

## PEER REVIEW HISTORY

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### ARTICLE DETAILS

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| <b>TITLE (PROVISIONAL)</b> | Cross-sectional associations of housework with cognitive, physical and sensorimotor functions in younger and older community-dwelling adults – the Yishun Study |
| <b>AUTHORS</b>             | Lee, Shuen Yee; Pang, Benedict Wei Jun; Lau, Lay Khoon; Jabbar, Khalid Abdul; Seah, Wei Ting; Chen, Kenneth Kexun; Ng, Tze Pin; Wee, Shiou-Liang                |

### VERSION 1 – REVIEW

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| <b>REVIEWER</b>        | Nadine Santos<br>University of Minho |
| <b>REVIEW RETURNED</b> | 12-Jul-2021                          |

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| <b>GENERAL COMMENTS</b> | <p>Briefly, in this cross-sectional study the authors sought to explore (potential) associations between housework and functional health among younger (&gt;65yo) and older (&gt;65yo) Singaporean community-dwelling adults. This is an interesting study, with due care in sample selection methods, and sound methodology &amp; analysis, which considers a topic of interest and often forgotten in how we go about studying PA - our PA is, in fact, a result of recreational and non-recreational activities, where the latter should not be ignored (as neither should, in itself, its potential role/association with health measures/indicators/etc) despite any absence of other programmed PA (such as gym, etc).</p> <p><b>ABSTRACT</b><br/>Overall it is well written. The two opening sentences may, however, need an adjustment. This reviewer suggests to opt to focus on what is to be gained to address both PA (recreational and non-recreational) as it is a more accurate picture of ADL, across age groups, rather than focus on protecting from "ill health" or what is studied in "richer" (vs. poorer) countries (I assume).</p> <p><b>ARTICLE SUMMARY</b><br/>1. would remove "even in high income countries" at the end of the second paragraph;<br/>2. in the third paragraph something is amiss, although the idea is there the sentence reads poorly, please revise (sentence 47 to 54 in the conclusion works better in articulating this point);</p> <p><b>INTRODUCTION</b><br/>1. The first sentence should be supported by a systematic review (or even a mixed study with meta analysis), and more recent, than the reference provided;<br/>2. The second sentence should be in the present sentence unless it is no longer the case (it was 27,5%, but isn't it anymore? What is the value now?). The verb tense should in fact be rectified throughout the introduction - in many places present tense or present perfect</p> |
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|  | <p>are more appropriate. The numbers provided (such in the first paragraph) are estimates?;</p> <p><b>METHODS</b><br/> 1. Detailed and well written. Just, please, inform if the instruments are validated for the country (if it is the case for any of them), and who administered the tests (if more than one person, was there a manual, methodological considerations, to guarantee no divergence between evaluators?). For any given participant, did the evaluation session all took place on the same day?</p> <p><b>RESULTS</b><br/> Well presented.</p> <p><b>CONCLUSION/DISCUSSION</b><br/> Overall, a great deal of care needs to be taken with some statements. For instance:<br/> 1. "In agreement with our findings, lower levels of housework activities were associated with mild cognitive impairment, cognitive decline and lower grey matter volume among older adults, suggesting that housework activities may have cognitive benefits, possibly through an increase in brain volume, as observed with exercise". The results/study type cannot at all suggest this because it is cross-sectional. In fact, cognitive impairment may be the impediment for higher PA level, in whatever manner it may occur. Simply put, there is no way of determining such in the present study<br/> or<br/> 2. "our results demonstrate that the intensity of housework affected different cognitive domains". Again the authors cannot infer this, there is or there isn't an association, but cannot be stated what "affects", "impacts", "determines", "leads to", "causes", what. Please revise the discussion to account for such instances.<br/> 3. please clarify a bit better what you mean by "The study findings cannot be generalised to people living in institutions". There are, nowadays, many different types of "institutions". Perhaps just indicate that the setting is community dwelling individuals and, thus, cannot be generalizable to other situations with different access to recreational/non-recreational opportunities/context.</p> |
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| <b>REVIEWER</b>        | Veronika van der Wardt<br>Philipps-Universität Marburg, Department of Primary Care |
| <b>REVIEW RETURNED</b> | 06-Aug-2021  |

