Author's response to reviews

Title: An exploratory study of associations of physical activity with mental health and work engagement

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Author's response to reviews: see over
**Response to the comments of the referees**

**Referee nr 1 (177583562863622_comment)**

<table>
<thead>
<tr>
<th>Comment</th>
<th>Response</th>
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<tbody>
<tr>
<td><strong>Title:</strong> specify the design of your study to clarify that it consists of original research</td>
<td>Title has been changed into: “An exploratory study of associations of physical activity with mental health and work engagement”</td>
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<tr>
<td><strong>Abstract - results:</strong> mention the results of the self-reported and objectively measured PA.</td>
<td>Results are now explicitly mentioned in the results section of the abstract as follows: “There was no statistically significant association between self-reported MVPA and mental health, resulting from both the crude (b=0.058, 95% CI -0.118 - 0.235) and adjusted analyses (b=0.026; 95% CI -0.158 - 0.210), nor between objectively measured MVPA and mental health for both crude and adjusted analyses (b=-0.144; 95% CI -1.315 - 1.027 ; b=-0.199; 95% CI 1.417 - 1.018 respectively). There was also no significant association between self-reported MVPA and work engagement (crude: b=0.005; 95% CI -0.005-0.016, adjusted: b= 0.002; 95% CI -0.010- 0.013), nor between objectively measured MVPA and work engagement (crude: b= 0.012; 95% CI -0.084- 0.060, adjusted: b=0.007; 95%CI -0.083-0.069).”</td>
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<td><strong>Introduction:</strong> you mention that PA is associated with mental health. PA may also be associated with physical health which may have some influences on mental health. Could you please provide some comments on this?</td>
<td>We have now added the possible mediating function of physical health; as follows: Physical health could function as a mediator for the physical activity-mental health relationship, although aerobic fitness—often referred to as the golden standard for physical activity-related measures (Ainsworth, 2009)—does not seem to be a plausible mechanism for the physical activity-mental health relationship (Lindwall et al, 2012; Dunn et al, 2001).</td>
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<td><strong>Methods - Study population:</strong> how were the participants of the subgroup (n=100) selected?</td>
<td>The participants of the subgroup were randomly selected. This has been added to the methods section. “Randomly selected participants of a subgroup (n=100) were asked to wear an accelerometer on the waist during a period of 7 consecutive days.”</td>
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<td><strong>Methods - page 7:</strong> please provide some details about the use of MET-values (e.g. how they are calculated,...)</td>
<td>MET values were ascribed to activities according to Ainsworth’s compendium. “To calculate the mean number of minutes per day spent in moderate (3-6 METs), and vigorous (&gt;6.0 METs) activities, activities were classified into intensity categories using Ainsworth’s compendium of physical activities (Ainsworth, et al., 1993). Then total time spent in the overall category (MVPA) was calculated by adding these two categories together.”</td>
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<td><strong>Methods - objectively measured PA:</strong> did all participants in the subgroup wore the accelerometer for 7 days? If not, what threshold of the number of days was used to</td>
<td>This was added to the methods sections: “Mean number of wearing days was 6.7. A threshold of at least 3 wearing days was considered a valid week. Total time spent in this category in minutes per week was calculated by summing all valid time periods in that category, divided by the number of valid wearing days (resulting in minutes per day) as the number of wearing days may vary across participants, and consequently multiplied by 7 (resulting in minutes per week).”</td>
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<td><strong>Discussion - page 10:</strong> &quot;It is possible that the participants did not perform enough MVPA to have an effect on MH or WE&quot;. From previous research it is known that there are some important barriers hampering the engagement in PA. Overcoming these barriers may be essential to increase the amounts of PA. Please provide some thoughts about it.</td>
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<td>Van Berkel and colleagues (2011) looked into determinants of physical activity of this study population. Perceived barrier ‘lack of time’ was considered one of the key determinants by this study population. This has been incorporated in the discussion section: “It is possible that the participants did not perform enough MVPA to show an association with MH or WE. The study population indicated to perceive barriers such as lack of time to engage in leisure time physical activity (Van Berkel et al., 2011). When aiming for an increase in physical activity, such barriers should be addressed.”</td>
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<td><strong>Discussion:</strong> to my opinion, qualitative research may be useful in this domain to explore the relationship between MVPA and MH and MVPA and WE. Could you provide some comments on this?</td>
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<td>Qualitative research provides information on the nature of the relationship. This would be a great idea to explore the possible relationship in a different way, and also to explore possible (psychosocial) working mechanisms. The following has been added to the discussion section: “Potential psychosocial mechanisms for the PA-MH and PA-WE relationship (for example: PA enlarges self efficacy and self esteem, which could contribute to MH and WE) could be explored in qualitative research, as this provides insight in the nature of this relationship and possible mechanisms.”</td>
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<td><strong>Introduction - page 4:</strong> &quot;WE is defined as: &quot;...&quot; reference 16 is included twice (16;16)</td>
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<td>The double reference has been removed.</td>
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The main problem to me is that the authors have not sufficiently argued or made a clear case for their study. As of now, the study seems like a mix between two analyses, both with physical activity (PA) as the exposure, and with mental health (MH) as the first outcome, and work engagement (WE) as the second. Reading the manuscript, I never fully get the grips on why it is of relevance to bring the two together in one and the same paper?

