Author's response to reviews

Title: Prevalence and determinants of overweight and obesity in old age in Germany

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Author's response to reviews: see over
### RESPONSES TO COMMENTS OF REVIEWERS

<table>
<thead>
<tr>
<th>Comments of reviewers</th>
<th>Response (citations from manuscript printed in italics, changes are underlined)</th>
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<tbody>
<tr>
<td><strong>Reviewer 1</strong></td>
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<tr>
<td>The study sets out to determine the prevalence of overweight and obesity in a group of older adults (n = 1882) aged 75 and over, and examines some of the possible determinants/associations with higher BMI/weight gain using cross sectional approach and longitudinal data. With the determinants / associations showing somewhat divergent findings. Certainly characterising / describing BMI in a large group of older adults (75+) is an interesting and laudable aim, especially in this older old group, however the clarity as to what the consequences / determinants of BMI is more challenging to interpret from this paper and thus the implications of the findings for translation. And with that may take away from the descriptive findings;</td>
<td>First of all, thank you for your insightful and helpful comments. We really appreciate it.</td>
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</table>

**Comments: essential revisions**

1) Re the differences in outcome based on cross sectional v longitudinal data:
   • It is worth a clear comment on the potential translation of the higher BMI determinants. Is a higher BMI likely to be beneficial/ adverse? Likely to be difficult to interpret without the context of frailty, also the metabolically healthy obesity phenotype. Is it fitting the obesity paradox? The limitations are well acknowledged in the discussion, but in the absence of a measure of recent weight/ muscle loss (which is a poor predictor of health irrespective of starting BMI) it is difficult to interpret. Shortened discussion may help. |

We added some details about the ‘obesity paradox’:

*Furthermore, it is unclear whether a reduction in BMI in old age is generally desirable, taking into account the “obesity paradox”. Many other factors need to be taken into account such as body fat percentage, medical history or frailty. This, in turn, raises also the question whether the WHO cut-off point of 25kg/m² for overweight in old age is too restrictive in this age-bracket (Cetin et al., 2013; Dahl et al., 2013; Hollander et al., 2012; Johnson et al., 2014).*

• Might it simply be that BMI is not necessarily a useful measure in older adults or as a predictor of health in older old (but possibly may be more useful as part of a more complex score) |

We agree with you. It cannot be ruled out that the BMI reach its limit as a holistic measure of excess weight in old age. Therefore, alternative measures, including waist circumferences should be used to validate our findings. To make it more precise, we added some details:

*Due to data availability, we were restricted to BMI as a measure of excess weight indicating need for weight management. Hence, alternative and important measures (Price et al., 2006), such as waist-to-height ratio, waist-to-hip ratio or waist circumference cannot be used to validate our findings across instruments.*

2) Discussion / conclusion
   • The discussion, would benefit from considerable cutting back / shortening around the discussion of the determinants (as a more concise discussion of the BMI determinants, given that acknowledgement of limitation are listed, would make it clearer for the reader). |

Thank you for your comment. We removed the more general
the specific findings of this study, rather than more general findings and extrapolations.

findings and extrapolations in the “Conclusion”:

The number of overweight and obese individuals in old age will increase due to demographic change. Most likely, the high prevalence of excess weight in children [1] and adolescents [2] will have a strong impact on the prevalence of excess weight of these individuals in old age. Moreover, in comparison to cohorts of similar age, 10–20 years ago current cohorts of the elderly are more likely to be obese [3]. Consequently, obesity is considered a growing problem among the elderly, both in absolute and relative terms. This is important to note since obesity leads to a higher probability to enter a long-term care facility, and more long term-care days before death [4]. Additionally, obesity plays a major role in old age disability [5] and cardiovascular-related disorders [6]. Consequently, we are likely to be faced with a growing burden of long-term care, disease, and disability, indicating the urgent need of intervention strategies.

Specific minor comments: clarifications

• In first part of discussion, it is stated that those with increased BMI were younger (but still over 75 from the inclusion criteria?), ie the study interestingly still shows age as a determinant even in a group > 75 years. (worth reminding the reader)

You are right. Individuals with highest prevalence rates (overweight and obesity) were found among participants aged ≤ 80 years. These individuals were 79 years (n=46) or 80 years (n=251).