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| <b>GENERAL COMMENTS</b> | <p>This is an interesting view on PA levels in older (and younger) adults, with household activities being the main focus, which adds to the existing evidence. However, there are several issues that should be addressed:<br/> Introduction: p.6: what is 'acute housework' (please add a definition) and how is this reflected in this analysis?<br/> Method:<br/> - please add details to the recruitment strategy, how were participants randomly selected from the Yishun study, by whom and how were they approached?<br/> - who completed the assessments, where was this done and how long did that take?<br/> - the wording of outcomes should be consistent across the manuscript: at times you refer to the test (e.g., PPA), in other places to sensorimotor/physiological function.<br/> - occupational and transport PA measurements need to be</p> |
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|  | <p>introduced in the Method section</p> <ul style="list-style-type: none"> <li>- the Statistical Analysis section should report on assumption testing.</li> <li>- it is not clear why household activities were dichotomised into HH und LH and not used as a continuous variable using MET/min.</li> <li>- an effect size calculation should be included</li> <li>- why were both GPAQ and LAPAQ used? The correlation analysis between the two should be included in the statistical Analysis section.</li> </ul> <p>Results:</p> <ul style="list-style-type: none"> <li>- p12. report of participant characteristics should use 'ethnicities' not 'race'.</li> <li>- p.12 report of figures for percentages PA exclusively derived from recreational or household PA do not add up (and are different from figures reported in Discussion) - please check</li> <li>- how many participants did both recreational and household PA?</li> <li>- figures in table 1 suggest that household PA is mostly done by women. Therefore gender should feature much more prominently in the analysis (and Discussion section).</li> <li>- please outline the role of transportational and occupational PA in your analysis (neither has been mentioned in the Method section)</li> <li>- Associations should be reported per outcome for LH and HH together and tabularized for better overview.</li> <li>- Effect sizes and relationship between PA outcomes from GPAQ and LAPAQ should be reported.</li> </ul> <p>Discussion:</p> <ul style="list-style-type: none"> <li>- The first paragraph overstates the effects of household PA on physical function and, depending on effect sizes, maybe on the other outcomes.</li> <li>- the role of gender needs to be discussed</li> <li>- could the lack of association between household PA and cognition be due to a ceiling effect on the scale?</li> <li>- the discussion is biased towards the (small) improvements in cognition but does not sufficiently discuss the small/lack of association between household PA and physical function in older people</li> <li>- the discussion should be shortened considerably and try less hard to emphasize the positive results but discuss all results with equal enthusiasm.</li> </ul> |
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| <b>REVIEWER</b>        | Dafna Merom<br>Western Sydney University, School of Health Science |
| <b>REVIEW RETURNED</b> | 16-Aug-2021  |

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| <b>GENERAL COMMENTS</b> | <p>In this research the authors examined the potential health benefits of households activity of two intensity levels: light intensity ( 2.5 METs, eg hanging laundry, dusting, cooking etc) and high intensity (4METs eg, vacuuming, window cleaning, washing floors etc). In a cross sectional design of random sample the authors compared younger adults to older adults (65 years and beyond) in relation to exposure to household activities and sensorimotor functions, cognitive tests and anthropometrics. The authors found that high-intensity household activity was associated with better function (sit-to-stand test) and better risk of falls profile in older adults, and both light and high intensity households were associated with cognitive performance tests such as attention and immediate/delay memory.</p> <p>Strengths: certainly, there is a novelty in this research as the contribution of household chores to the above outcomes have not been studied before. Second, statistical analysis is robust, given they have adjusted in the analysis to other domains of exercise. Third, the use of the WHO Global PA Questionnaire was appropriate</p> |
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|  | <p>as it does not include households allowing for the mutual exclusive assessment.</p> <p>However, the cross-sectional nature of this study suggests that these findings may strongly reflect the “reverse causation bias” whereby those seniors who have better functional and cognitive capacity are able to do the heavy households, which the authors have acknowledged, but not enough to suggest that this issue should be further studied in a longitudinal and controlled trial to establish causality. Further, the average age of the young sample suggest that this population did not reach yet the age of decline in any of the outcome tested. In light of the above I would suggest the following:</p> <ol style="list-style-type: none"> <li>1) The title of the manuscript should include the design: for example, The Yishun Cross-sectional Study</li> <li>2) The abstract conclusion should be toned down: “In Singapore household PA may improve functional health yet further longitudinal and intervention studies are needed to establish causality”.</li> <li>3) The above point 2, should be also included in the conclusion of the discussion</li> <li>4) In the discussion the authors should highlight the fact that younger adults are not expected to experience declines in sensorimotor abilities such as balance, sit-to-stand or cognitive abilities – hence the results with younger population was not surprising.</li> </ol> <p>Other comment:<br/>Introduction pg. 5 line 48, a reference is needed in relation to the assertion that “Few studies have examined the independent effects of non-recreational activity, such as housework tasks, on age-associated decline in functional ability&gt; can the authors cite these few studies (I think these were mentioned in the SR ref 7.</p> |
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### VERSION 1 – AUTHOR RESPONSE

Reviewer: 1

Dr. Nadine Santos, University of Minho

Comments to the Author:

Briefly, in this cross-sectional study the authors sought to explore (potential) associations between housework and functional health among younger (>65yo) and older (>65yo) Singaporean community-dwelling adults. This is an interesting study, with due care in sample selection methods, and sound methodology & analysis, which considers a topic of interest and often forgotten in how we go about studying PA - our PA is, in fact, a result of recreational and non-recreational activities, where the latter should not be ignored (as neither should, in itself, its potential role/association with health measures/indicators/etc) despite any absence of other programmed PA (such as gym, etc).

