Author's response to reviews

Title: Association of total daily physical activity with disability in community-dwelling older persons: a prospective cohort study

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Author's response to reviews: see over
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Jigisha Patel, MRCP, PhD
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Dear Dr. Patel:

Thank you for the opportunity to review and resubmit the manuscript # 1888432462723401 entitled “Association of total daily physical activity with disability in community-dwelling older persons: a prospective cohort study.”

Responses to each referee’s comments are included below and we have highlighted the associated changes we have made in the manuscript.

We thank you for considering this revised manuscript for publication in BMC Geriatrics. Please do not hesitate to contact me if you have further questions or concerns.

Sincerely,

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Referee 2
Introduction: The authors might expand upon the use of actigraphy among older/younger people.

We include a sentence on the use of actigraphy in studies among older and younger community-dwelling persons (see Introduction, page 5).

Methods: Some additional details concerning the actigraphy would be informative. How long? They mention up to 10 days- what determined the duration? Was there a bias in selecting patients who underwent actigraphy, since not all subjects had readings? Please clarify (minor revision).

Participants were visited in their community residence to place the actigraph by a trained study coordinator and research assistant and a return visit was scheduled for 10 days later. Prior to the adding actigraphy into the Rush Memory and Aging Project, we were concerned that activity might vary between weekend and weekdays. Therefore, we chose ten days of data collection to ensure that we obtained at least a full week of data. Due to pick-up scheduling for the participants, a range of pickup dates occurred; however, as the average number of days of data for the cohort was slightly greater than 9 days, most data approached being collected for 10 days and exceeded the 7 day goal. We now provide some additional details on the duration of actigraphy measurements (see Methods, Quantitative Total Daily Physical, page 7; Results, Baseline Participant Characteristics, page 10; and Results, Total Daily Physical Activity and Incident Disability, page 11). We clarify that once actigraphy became available, all current Memory and Aging Project participants were invited to wear the actigraph. There were no exclusion criteria apart from agreeing to wear the actigraph (see Methods, Quantitative Total Daily Physical Activity Assessment, page 7).

Discussion: The authors could expand further on the difference between measured and self reported physical activity, and the implications which their findings have on promoting activity among older people. What, at the end of the day, has been gained by measuring activity? Since the finding seems to be independent of self reported activity, how might the two measures be incorporated together and translated into a more comprehensive measure of activity levels among the elderly?

We have extensively re-organized the discussion to address the implications of measured and self-reported physical activity and the implications on promoting activity among older persons as suggested. We describe how total daily physical activity in addition to self-report activity can potentially be utilized to identify older persons at risk for disability and monitor the promotion of activity in older persons (see Discussion, pages 14-16).

Conclusion: Again the differentiation between self reported versus measured physical activity might be stressed(.discretionary revision).

We have added a sentence in the conclusion about the differentiation between self-reported versus measured physical activity (see Conclusion, page 17).
Referee 2

I am labeling them MCR (major compulsory), MER (minor essential), and DR (discretionary) revisions below.

METHODS

(1) Participant selection (MER). (a) How many participants lived in continuous care retirement facilities and how many lived in their homes? (b) As many lifestyle variables correlate with educational level, could authors please comment on the selection of participants, who seemed to have an unusually high educational level (mean = 14.8 years, SD = 3.0)?

(a) For the overall Memory and Aging Project Study cohort at time of data analysis (n=1336), 74.6% were residing in a continuous care retirement communities and the remainder in a private residential property. We have added this information under Methods, Participants (see page 6).

(b) Recruitment of participants in the Memory and Aging Project is described in the reference 20. In brief, recruitment involved providing community-based presentations at the invitation of leadership in continuous care retirement communities along with churches and social service agencies (see Methods, Participants, page 6). The greatest education peaks were noted for completion of high school (12 years of formal education) and completion of college (16 years of formal education). We agree that high education level of the Rush Memory and Aging Project may limit generalizability of the findings to older persons with a lower than high school education level. We have added this point as a limitation of the analysis in the Discussion section (see page 17).