We added these details to make it more clear:

Highest prevalence rates of both overweight and obesity were found among participants aged ≤ 80 years (79 or 80 years), severely impaired in mobility and not taking long walks at least once a week.

• Please clarify for the reader the nature of gymnastics, if 42% of >75 year olds are partaking in / capable of gymnastics?

Individuals were solely asked how often they have done gymnastics. We regret that we cannot provide you with further details.

• 54% long walks (if not already stated, please clarify what is meant by a long walk, eg duration)

It is asked whether individuals go hiking or walking long distances. Thus, unfortunately, we cannot provide you with further details.

Thank you again for your insightful comments. We really appreciate it.

Reviewer 2

Major Compulsory Revisions

1. The approach to longitudinal analysis is poorly detailed. It is not clear 1) how change between Wave 3/Wave 5 was quantified or 2) if change scores or baseline values were used as predictors in longitudinal regression analysis.

First of all, thank you for your insightful and helpful comments. We really appreciate it.

We added some details to make it more clear:

We used fixed effects (FE) regressions (Cameron & Trivedi, 2005) to estimate effects of time dependent variables on BMI, and overweight or obesity, respectively.

In such a case, a random effects regression is inconsistent since this model assumes that there is no correlation between unobservable individual effects and regressors (in detail: Cameron & Trivedi, 2005, ch. 21.2.1). Because these unobservable individual effects were cancelled out by within-transformation in FE-regression (for more technical details: Cameron & Trivedi, 2005, ch. 21.2.2 and Appendix 1), time-constant unobserved heterogeneity is no longer a problem. This implies that we only exploit within-variation (therefore, the FE estimator is also called ‘Within-Estimator’). Thus, we
can obtain causal estimates via FE-estimator (average treatment effect on the treated (Brüderl, 2010)), but generally internal validity should be interpreted with caution as we do not have a controlled stimulus. In order to deal with heteroskedasticity and autocorrelation, we computed cluster-robust standard errors (Stock & Watson, 2008; Cameron & Trivedi, 2009).

**Appendix 1**

The error-components model is our starting point:

\[ y_{it} = x_{it}'\beta + \alpha_i + \varepsilon_{it} \]

By averaging this equation over time for each individual i (between-transformation), we get:

\[ \bar{y}_i = \bar{x}_i'\beta + \alpha_i + \bar{\varepsilon}_i \]

By subtracting the second equation from the first equation for each t (within-transformation), we get:

\[ y_{it} - \bar{y}_i = (x_{it} - \bar{x}_i)'\beta + (\varepsilon_{it} - \bar{\varepsilon}_i) \]

Now, the idiosyncratic error-term \( \varepsilon_i \) is removed. We have “time-demeaned” our data (the between-variation was subtracted). This model can be estimated by OLS.

<table>
<thead>
<tr>
<th>An additional table of descriptive statistics on change between W3 and W5 is necessary, indicating the magnitude of change in the outcome and predictors.</th>
<th>Thank you for your insightful comment. We included a table (Table 2) with descriptive statistics (waves 3-5).</th>
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<td>If change scores were used, then the analysis is incomplete. For example, Table 3 indicates the variable ‘Cycling, at least once a week (Ref.: Never/once a week). There is no indication of the effect of reducing the frequency of any physical activity between waves.</td>
<td>Thank you for your comment. We used FE regressions rather than First Differences (FD, also referred to as Change Score model) Regressions. To make the longitudinal effect more clear, we extended the heading of Table 3: Table 3: Longitudinal regressions (Within-Estimations): Predictors of BMI, Overweight and Obesity</td>
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<tr>
<td>The text in the results section with respect to longitudinal analysis is similarly unclear and must be rewritten to clarify the associations noted in the analysis.</td>
<td>Thank you for your comment. We added more details in this section in order to improve the readability: Furthermore, increasing impairments in walking (e. g. substantial mobility impairment/disability of walking in the total sample: ( \beta=-0.97 )) and increasing cognitive impairment decreased BMI in women and in the total sample. For example, when the Global Deterioration Scale in the total sample increased by one unit, the BMI decreased by -0.16 units.</td>
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<td>2. Table 1 is difficult to interpret and does not match with the Results text. For example, ‘The majority of participants had elementary education (59.5%)’ – this is not immediately evident from the table. It would seem to be more intuitive to report the % within each BMI category rather than the % of the total. For example, it is more sensible to report the ‘Sex’ breakdown of ‘Obese’ as Women 67.8%, Men 32.2%. From the table, Cramer’s V and p-values appear to describe the trend across each category of BMI; however the Results text under Please see the revised Table 1.</td>
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</table>
‘Descriptive and bivariate analyses’ suggests that differences within each BMI category were measured – e.g. ‘Prevalence of obesity varied substantially by selected sample characteristics…’.