Thank you for your comments.

#### ABSTRACT

Overall it is well written. The two opening sentences may, however, need an adjustment. This reviewer suggests to opt to focus on what is to be gained to address both PA (recreational and non-

recreational) as it is a more accurate picture of ADL, across age groups, rather than focus on protecting from "ill health" or what is studied in "richer" (vs. poorer) countries (I assume).

Thank you for your comments. We have edited the abstract introduction to focus on the improvement in physical and cognitive function with PA across age groups, stating that "Regular moderate-to-vigorous intensity recreational physical activity (PA) improves physical and cognitive functions. However, the age-associated relationships between non-recreational PA with functional ability remain less explored. We examined the associations between housework and functional health among younger and older Singaporean community-dwelling adults."

#### ARTICLE SUMMARY

Comment #1: would remove "even in high income countries" at the end of the second paragraph;

Response #1: Thank you for your suggestion. We have edited the strengths and limitations section to reflect those specific to the methodology of the study, in accordance with the comments by the Editor and the requirements of the Journal.

Comment #2: in the third paragraph something is amiss, although the idea is there the sentence reads poorly, please revise (sentence 47 to 54 in the conclusion works better in articulating this point);

Response #2: Thank you for your suggestion. We have edited the strengths and limitations section to reflect those specific to the methodology of the study, in accordance with the comments by the Editor and the requirements of the Journal.

#### INTRODUCTION

Comment #1: The first sentence should be supported by a systematic review (or even a mixed study with meta analysis), and more recent, than the reference provided;

Response #1: Thank you for the suggestion. We have included two recent systematic reviews for the first sentence in the introduction [ref 2 and 3], on physical activity with chronic diseases, mortality and falls. The references are:

2. Geidl W, Schlesinger S, Mino E, Miranda L, Pfeifer K. Dose-response relationship between physical activity and mortality in adults with noncommunicable diseases: a systematic review and meta-analysis of prospective observational studies. *Int J Behav Nutr Phys Act* 2020; 17(1): 109.

3. Sherrington C, Fairhall N, Kwok W, et al. Evidence on physical activity and falls prevention for people aged 65+ years: systematic review to inform the WHO guidelines on physical activity and sedentary behaviour. *Int J Behav Nutr Phys Act* 2020; 17(1): 144.

Comment #2: The second sentence should be in the present tense unless it is no longer the case (it was 27.5%, but isn't it anymore? What is the value now?). The verb tense should in fact be rectified throughout the introduction - in many places present tense or present perfect are more appropriate. The numbers provided (such in the first paragraph) are estimates?;

Response #2: Thank you for your comment. The levels of insufficient physical activity was from a global surveillance data in 2016 (published in 2018), pooled from 358 surveys across 168 countries including 1.9 million participants. This is the most recent large-scale data for global prevalence of physical activity to the best of our knowledge. We have edited the introduction paragraph to state that "Yet, global surveillance data indicate that in 2016, levels of insufficient PA remained high (27.5%) and stable across previous 10 years <sup>4</sup>. The prevalence of insufficient PA was also more than double in high-income countries than low-income countries (36.8% vs 16.2%), and was the highest in Singapore (36.5%), among high-income Asia Pacific countries <sup>4</sup>."

## METHODS

Comment #1. Detailed and well written. Just, please, inform if the instruments are validated for the country (if it is the case for any of them), and who administered the tests (if more than one person, was there a manual, methodological considerations, to guarantee no divergence between evaluators?). For any given participant, did the evaluation session all took place on the same day?

Response #1: Thank you for your comment. The instruments used in the study including the Global Physical Activity Questionnaire (GPAQ), Longitudinal Ageing Study Amsterdam PA questionnaire (LAPAQ), Repeatable Battery for the Assessment of Neuropsychological Status (RBANS), Short Physical Performance Battery (SPPB) and physiological profile assessment (PPA) have been validated and are widely used globally. The references for validations are included in the methods section upon mention of the specific test.

Normative data for RBANS, SPPB and PPA have also been previously published in Singaporean populations:

1. Collinson SL, Fang SH, Lim ML, Feng L, Ng TP. Normative data for the repeatable battery for the assessment of neuropsychological status in elderly Chinese. *Arch Clin Neuropsychol*. 2014 Aug;29(5):442-55. doi: 10.1093/arclin/acu023. Epub 2014 Jun 5. PMID: 24903208.
2. Lee SY, Choo PL, Pang BWJ, Lau LK, Jabbar KA, Seah WT, Chen KK, Ng TP, Wee SL. SPPB reference values and performance in assessing sarcopenia in community-dwelling Singaporeans - Yishun study. *BMC Geriatr*. 2021 Mar 30;21(1):213. doi: 10.1186/s12877-021-02147-4. PMID: 33781211; PMCID: PMC8008740.