The relevance of bringing the two analyses together in one paper can be found in occupational health. A paragraph on the importance of MH and WE to occupational health has been added to the introduction:

“Mental health is important for occupational health. Mental disorders are the second most frequent cause of absenteeism from work in Europe, after musculoskeletal disorders (WHO, 2010; Vaez et al., 2007). Globally, it is one of the leading causes for work disability (WHO, 2010). However, mental health is not merely the absence of disorders but also comprises well-being (WHO, 2001). A concept from positive occupational psychology, used as a work-related indicator of well-being, is work engagement (WE). Ouweneel and Schaufeli (2009) described WE as work-related happiness, representing a positive affective-cognitive state. WE is negatively associated with burnout, depression, distress and psychosomatic complaints (Schaufeli, Taris, & Van Rhenen, 2008; Schaufeli & Bakker, 2003). Furthermore, it is considered an antecedent for long-term levels of depression and anxiety symptoms (Innstrand, Langballe & Falkum, 2012) and a predictor of long-term general well-being (Hakanen & Schaufeli, 2012). In addition, it is positively related to job performance (Demerouti & Bakker, 2006) and has shown to be a (negative) predictor of sickness absenteeism from work (Schaufeli et al., 2008).”

There are no clear arguments presented in the introduction for how the concepts of MH and WE relate, and again is related to PA is not discussed in general terms, or in light of the results of the study. Why would WE be related to PA?

How the concepts of MH and WE relate has been stated more clearly in the introduction.

“To date, there is no evidence for effective strategies to improve WE. However, since WE can be equated to happiness at work, it has been hypothesized that evidence based strategies to improve happiness could also be effective to improve WE (Ouweneel, Schaufeli, & Leblanc, 2009). Next to psychological strategies to improve happiness, stimulating physical activity is also considered an effective strategy to improve happiness (Wang et al. 2012). However, to date, the associations of physical activity and WE remain unexplored.”

We hypothesized there could be an association between PA and WE, as associations of PA with well-being and happiness outside the work domain have been found in previous studies. For occupational health, it would be relevant to know whether PA also is associated with well-being within the work domain. This has been presented more clearly in the introduction.

“Mental health is important for occupational health. Mental disorders are the second most frequent cause of absenteeism from work in Europe, after musculoskeletal disorders (WHO, 2010; Vaez et al., 2007). Globally, it is one of the leading causes..."
for work disability (WHO, 2010). However, mental health is not merely the absence of disorders but also comprises well-being (WHO, 2001). A concept from positive occupational psychology, used as a work-related indicator of well-being, is work engagement (WE). Ouweneel and Schaufeli (2009) described WE as work-related happiness, representing a positive affective-cognitive state. WE is negatively associated with burnout, depression, distress and psychosomatic complaints (Schaufeli, Taris, & Van Rhenen, 2008; Schaufeli & Bakker, 2003). Furthermore, it is considered an antecedent for long-term levels of depression and anxiety symptoms (Innstrand, Langballe & Falkum, 2012) and a predictor of long-term general well-being (Hakanen & Schaufeli, 2012). In addition, it is positively related to job performance (Demerouti & Bakker, 2006) and has shown to be a (negative) predictor of sickness absenteeism from work (Schaufeli et al., 2008).”

| What is the proposed model and direction of causality? | Our hypothesis was, that MVPA is associated with MH and WE, in the same way that MVPA has been found to be associated with other psychological well-being measures: more MVPA is associated with better (higher scores on) mental health and work engagement. This has been stated more explicitly in the introduction:

“There is some evidence of a positive association between physical activity and subjective mental well-being outside the work domain. Hamer and Stamatakis (2010) found that self-reported moderate to vigorous physical activity (MVPA) was linked to subjective psychological well-being, while objectively measured MVPA was not. Our hypothesis is that the same associations are to be found between MVPA and mental health (MH) and between MVPA and WE, i.e. high MVPA is associated with better MH and higher WE. Hence, the aim of this study was to explore these associations, by both objective measures (accelerometry) and self-reports for MVPA.” |

| Do the authors propose that there is a possible causal link, or would they suspect that those who have a high WE also do more PA, and if so that this means the potential association would be due to one or more third variables? | In literature, a causal link between physical activity and mental health (i.e. disorders) has been demonstrated.