(2) Longitudinal design (MER). How many annual evaluations did participants complete, and what was the span of follow-up (e.g., x evaluations in y years)? What was the distribution of follow-up evaluations and durations?

For the longitudinal disability cohort (n=584), we now clarify the date associated with actigraphy data collected from the first eligible participant to the date of analysis was 5.2 years. Given that actigraphy was rolled into the study proximate to the time of the annual evaluation in the Memory and Aging Project, the mean follow-up time was 3.4 years (SD=1.3). We have added this information into the Results section (see Results, Total Daily Physical Activity and Incident Disability, pages 11-12).

(3) Actigraphy (MCR). Please clarify the methods and provide details regarding the “quantification of total daily physical activity,” including information regarding reliability and validity. Did participants wear the Actical instruments during the daytime only? What were the designated wearing times? What amount of wearing time was considered adherent to the protocol? How were valid sedentary hours (“values of zero reflect no activity”, p. 7) distinguished from non-wear times or non-adherence? Why was the non-dominant wrist chosen, rather than the hip? What software was used to interpret the raw data?

Buchman, Wilson, & Bennett (2008), cited as a reference, do not provide sufficient information and discuss a sample different from the one included in the current study (N = 521 vs. N = 584).
We have added additional detail regarding the assessment of total daily physical activity with actigraphy (see Methods, Quantitative Total Daily Physical Activity, page 7). Participants were provided a water-proof actigraph with a band that was placed on the non-dominant wrist. The non-dominant wrist was chosen rather than the hip or leg to minimize removal of the device which would increase missing data. In pilot studies, when the actigraphy was worn as a belt or on the leg, individuals were more likely to remove the device when using the washroom or bathing and then forget to put it back on. Participants were instructed not to remove the actigraph until it was retrieved 10 days later. Therefore, continuous readings were taken rather than just daytime values. Upon retrieving the device at the end of the recording period, the trained study coordinator downloaded the data onto a laptop and software provided by Respironics, Inc. (Bend, OR) was used to review the quality and completeness of the recording. If there was evidence of device failure or poor quality data, a new device was placed and retrieved 10 days later. Data downloaded from the device was imported as a CEV file and uploaded to the central Rush Alzheimer’s Disease Center computers and could be imported into Excel or other data analysis packaged. For the current paper, we summarized the data using SAS. Data was partitioned into 24-hour periods from the time of placement to the time of retrieval, and only data from complete 24-hours periods was used to determine average total daily physical activity. Based on the effort to reduce non-adherence and quality measures described above, the remaining data for analysis had a higher likelihood for actigraphy readings of zero reflecting valid sedentary periods.

Regarding the authors’ research question, it seems important to determine whether actigraphy outcomes and ADLs are independent. Could it be that actigraphy actually overlaps with and measures the completion of activities of daily living? Considering individuals who do not self-report any additional leisure/exercise activities, could actigraphy have recorded completion of activities of daily living exclusively, thereby generating the relatively low observed correlation between self-report of leisure/exercise and actigraphy, yet the high predictive value of actigraphy with regard to ADLs?

We conducted further analyses to answer the reviewer’s important point about the independence of total daily physical activity from disability in activity of daily living. In the prevalent disability cohort (n=870), the correlation coefficient between each $10^5$ counts/day of total daily physical activity and total score on the ADL disability scale (range=0-6) was -0.28 (see Table 1, page 23). Therefore, total daily physical activity and report of ADL disability are not completely overlapping measures.

In the prevalent disability cohort, there were 155 persons who provided a self-report of zero hours of physical activity. The mean activity counts/day for these participants was $2.5 \times 10^5$ (SD=1.5). For this subset, the correlation coefficient for each $10^5$ counts/day of total daily physical activity and score on the ADL scale was -0.39. Therefore, for sedentary persons by self-report, the total daily physical activity does not completely overlap with ability to perform activities of daily living (see Results, Baseline Participant Characteristics, page 10).