3. Pang BWJ, Wee SL, Lau LK, Jabbar KA, Seah WT, Ng DHM, Tan QLL, Chen KK, Jagadish MU, Ng TP. Sensorimotor Performance and Reference Values for Fall Risk Assessment in Community-Dwelling Adults: The Yishun Study. *Phys Ther.* 2021 Jul 1;101(7):pzab035. doi: 10.1093/ptj/pzab035. PMID: 33513229.

All assessments were based on standardized protocols and administered by trained researchers. The evaluation sessions were mostly done within the same day. Detailed methodology for this study has been published elsewhere [Pang BWJ, Wee SL, Lau LK et al. *Prevalence and Associated Factors of Sarcopenia in Singaporean Adults-The Yishun Study. J Am Med Dir Assoc.* 2021 Apr;22(4):885.e1-885.e10. doi: 10.1016/j.jamda.2020.05.029. Epub 2020 Jul 19. PMID: 32693999]. We included in the methods section under "Participants" that "All assessments were based on standardized protocols and administered by trained researchers at the Geriatric Education & Research Institute Lab on Yishun Health Campus, mostly within one visit."

## RESULTS

Well presented.

Thank you for your comment.

## CONCLUSION/DISCUSSION

Comment #1: Overall, a great deal of care needs to be taken with some statements. For instance: "In agreement with our findings, lower levels of housework activities were associated with mild cognitive impairment, cognitive decline and lower grey matter volume among older adults, suggesting that housework activities may have cognitive benefits, possibly through an increase in brain volume, as observed with exercise". The results/study type cannot at all suggest this because it is cross-sectional. In fact, cognitive impairment may be the impediment for higher PA level, in whatever manner it may occur. Simply put, there is no way of determining such in the present study

Response #1: Thank you for your comment. We agree that similar to the present cross-sectional study, earlier cross-sectional studies on housework activities cited in the discussion only show associations between lower levels of housework with mild cognitive impairment, cognitive decline and lower grey matter volume. We included a citation on a 6-month randomized clinical trial that observed increases in brain volume, in both grey and white matter regions, among older adults who participated in the aerobic fitness training but not older adults who participated in stretching and toning (nonaerobic control group) [ref 29: Colcombe SJ, Erickson KI, Scalf PE, et al. *Aerobic Exercise Training Increases Brain Volume in Aging Humans. The Journals of Gerontology: Series A* 2006; 61(11): 1166-70]. These findings suggest that similar to exercise, the observed positive associations

between housework physical activity and cognitive function could plausibly be through an increase in brain volume.

We have edited the discussion to state that “Earlier studies observed that lower levels of housework activities were associated with mild cognitive impairment, cognitive decline and lower grey matter volume among older adults <sup>11,27,28</sup>, suggesting a positive association between housework activities and cognitive function, plausibly through an increase in brain volume, as observed with exercise interventions in older adults <sup>29,30</sup>”.

or

Comment #2: "our results demonstrate that the intensity of housework affected different cognitive domains". Again the authors cannot infer this, there is or there isn't an association, but cannot be stated what "affects", "impacts", "determines", "leads to", "causes", what. Please revise the discussion to account for such instances.

Response #2: Thank you for your comment. We have edited the sentence to state that “Our results demonstrate, for the first time, that the intensity of housework was differentially associated with specific cognitive domains”.

Comment #3: please clarify a bit better what you mean by "The study findings cannot be generalised to people living in institutions". There are, nowadays, many different types of "institutions". Perhaps just indicate that the setting is community dwelling individuals and, thus, cannot be generalizable to other situations with different access to recreational/non-recreational opportunities/context.

Response #3: Thank you for your suggestion. We have clarified the sentence by stating that “The study findings in community-dwelling individuals cannot be generalised to institutionalised older adults, such as those in nursing homes”.

Reviewer: 2

Dr. Veronika van der Wardt, Philipps-Universität Marburg

Comments to the Author:

This is an interesting view on PA levels in older (and younger) adults, with household activities being the main focus, which adds to the existing evidence. However, there are several issues that should be addressed:



Comment #1: Introduction: p.6: what is 'acute housework' (please add a definition) and how is this reflected in this analysis?

Response #1: Thank you for the suggestion. We have clarified the term 'acute housework' by replacing it with 'single bout of housework'. Earlier studies show that both a single bout and chronic housework are associated with improved cognition, brain volume and executive function, and negatively associated with frailty, suggesting that housework is associated with better cognitive and physical health.

Method:

Comment #2: please add details to the recruitment strategy, how were participants randomly selected from the Yishun study, by whom and how were they approached?

Response #2: The detailed methodology on recruitment and sampling has been published elsewhere previously [*Pang BWJ, Wee SL, Lau LK et al. Prevalence and Associated Factors of Sarcopenia in Singaporean Adults-The Yishun Study. J Am Med Dir Assoc. 2021 Apr;22(4):885.e1-885.e10. doi: 10.1016/j.jamda.2020.05.029. Epub 2020 Jul 19. PMID: 32693999.*]

We have included this citation in the methods section, under 'Participants' [ref 16].

