Author's response to reviews

Title: Predicting nursing home admission in the U.S.: a meta-analysis

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Author's response to reviews: see over
Dear Dr. Saltman,

We thank you for the opportunity to revise and resubmit our manuscript, “Predictors of nursing home admission: a Meta-Analysis in the U.S.” (1188633327125364) for publication in *BMC Geriatrics*. Below we outline how we address each reviewer’s comments:

**Dr. Höfler**

**Major Compulsory Revisions**

1. **Deletion of causal language**

   The term “effects” was deleted throughout the manuscript and replaced with the term “empirical associations,” as recommended by Dr. Höfler. The only exception was when we referred to random or fixed “effects” models, as these are commonly-used terms for such procedures in meta-analysis.

2. **Restriction to the U.S.**

   The first two sentences of the Background now explicitly refer to the U.S., as suggested:

   “The cost of nursing home (NH) care for persons 65 years of age and over is estimated to be roughly 150 billion dollars by 2007 in the United States (U.S.). About 62% of this cost in the U.S. is assumed by public, taxpayer-financed sources such as Medicaid and Medicare.”

   Also, in the statement of study objective in the Background section, we are more explicit in acknowledging the U.S. focus of the current meta-analysis:

   “This study systematically reviews the long-term predictors of NH admission (i.e., predictors of NH entry 1 year or more in the future) for U.S. older adults in the community.” (p. 5)

3. **Critique of meta-analyses**

   We have now added a paragraph (the 2nd paragraph of the Discussion section) that provides a more in-depth critique of meta-analyses, particularly when attempting to synthesize results across observational studies:

   “Several of the results showed significant heterogeneity, suggesting a lack of sensitivity in the pooled empirical associations. The published data available did not offer the opportunity to test the clinical sources of heterogeneity (i.e., subgroup or meta-regression analyses) beyond visual
inspection of effect sizes across data sources and predictors. This is a potential weakness of meta-
analyses, particularly when attempting to synthesize across observational studies (as opposed to
randomized controlled trials), as various methods related to sampling, measurement, and research
design could mask associations between predictors and clinical outcomes of interest.” (pp. 13-14)

4. **Logical links of key words**
   A sentence was placed following the presentation of key words in the Abstract (p. 2) and Methods
   (p. 6): “Any reports including these key words were retrieved.”

5. **Meaning of “variables were measured in an identical way”**
   The sentence on p. x was revised to provide more clarification to the phrase “…variables were
   measured…in similar or identical way:”

   “This allowed for a much clearer interpretation of results in the meta-analysis, as pooled estimates
   for each predictor were based on variables that were closely operationalized or measured across
   studies as opposed to variables that were grouped in more general categories (e.g., “functional
   status”).” (p. 8)

6. **Flow chart of identification process**
   Figure 1 is now provided that illustrates the identification process of studies in the meta-analysis.

7. **Odds ratios**
   We have added a statement in the Discussion section noting the potential problems of using the odds
   ratio as a measure of association:

   “Concerns have also been raised in the use of odds ratios as measures of association (the most
   common statistic used to report pooled effects in meta-analyses), particularly in instances where
   there is existence of heterogeneity.45” (p. 13)

**Minor Essential Revisions**

8. **Use of “activities” in abstract**
   As suggested by Dr. Höfler, “activity” as changed to “activities.”

**Dr. Stuck**

**Major Compulsory Revisions**

9. **Distinction between short-term and long-term nursing home stays**
   As recommended by Dr. Stuck, the following revisions were made: a) the title was changed to reflect
   a meta-analysis of nursing home admissions in the U.S.; b) the term “predict institutionalization” is
   avoided throughout the manuscript in favor of “NH admission” or “NH entry;” and c) the limitation
   that the pooled studies do not differentiate between long-stay or short-stay entry events is included at
   the beginning of the limitations section (p. 13, 2nd sentence).

10. **Adjusted vs. unadjusted estimates**
    We now provide clarification on the use of adjusted and unadjusted estimates in the Methods
    section:
“Almost all the studies included only reported adjusted estimates; therefore, these estimates were used for pooling purposes.” (p. 8)

We thank Dr. Stuck for raising this issue as a potential limitation. We have expanded the limitations section in the Discussion to address the inclusion of adjusted estimates:

“Similarly, as it is an issue in all meta-analyses of observational studies, extracted predictors of NH admission were derived from studies that included models with varying numbers of adjusting covariates; variations in adjustment across predictive models pose challenges to standardization when pooling estimates in meta-analyses.” (p. 13)

11. Implications of results
We have revised the Discussion and Abstract to reflect more appropriate implications of the research, as suggested by Dr. Stuck. Specifically, the sentence “When clinicians are presented with an elderly patient living in the community, these meta-analytic results provide guidance on those indicators likely to predict NH entry some time in the future” in the Discussion section was deleted. We have also revised the subsequent paragraph to scale back the emphasis on clinical relevance:

“In order to maximize the relevance of these findings, we relied on the pooled logistic regression estimates to determine whether an older patient is at risk for NH admission or not at some point in the future (i.e., 1 year or more). Older adults with 3 or more ADL dependencies had approximately 3.25 times the odds to enter a nursing over a 2-6 year interval. Similarly, elderly patients with 4 or more errors on a short screening tool (Short Portable Mental Status Questionnaire40) had more than twice the odds to enter a NH 3 years in the future. In some instances, older adults or their caregivers have to deal with the consequences of a cataclysmic event (e.g., an injurious fall46) that sets into motion a cascade of crises where instant and unavoidable long-term care decisions are made on an ad-hoc basis. However, awareness of the important thresholds reported here may inform older adults and their caregiving families in the years prior to a potential admission event. Earlier intervention in the long-term care decision-making process may also prompt the mobilization of community-based resources or clinical services to forestall a NH admission.47” (p. 14)