The Geriatric Depression Scale is described in the methods but not included in Table 1 and should be added.

We did not add the Geriatric Depression Scale since it was solely included in sensitivity analyses. Table 1 only refers to variables included in our main model and time-invariant sociodemographic variables.

To make it more clear, we added some details in the Results section:

Sample characteristics

Table 1 depicts descriptive findings. It is worth mentioning that we solely present variables included in our main model and time-invariant sociodemographic variables.

3. ‘Overweight’ and ‘Obesity’ as described in the methods section are not exclusive categories. Suggest using multinomial logistic regression in place of binary to investigate Overweight (BMI: 25-29.9kg/m²) and Obese (BMI>30kg/m²) exclusively.

Thank you for your comment. We thought about it for quite a while. Nevertheless, we believe that binary logistic regressions are more consistent since multinomial logistic regression does not exist in current statistical software. Consequently, we used binary logistic regressions cross-sectionally and binary logistic regressions (with fixed effects) longitudinally.

4. A more in-depth discussion of the findings is required. Specifically, the literature surrounding obesity/BMI and cognition is rather mixed. The Benito-Leon paper which is referenced, while very relevant, is a cross-sectional analysis and not fully representative of the substantial body of evidence in this area.

We added some details in the discussion:

The strong association between cognitive impairment and BMI has also been reported in the literature (Benito-León et al., 2013) and can be explained by frailty (Robertson et al., 2013) of severely impaired individuals (GDS > 5) who had mean BMI of 22.1 (±3.9). However, the relation between cognitive impairment and BMI is complex and literature is inconclusive (Gunstad et al., 2010; Elias et al., 2003; Jeong et al., 2004; Kilander et al. 1997; Kuo et al., 2006; Smith et al., 2011).

There is also much debate about the ‘obesity paradox’ in older adults which should be discussed.

We added some details about the ‘obesity paradox’:

Furthermore, it is unclear whether a reduction in BMI in old age is generally desirable, taking into account the “obesity paradox”. Many other factors need to be taken into account such as body fat percentage, medical history or frailty. This, in turn, raises also the question whether the WHO cut-off point of 25kg/m² for overweight in old age is too restrictive in this age-bracket (Cetin et al., 2013; Dahl et al., 2013; Hollander et al., 2012; Johnson et al., 2014).

The use of self-reported BMI is a major limitation and needs to be recognised as such. This must be taken into consideration particularly when comparing findings to studies where measured BMI is used. There is considerable research published in this area, specifically with reference to older adults.

We took this into consideration in “Comparison to previous studies”:

Comparison to previous studies

Since it is difficult to compare findings of self-reported BMI (srBMI) and measured (mBMI), we explicitly state the method of measurement used in previous studies in parentheses (srBMI, mBMI or, more generally, systematic review).

For instance:

This study adds to data on the prevalence of excess weight in the German adult population, as available studies were restricted to samples aged < 80 years (Mensink et al., 2013) (mBMI).

Another example:
Comparable to Weng et al. (2004) (srBMI), a significant association between having children and overweight, but not for obesity, was detected. When we used number of children instead of a dummy-variable like Weng et al. (2004), we also obtained significant associations with obesity, with marked sex differences.