For easier reference, the sampling strategy from the paper by Pang et al 2021 stated that: "Random sampling was employed to obtain a representative sample of approximately 300 male and 300 female participants, filling quotas of 20 to 40 participants in each sex- and age-group (10-year age-groups between 21 and 60 years old; 5-year age-groups after 60 years old). Conventionally, the sample size of 30 or greater per age-group is sufficient for normative measures. Between October 2017 and February 2019, using 2-stage random sampling, 50% of all housing blocks were selected, and 20% of the units were approached for participant recruitment. Between March and November 2019, 50% of all housing blocks were randomly selected and all units approached. Up to 3 eligible participants were recruited from each unit. Nonresponse units were recontacted a second time at a different time of day on a later date. Older adults (>75 years of age) were additionally recruited through community sources and from a list of registered participants in 4 senior activity centres."

Comment #3: who completed the assessments, where was this done and how long did that take?

Response #3: All assessments were based on standardized protocols and administered by trained researchers at the research laboratory on Yishun Health Campus in Singapore. The evaluation sessions were mostly done within the same day. Detailed methodology for this study has been published elsewhere [Pang BWJ, Wee SL, Lau LK et al. *Prevalence and Associated Factors of Sarcopenia in Singaporean Adults-The Yishun Study. J Am Med Dir Assoc. 2021 Apr;22(4):885.e1-885.e10. doi: 10.1016/j.jamda.2020.05.029. Epub 2020 Jul 19. PMID: 32693999*]. We included in the methods section under “Participants” that “All assessments were based on standardized protocols and administered by trained researchers at the Geriatric Education & Research Institute Lab on Yishun Health Campus, mostly within one visit.”.

Comment #4: the wording of outcomes should be consistent across the manuscript: at times you refer to the test (e.g., PPA), in other places to sensorimotor/physiological function.

Response #4: Thank you for your comment. We have edited the manuscript to reflect that PPA scores are indicative of sensorimotor function in the abstract, methods and results sections. We also used “sensorimotor function” throughout the manuscript, and only indicated “PPA” in the abstract and results section, when describing the actual scores for PPA.

Comment #5: occupational and transport PA measurements need to be introduced in the Method section

Response #5: Thank you for your comment. Occupational and transport PA measures have been introduced in the Methods section, on page 8 paragraph 3, under ‘Housework, recreational, transport and occupational PA’. We stated that “Recreational (sport, fitness or leisure time activities), transport (active commuting/travel) and occupational (work) PA were determined using the Global Physical Activity Questionnaire (GPAQ), which consists of questions assessing the frequency and duration of vigorous- or moderate-intensity activities during a typical week <sup>19</sup>”.

Comment #6: the Statistical Analysis section should report on assumption testing.

Response #6: Thank you for your comment. We have included in the methods section under ‘statistical analysis’ that “Normality and homogeneity of variances assumptions were tested using Shapiro-Wilk and Levene’s test respectively.”.

Comment #7: it is not clear why household activities were dichotomised into HH und LH and not used as a continuous variable using MET/min.

Response #7: Thank you for your comment. We dichotomised Heavy housework (HH) and Light housework (LH) into high and low volume groups for greater clarity in interpretation/ presentation of between group comparison results. Also, we wanted to investigate the interaction effects between age and housework groups (independent variables), on cognitive, physical and sensorimotor functions (dependent variables), to determine if associations between housework volume on functional health differed between age groups. Hence, categorising housework activities into groups would be more appropriate for the analyses in the present study.

Comment #8: an effect size calculation should be included

Response #8: We calculated the effect size for an a-priori sample size calculation and reported it under 'statistical analysis', stating that "A sample size of 400 (100 per group) was needed for the trial to have 80% power to detect a two-sided hypothesis test at an  $\alpha$  level of 0.05 (effect size of 0.2) (G\*Power, version 3.1, Germany)". We have also included and reported effect sizes in the results section for ANOVA, and stated in the methods 'statistical analysis' section that "Effect sizes are reported with partial eta squared ( $\eta^2_p$ )<sup>26</sup>".

Comment #9: why were both GPAQ and LAPAQ used? The correlation analysis between the two should be included in the statistical Analysis section.

Response #9: GPAQ and LAPAQ measures were mutually exclusive in this present study. GPAQ measures the transport, recreational and occupational-related physical activity and does not assess housework-specific physical activity. As such, we used a sub-questionnaire of LAPAQ which includes specific questions on frequency and time spent on light and heavy household tasks. As our research question involved housework, recreational, transport and occupational PA, we used both GPAQ and LAPAQ in this study. These measures have been included in the methods section under 'Housework, recreational, transport and occupational PA'.

Results:

Comment #10: p12. report of participant characteristics should use 'ethnicities' not 'race'.

Response #10: Thank you for your comment, we have replaced 'race' with 'ethnicities', stating that "Ethnic distribution of participants (82.0% Chinese, 8.4% Malay, 6.7% Indians, and 2.9% from other ethnicities".