We also revised the implications section of the Discussion to again interpret the findings in more cautious fashion, with an emphasis on future research directions:

“The findings in this meta-analysis suggest that once certain functional or cognitive thresholds are reached, future risk of NH admission increases substantially (net a host of other factors). As suggested in prior research, intervention in the earlier stages of a chronic disease trajectory that offers respite and support to older adults or their caregiving families may help to potentially delay NH entry.47,48 However, experimental research (such as randomized controlled trials) would better inform whether intervention in earlier stages of chronic disease trajectories for older adults may help to delay clinical outcomes such as NH admission.

The results may offer useful prognostic information for clinicians, families, and older patients. For example, the significant predictors from the current meta-analyses could be converted into a practical screening tool of NH admission risk. A series of single dichotomous codes (1 = yes; 0 = no) could be applied for each indicator and then further weighted according to the effect size reported here. Summing these numbers and standardizing the sum would create a “risk score” on a 0-10 metric that offers guidance as to whether a geriatric patient is at risk for NH entry in the future.
An almost identical algorithm has been utilized to predict NH admission in a smaller, clinic-based sample of persons with Alzheimer’s disease where presence of a particular risk factor was calculated (i.e., the “value;” 1 = present; 0 = absent) and multiplied with the coefficient value of that risk factor as a weight (derived from Cox regression models). The products of the values and weights were then summed, and this value was successfully applied as a prognostic tool to predict NH care and death among a second, validation sample of individuals with Alzheimer’s disease. Relying on published data for this meta-analysis did not allow us to test the predictive accuracy of this proposed prognostic index because individual level data were not available to model. The next step in testing such a tool is to apply it to individual patient data across nationally representative samples (e.g., the publicly available data sources described in Table 1) and determine its specificity and sensitivity to NH admission over various follow-up intervals, thus offering empirical evidence for its efficacy as a screening tool for risk of NH entry. It is important to note that similar tools sued to predict clinical outcomes such as hospital admission have explained areas under receiver operant curves of .70 or below. This suggests that creating risk prognostic tools are helpful for population- or group-based planning strategies but less advantageous for individual clinical decision-making.” (pp. 15-16)

We have also revised the final two sentences in the Abstract:

“The pooled associations provided detailed empirical information as to which variables emerged as the strongest predictors of NH admission (e.g., 3 or more ADL dependencies, cognitive impairment, prior NH use). These results could be utilized as weights in the construction and validation of prognostic tools to estimate risk for NH entry over a multi-year period.” (pp. 2-3)

12. Possible interactions between risk factors
An additional limitation of note was the inability to pool interaction terms across published studies; this limitation is now included on p. 14:

“Another important limitation to note is that the meta-analysis was limited to individual predictors of NH admission. Interactions between sociodemographic characteristics, indicators of functional impairment, and similar predictors is likely to occur given the wide range of variables that potentially influence NH entry. The reliance on published data limited this meta-analysis to pool similar variables across studies; future meta-analysis of predictors of NH admission or other healthcare transitions could utilized pooled individual data methods to conduct a meta-analysis of key interaction terms.”

Dr. Williams

Minor Essential Revisions
13. Matching of numbers in Figure 1 and text
The values presented in Figure and the text now match. Both the text and Figure 1 now indicate the exclusion of 3,861 reports. Also, the text indicates the inclusion of 99 reports, and similar to Figure 1, also notes that one report included 3 separate studies of nursing home admission resulting in 101 reports:

“A further 615 reports were excluded from the meta-analysis based on failing the inclusion criteria specified above, leaving 99 studies. One study presented results within three different data sources, and each of these analyses were treated as a separate “study” resulting in the identification of 101 studies reporting from 25 various data sources.” (p. 9)
14. **Abstract: “Background”**
The subheading *Backgrounds* was revised to *Background* in the Abstract.

15. **p. 5, second to last line: “review”**
   “Review” is now changed to “reviews” on p. 5, per the recommendation of Dr. Williams.

16. **Use language referring to increased odds instead of increased likelihood**
   Per the recommendation of Dr. Williams, all language reporting the results of the pooled logistic regression results now refers to “odds” of entry, instead of increased likelihood.

**Discretionary Revisions**

17. **Rates of nursing home admission**
   Dr. Williams offers an excellent suggestion: to provide percentage of participants who entered nursing homes for the selected studies so the reader can ascertain variation in entry rates across reports. Tables 2 and 3 now provide percentages of residents who entered nursing homes across the studies pooled for this meta-analysis, which suggests that for several of the findings variation in nursing home admission rate may have explained heterogeneity of the pooled effects (see point 18 below).

18. **Heterogeneity in the odds ratios**
   As noted above in points 3 and 10, additional clarification was provided in the limitations section of the Discussion regarding heterogeneity of the pooled effects. Per Dr. Williams’ suggestion, we expanded the description of limitations by noting the variation in nursing home admission rate as well:

   “Related to this issue, variation in the outcome rates (i.e., percentages of participants who entered NHs; see Tables 2 and 3) may have led to the observed statistical heterogeneity.” (p. 13)

Sincerely,

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