section as follows.

Method: (page 7, line 20)
We categorized them to the four frequencies, respectively; never; a few times a year; once or twice a month; and once a week or more.

MINOR REVISION
1. There is one spelling mistake in the reference N°25. “Generalized Linear Models” (Page 14 of 25, line 47)
Response;
I apologize for our mistake. We modified as follows.
Reference
31. McCullagh P., & Nelder JA., (1989) Generalized Linear Models, second ed. CRC Press.

2. It is not necessary to mention twice the Ethics in the article: Study design and in the Ethics approval part (Page 13 of 25, line 29)
Response;
Thank you for your comment. We deleted it in "study design" part (page 6, line 15).

Others:
I found some mistakes in our manuscript. I apologize for our some mistakes. In addition, major results and discussions have not changed.
Introduction: (page 4, line 8)
Under these circumstances, the costs for long-term care insurance (LTCI) are expected to rise from 100 billion USD in 2016 to 210 billion USD by 2025.
Table 2: Hobby activities group(Care Lv4+), p =.019

Again, we would like to thank the reviewers and editor again for their helpful suggestions. We believe that our paper is improved as a result of attending to their suggestions, and we hope that our paper is now acceptable for publication. We look forward to hearing from you.
Sincerely.

VERSION 2 – REVIEW

REVIEWER	Nanako Tamiya Department of Health Services Research , Faculty of Medicine, Research and Development Center for Health Services, University of Tsukuba
REVIEW RETURNED	09-Oct-2018

GENERAL COMMENTS	All my comments were addressed satisfactory

VERSION 2 – AUTHOR RESPONSE

Reviewer 2:
1. Please state any competing interests or state 'None declared': None declared
Response;
Thank you for your comment. we reconfirmed it. In addition, we had already shown it in competing interests part (page 15).