Comment #11: p.12 report of figures for percentages PA exclusively derived from recreational or household PA do not add up (and are different from figures reported in Discussion) - please check

Response #11: Thank you for your comment. The percentages of participants who met the recommended PA levels were derived by calculating the proportion of participants within the younger and older groups who achieved  $\geq 600$  MET min/week, exclusively from recreational PA (GPAQ), compared with Housework PA (LAPAQ). For recreational PA, 36% ( $n=90$ /Total  $n=249$ ) of the younger participants and 48% ( $n=116$ /Total  $n=240$ ) of the older participants met the PA requirements. For housework PA, 61% ( $n=152$ /Total  $n=249$ ) of the younger participants and 66% ( $n=159$ /Total  $n=240$ ) of the older participants met the PA requirements. These results suggest that a greater proportion of participants met the PA requirements derived exclusively from housework activities, compared to PA derived solely from recreational activities.

In the discussion section, we reported the differences between the percentages of those who met the PA requirements derived from housework activities, compared with recreational activities, within the younger and older groups (i.e.,  $61\%-36\% = 25\%$  in the younger group and  $66\%-48\% = 18\%$  in the older group). We stated that "Notably in this present study, 25% and 18% more participants in the younger and older group, respectively, met the PA guidelines derived exclusively from housework, than that attained solely through recreational PA."

Comment #12: how many participants did both recreational and household PA?

Response #12: Majority of the participants (53% ( $n=133$ ) in the younger group and 62% ( $n=149$ ) in the older group) did both recreational and housework PA (i.e., MET min/week $>0$  for both housework and recreational PA). As such, we adjusted for recreational PA in all the analyses between low and high light/heavy housework groups, but the adjustments did not affect any of the results presented. Thus, we excluded recreational PA in the analyses.

Comment #13: figures in table 1 suggest that household PA is mostly done by women. Therefore gender should feature much more prominently in the analysis (and Discussion section).

Response #13: Thank you for your comment. We have included in the results section on page 11 under 'Participant characteristics' that "Compared with low HH and LH groups, majority of participants in high HH and LH groups were women, regardless of age groups". We also added in the discussion section on page 17 that "While we adjusted for sex in all analyses, compared with low housework groups, participants in high housework groups were mostly women, which is consistent with earlier studies showing greater involvement in household chores among women than men <sup>44</sup>. Future studies should investigate the sex-specific effects of housework on functional health."

Comment #14: please outline the role of transportational and occupational PA in your analysis (neither has been mentioned in the Method section)

Response #14: Thank you for your comment. We stated in the methods section on page 8, under 'Housework, recreational, transport and occupational PA' that "Recreational (sport, fitness or leisure time activities), transport (active commuting/travel) and occupational (work) PA were determined using the Global Physical Activity Questionnaire (GPAQ), which consists of questions assessing the frequency and duration of vigorous- or moderate-intensity activities during a typical week <sup>19</sup>".

We also stated in the results section on page 11 that "...occupational PA did not differ between high and low HH and LH groups in younger and older adults (all  $p > 0.05$ , Table 1). Within the younger but not the older group, transport-related PA was 39% lower in low LH than high LH group ( $p = 0.003$ , Table 1)."

Transportation and occupational PA were included in the analyses as confounding factors, as mentioned on page 12 paragraph 1 "For subsequent light housework analyses, age, sex, height, education, transport PA and heavy housework were included in the model to adjust for confounding variables. To adjust for confounding factors, age, sex and light housework were included in model for subsequent heavy housework analyses. Adjusting for recreational and occupational PA in the analyses did not affect any of the results presented; hence, data are presented with recreational and occupational PA excluded from the model."

Comment #15: Associations should be reported per outcome for LH and HH together and tabularized for better overview.

Response #15: Thank you for the suggestion. We have edited the results section to place the HH and LH associations with cognitive function together (Fig 1&2), and the HH and LH associations with physical and sensorimotor function together (Fig 3&4). We presented our analyses with LH and HH separately for outcome measures for greater clarity and distinction between LH and HH analyses. We also presented our data in a graphical format for a better visual representation and comparison between age and housework groups, as our analyses involved two-way ANOVA which considers between group interactions (age\*housework).

However, we have added the raw values (mean and SD) for all outcome measures between housework (LH and HH) and age (younger and older) groups in a supplementary table S1 for a better overview. We included in the results section on page 14 that “Mean (SD) values of cognitive, physical and sensorimotor performance between age and housework groups are presented in Supplementary Table S1.”.

Comment #16: Effect sizes and relationship between PA outcomes from GPAQ and LAPAQ should be reported.