<table>
<thead>
<tr>
<th>Minor Essential Revisions</th>
<th>What we meant by the phrase “Yet, little data exists on the prevalence of excess weight in populations aged 80 years or older” was: In general, little data exists on the prevalence of excess weight in populations aged 80 years or older.</th>
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<tr>
<td>5. The precise age profile of the sample needs clarification. The cohort is variously referred to as ‘aged 80 years or older’ in the Abstract Background and ‘79 years and older’ in the Abstract Methods. Inclusion criteria specify ( \geq 75 ) years. Please indicate the mean age and age range of the sample at baseline, i.e Wave 3 and follow up, i.e Wave 5.</td>
<td>We added some details in the results section to make it more clear: Of the ( n=1,882 ) participants in wave 3, 65.8% were female (Table 1). Mean age was 84.0 years (±3.3), ranging between 79 and 97 years. The mean age and age range of the sample in wave 4 and 5 was also included in an endnote: In wave 4, mean age was 85.4 years (±3.2, min: 80, max: 98), while in wave 5 mean age was 86.8 years (±3.0, min: 81, max: 98).</td>
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<td>6. In the Results section, under ‘Descriptive and bivariate analysis’, the unit for mean BMI is missing</td>
<td>We added it: Mean BMI was 25.8 kg/m(^2) (±4.2 kg/m(^2)).</td>
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<td>7. OLS regression is abbreviated in Tables 2&amp;3. Please include the full term in the Methods section and table footnote.</td>
<td>We added it in “Statistical analyses”: Second, by using cross-sectional regressions, we examined predictors of BMI (linear Ordinary Least Squares (OLS) regression) and overweight or obesity (logistic regression), respectively.</td>
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<td>In Table 3: Ordinary Least Squares (OLS) Regressions</td>
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<td>In Table 4: Ordinary Least Squares (OLS) Regressions</td>
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<td>8. Specify the unit of measurement for OLS regression in the Tables (i.e. #-coefficient).</td>
<td>We added the unit of measurement for OLS regression in the Tables:</td>
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<td>In Table 3: OLS-Regressions (Beta-Coefficients reported)</td>
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<td>In Table 4: FE-Regressions (Beta-Coefficients reported)</td>
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<td>9. For the ‘alternate model specifications’, it is indicated that ‘these specifications underlined the robustness of our baseline models’. Please state explicitly that these alternate models did not affect the findings (in terms of significant predictors) of the original models.</td>
<td>We added some details to be more explicitly. In “Statistical Analyses”: In order to ensure the robustness of our findings in terms of significance, we tested various alternate model specifications. These models differ by adding (comorbidity, depression) or removing (cognitive impairment, mobility impairments) predictors that might be endogenous.</td>
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<td>In “Alternate model specifications”: Robustness was checked by comparing the baseline models (Table 3 and Table 4) with alternate models (results not shown, but are available upon request from authors). In a</td>
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<td>Discretionary Revisions</td>
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| **10.** The effect of replacing single physical activities with an index score in alternate models as mentioned in the methods section is neither justified in the Methods nor reported on in the Results or Discussion sections and should therefore be removed from the paper. | We removed it in “Physical activity” (Methods):  
In an alternate model specification, we replaced these single activities by an index score. Firstly, each physical activity was recoded: 7 = every day, 3 = several times a week, 1 = once a week, 0 = less than once a week/never. Secondly, an index score was created by averaging these items.  
We also removed it in “Alternate model specifications” (Results):  
Cross-sectionally, physical activity score (model V) was associated with a lower BMI and a lower probability of overweight and obesity (except for overweight in women). Contrarily, in longitudinal analyses, physical activities increased BMI in the total sample (p=.06) and in women. |
| **11.** The inclusion of results for men and women combined (‘All’) in Table 2 & 3 does not add to the interpretation or discussion of the results and seems unnecessary. | We think that the inclusion of results for men and women combined (‘All’) gives the reader a short overview. Thus, we would like to present our Table 3+4 in the current form. However, if you insist on this, we would adjust our tables. |
| **12.** The popularity of gymnastics as a PA in this age-group is surprising, one would expect gardening etc. to be more relevant. Is it plausible that >40% of adults aged 80+ partake in gymnastics more than once a week? | Thank you for your comment.  
We were also surprised and critically reflected the data another time. Nevertheless, it is correct. More than 40% of these individuals reported doing gymnastics at least once a week.  
Thank you again for your insightful comments. We really appreciate it. |
| **Reviewer 3** | |
| No major compulsory revisions | First of all, thank you for your review. We really appreciate it. |
| No minor essential revisions | |
| No discretionary revisions. | |
| This paper sets out a very thoughtful exposition of data relating to body mass index from a longitudinal database. Statistical methods, whilst complex, where appropriate and reasonable applied. Aims and methods were clearly set out. Discussion of results reasoned and valid. Future direction for research clearly defined. | |