RESULTS

(1) Participants (MER). (a) Please include an additional Table that details Participant Characteristics by Incident Disability – Characteristics at Follow-Up, including the follow-up duration (mean, standard deviation). (b) Please provide...
the age range/frequency distribution at baseline and follow-up, given that the introduction notes paucity of data related to “persons over the age of 80” and the discussion relates the results to “very old adults.” (c) Please provide the distribution of activity counts/day at baseline and follow-up for the 584 participants; see Buchman et al. (2008) cited in text as a model.

(a) In Table 2 which lists the characteristics of the participants who were in the incident disability analyses, we have added a row for follow-up duration (mean, standard deviation) for the group of participants developing ADL disability and the group of participants not developing ADL disability.

(b) For the prevalent disability cohort (n=870), the number of participants greater than or equal to age 80 was 569 (65.4%). For the incident disability cohort (n=584), the number of participants greater than or equal to age 80 was 384 (65.8%). We have added this information into the Results (see Baseline Participant Characteristics and Total Daily Physical Activity and Incident Disability, pages 9-10 and 11, respectively).

(c) We now provide the baseline distribution of activity counts/day for the 584 in the incident disability analyses (see Results, Total Daily Physical Activity and Incident Disability, page 11). The mean activity counts/day was 3.1 x 10^5 (SD=1.5)

(2) Statistical analyses (DR). Please provide visual representations of the Cox hazard models, to enhance the impact of results on the reader.

We now provide Figure 1 to visually show the reader the results of the Cox hazard model for developing incident disability for a typical participant in the 10th percentile for total daily physical activity and in the 90th percentile for total daily physical activity (see Figure 1).

DISCUSSION

Actigraphy (MER). Given that “measures do not directly respond to observed movements but are proportional to the degree and intensity of movements as reflected in recorded activity curves,” what is the clinical significance of the data? How would a reader translate the difference between the 10th percentile (1.01 x 10^5 counts/day) and the 90th percentile (4.72 x 10^5 counts/day) into clinically meaningful recommendations for titration of intervention, as suggested? Is there a counts/day cut-off for sedentary lifestyle, given the concurrently available self-report data? Authors argue that actigraphy “captures movement more precisely … and results in a more robust measure of effect size” than self-report. However, no data on reliability/validity are provided (see comments in Methods above).

We have extensively re-written the discussion section to provide a rationale for the clinical significance of measuring total daily physical activity and how such a measure can be utilized along with self-report physical activity to inform identification and monitoring of older persons at risk for developing disability (see Discussion, pages 14-16). For sedentary persons by self-report as compared to non-sedentary persons, the mean activity counts for the prevalent cohort was lower (2.5 vs.3.0 x 10^5 counts per day, \(t_{863}=-3.9, p<0.001\)).
We have removed the statement about actigraphy capturing movement more precisely from the discussion. However, the total daily physical activity has been shown to be associated with mortality, cognitive decline and dementia, and now ADL disability.

We agree with the reviewer that it would be useful to have metrics for translating actigraph measures into physical activity recommendations for older adults. This is an active area of research but additional studies will be needed to confirm the best way to translate total daily physical activity measures into recommendations for very old adults.

**General comments (DR).** It seems that the discussion repeats parts of the introduction. Authors may consider omitting repeated materials and, instead, spend more time on the implications of the finding that cognitive limitations and dementia diagnoses did not affect the relation between physical activity and disability. This is very interesting and potentially broadens clinical applicability of the findings.

We have extensively revised the discussion to remove some repetitive statements to give more information on interpreting the findings on the implications that cognitive limitations and dementia diagnoses did not affect the relation between total daily physical activity and disability (see Discussion, pages 14-16).

**Referee 1**

**Minor Essential Revisions**
1. The authors do not report how they corrected for multiple comparisons in their analyses. This should be stated.

We now add a statement in our data analysis section that we adjusted the p-value for significance to <0.01 rather than <0.05 to correct for multiple comparisons (see Methods, Statistics, page 9).

**Discretionary Revisions**
2. A very informative addition to your data analysis would be an examination of the relative importance of variance of activity over days (e.g. # days with counts > 50% greater, or just variance over the entire 2 weeks).

We appreciate the reviewer’s feedback about examining variance of activity and its relationship with disability measures. We agree this can be an important follow-up line of future investigation.