Response #16: Thank you for your comment. In this present study, we used the sub-questionnaire for housework activities (heavy and light housework) from LAPAQ, as opposed to recreational, transport and occupational PA from GPAQ. The PA measures from LAPAQ and GPAQ in this study are mutually exclusive. We adjusted for transport, recreational and occupational PA (GPAQ) in our two-way ANOVA analyses between age (younger vs older) and housework PA (low vs high heavy and light housework) (LAPAQ) groups. The effect sizes and relationships between PA measured by GPAQ and LAPAQ on cognitive, physical and sensorimotor performance outcomes is beyond the scope of this study and should be investigated in future studies.

Discussion:

Comment #17: The first paragraph overstates the effects of household PA on physical function and, depending on effect sizes, maybe on the other outcomes.

Response #17: Thank you for your comment. We have edited the first paragraph of the discussion to state that “The present study is the first to report that housework activity is associated with cognitive, physical and sensorimotor functions among older but not younger adults in Singapore. These positive associations of housework with functional performance in older adults were independent of recreational, occupational and transport-related physical activities. We also show that more adults attained recommended physical activity levels through housework than recreation.”.

Comment #18: the role of gender needs to be discussed

Response #18: Thank you for your suggestion. We have included in the discussion section on page 17 that “While we adjusted for sex in all analyses, compared with low housework groups, participants in high housework groups were mostly women, which is consistent with earlier studies showing greater involvement in household chores among women than men<sup>44</sup>. Future studies should investigate the sex-specific effects of housework on functional health.”.

Comment #19: could the lack of association between household PA and cognition be due to a ceiling effect on the scale?

Response #19: Thank you for your suggestion. In this study, we show that global cognition (RBANS score) was positively associated with higher levels of both light housework and heavy housework, in older but not the younger adults. We proposed that the lack of association between housework and cognitive function in younger adults could be due to higher education levels and associated baseline cognitive function, which may reduce the potential for better cognitive function associated with housework (Discussion section, page 14 second paragraph). The distribution of index scores for RBANS and specific cognitive domains (attention, immediate and delayed memory, visuospatial-construction and language) in our study participants did not suggest the presence of a ceiling effect.

Comment #20: the discussion is biased towards the (small) improvements in cognition but does not sufficiently discuss the small/lack of association between household PA and physical function in older people

Response #20: Thank you for your comment. We included in the discussion section on page 15 paragraph 2 that there was a significant positive association between heavy housework activities with physical and sensorimotor performance in older adults, stating that “...higher levels of heavy housework activities were also independently associated with better physical (chair-stand time) and sensorimotor (PPA) performance in older but not younger adults. Among older Swedish adults, longer chair-stand time and poorer cognitive performance (processing speed and executive function) independently increased the risk of injurious falls over 3–10 years by 10–23%<sup>38</sup>. Unlike older adults, younger adults have higher functional abilities and are unlikely to experience decline in sensorimotor and physical function, potentially explaining the lack of associations between housework activities with physical and sensorimotor performance. These results collectively suggest that the higher

cognitive, physical and sensorimotor functions related to heavy housework activities might plausibly be associated with lower physiological fall risk among community-dwelling older adults.”

In addition, we did not find a significant association between light housework activities and physical function in older adults, stating on page 16 paragraph 2 that “...light housework was not associated with physical or sensorimotor function. The lack of associations could be due to the already high functional ability of our study participants<sup>23</sup>. In support, compared with lower intensity exercise, greater improvements in functional ability and decreased fear of falling were observed after high intensity exercise in older adults<sup>39-41</sup>. These results indicate a dose-response effect for exercise intensity on physical and sensorimotor function and associated falls risk in older adults. Similarly, we propose that the positive associations between housework with physical and sensorimotor function is dependent on intensity, especially in community-dwelling older adults.”.

Comment #21: the discussion should be shortened considerably and try less hard to emphasize the positive results but discuss all results with equal enthusiasm.

Response #21: Thank you for your comments. We have shortened the discussion section to focus on the main findings.

Reviewer: 3

Dr. Dafna Merom, Western Sydney University

Comments to the Author:

In this research the authors examined the potential health benefits of households activity of two intensity levels: light intensity ( 2.5 METs, eg hanging laundry, dusting, cooking etc) and high intensity (4METs eg, vacuuming, window cleaning, washing floors etc). In a cross sectional design of random sample the authors compared younger adults to older adults (65 years and beyond) in relation to exposure to household activities and sensorimotor functions, cognitive tests and anthropometrics. The authors found that high-intensity household activity was associated with better function (sit-to-stand test) and better risk of falls profile in older adults, and both light and high intensity households were associated with cognitive performance tests such as attention and immediate/delay memory.

Strengths: certainly, there is a novelty in this research as the contribution of household chores to the above outcomes have not been studied before. Second, statistical analysis is robust, given they have adjusted in the analysis to other domains of exercise. Third, the use of the WHO Global PA Questionnaire was appropriate as it does not include households allowing for the mutual exclusive assessment.



However, the cross-sectional nature of this study suggests that these findings may strongly reflect the “reverse causation bias” whereby those seniors who have better functional and cognitive capacity are able to do the heavy households, which the authors have acknowledged, but not enough to suggest that this issue should be further studied in a longitudinal and controlled trial to establish causality. Further, the average age of the young sample suggest that this population did not reach yet the age of decline in any of the outcome tested. In light of the above I would suggest the following:

Comment #1: The title of the manuscript should include the design: for example, The Yishun Cross-sectional Study

Response #1: Thank you for your comment. We have edited the title of the manuscript to include the design “Cross-sectional associations between housework with cognitive, physical and sensorimotor functions in younger and older community-dwelling adults – the Yishun Study”.

Comment #2: The abstract conclusion should be toned down: “In Singapore household PA may improve functional health yet further longitudinal and intervention studies are needed to establish causality”.

Response #2: Thank you for your suggestion. We have edited the conclusion of the abstract to state that “Housework PA is positively associated with functional health among community-dwelling older adults, independent of recreation and other non-recreational physical activities. Further longitudinal and intervention studies are needed to establish causality.”.

Comment #3: The above point 2, should be also included in the conclusion of the discussion

Response #3: Thank you for your comment. We have included in the conclusion of the discussion that “...our study suggests that a combination of light and heavy housework is associated with higher cognitive function, specifically in attention and memory domains, among community-dwelling older adults” and “Future longitudinal and intervention studies are required to establish causality between housework activities and functional health”.

Comment #4: In the discussion the authors should highlight the fact that younger adults are not expected to experience declines in sensorimotor abilities such as balance, sit-to-stand or cognitive

abilities – hence the results with younger population was not surprising.

Response #4: Thank you for your comment. We included in the discussion section on page 16 paragraph 1 that “Unlike older adults, younger adults have higher functional abilities and are unlikely to experience decline in sensorimotor and physical function, potentially explaining the lack of associations between housework activities with physical and sensorimotor performance.”.

Other comment:

Introduction pg. 5 line 48, a reference is needed in relation to the assertion that “Few studies have examined the independent effects of non-recreational activity, such as housework tasks, on age-associated decline in functional ability> can the authors cite these few studies (I think these were mentioned in the SR ref 7.

Response: Thank you for the comment. We have included the citations for studies that have examined the effects of housework task on cognitive function in older adults:

10. Stephan AJ, Strobl R, Müller M, et al. A high level of household physical activity compensates for lack of leisure time physical activity with regard to deficit accumulation: Results from the KORA-Age study. *Prev Med* 2016; 86: 64-9.

11. Koblinsky ND, Meusel L-AC, Greenwood CE, Anderson ND. Household physical activity is positively associated with gray matter volume in older adults. *BMC Geriatrics* 2021; 21(1): 104.

12. Tsuchiya K, Mitsui S, Fukuyama R, et al. An acute bout of housework activities has beneficial effects on executive function. *Neuropsychiatr Dis Treat* 2018; 14: 61-72.

#### VERSION 2 – REVIEW

|                        |  |
|------------------------|--|
| <b>REVIEWER</b>        | Veronika van der Wardt<br>Philipps-Universität Marburg, Department of Primary Care |
| <b>REVIEW RETURNED</b> | 23-Aug-2021  |

|                         |  |
|-------------------------|--|
| <b>GENERAL COMMENTS</b> | Thank you for the much improved manuscript, just two further comments:<br>The wording of participant recruitment is still confusing, it reads as if the participants for the cross sectional study are a sub-sample from the Yishun Study while it seems you used almost the whole dataset from that study. Please clarify why is there a difference in the sample size (n=489 in the cross sectional study and n=536 in the Yishun study).<br>And a very minor issue: Please add the lack of PPI in the limitations of the study. |
|-------------------------|--|

## VERSION 2 – AUTHOR RESPONSE

Reviewer Report:

Reviewer: 2

Dr. Veronika van der Wardt, Philipps-Universität Marburg

Comments to the Author:

Thank you for the much improved manuscript, just two further comments:

The wording of participant recruitment is still confusing, it reads as if the participants for the cross sectional study are a sub-sample from the Yishun Study while it seems you used almost the whole dataset from that study. Please clarify why is there a difference in the sample size (n=489 in the cross sectional study and n=536 in the Yishun study).

And a very minor issue: Please add the lack of PPI in the limitations of the study.

Thank you for your comment. The differences in sample size was due to the availability of Longitudinal Ageing Study Amsterdam PA questionnaire (LAPAQ) housework data from only 489 participants. We have clarified this in the results section on page 11, stating that "A total of 249 participants (57% women) with mean age of 44 years (SD 14 years) in the younger group, and 240 participants (57.1% women) with mean age of 75 years (SD 6 years) in the older group, had housework (LAPAQ) data available and were included in the analysis."

We have also added the lack of PPI as a limitation of the study on page 17 of the discussion section, stating that "Another potential limitation included the lack of patient or public involvement in the design, planning, conduct or reporting of the study."

Reviewer: 2

Competing interests of Reviewer: no competing interests.