“Furthermore, Hamer, Stamatakis & Steptoe (2009) found a dose-response relationship between physical activity and psychological distress; with a greater risk reduction for activity of higher intensity levels and longer duration.”

But given the cross sectional design of this study, we cannot make inferences on causality, but only on associations. We formulated our hypothesis more clearly.

“There is some evidence of a positive association between physical activity and subjective mental well-being outside the work domain. Hamer and Stamatakis (2010) found that self-
reported moderate to vigorous physical activity (MVPA) was linked to subjective psychological well-being, while objectively measured MVPA was not. Our hypothesis is that the same associations are to be found between MVPA and mental health (MH) and between MVPA and WE, i.e. high MVPA is associated with better MH and higher WE. Hence, the aim of this study was to explore these associations, by both objective measures (accelerometry) and self-reports for MVPA.”

In addition, the associations have been checked for confounding and interaction of other variables (effect modification). This has been made more clear in the methods section:

“The analyses of the associations between PA and WE, and PA and MH were adjusted for socio-demographic variables (e.g. age, gender, and educational level). These variables (age, gender, education, and marital status) were also checked for potential effect modification, (adding interaction terms to the regression model). Additionally, Body Mass Index (BMI) was taken into account because BMI was previously found to be associated with mental health and also with PA (Ball, Burton & Brown, 2009)”

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<th>From the introduction, the authors argue that WE is related to mental health problems – but why would this mean that it is meaningful to study links between WE and PA? This goes back to the first bullet point in this list, where I wonder if the authors should have rather proposed that MH would act as a mediator for any possible association between PA and WE?</th>
<th>We did not hypothesized MH to be a mediator for the possible association between PA and WE, because according to the WHO-definition, well-being (also in the work domain) is part of MH, as are mental health problems/disorders. Associations of PA and well-being outside the work domain have been found in previous studies.</th>
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<td>To me, work engagement is understood as a very psychological concept, and specifically related to work. There are other concepts that better grasp more global concepts such as “well-being” and “quality of life”. The last sentence in the intro, before the aim is presented, suggests that PA and WE should be associated on the grounds of previous studies linking PA and global subjective well-being. I think the authors need to provide a clearer argument to warrant the analysis suggested.</td>
<td>Work engagement is indeed a concept from positive occupational psychology. There are indeed other concepts that better grasp more global concepts of well-being, but we specifically explored the association with WE, in the light of occupational health. The relevance to the field of occupational health has been stated more clearly in the introduction. (See first response)</td>
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This last point might also be particularly relevant given the sample at hand here, which consists of researchers. Is it plausible that PA is an important factor for WE among researchers? Could it not be argued that PA would be of particularly little relevance for WE in this group?

We added to the discussion, that this point should be taken into account when generalizing the results. “Nevertheless, it is not recommended to generalize the results to different professions; it could be argued the relationship between physical activity and work engagement is different for professions that require for example more physical activity at work.”

There was a total n of 257 in the study. The authors should provide a power analysis to support their methodological considerations regarding statistical power (pg10).

The power analysis of the RCT has been added. Taken the number of covariates in the model into account, this total number of participants is enough to show associations (n=10 per independent variable).

“The sample size of the RCT was based on finding an effect on the primary outcome; work engagement. An effect of a 10% increase in mean score was expected to be relevant and feasible. With a power of 90% and a two-sided alpha of 5%, both groups needed 89 participants. Accounting for a loss to follow-up of 25% over 12 months, each group needed 119 workers at baseline, thus an initial total of 238 participants for the two groups. The sample size calculation has been described more extensively elsewhere (Van Berkel et al., 2011). Because of the number of independent variables in the model, this number is expected to be enough to show associations, under the assumption that 10 cases are needed for each independent variable.”

The authors should also provide details on their measurements and how they conform with psychometric requirements for the statistical models used. The combination of weak statistical power and measurement issues could be very relevant for the results here.

We used validated measuring instruments. Findings of psychometric qualities of measuring instruments have been added to the methods section.

“The UWES has shown sufficient internal consistency (Schaufeli & Bakker, 2003).”

“The Dutch version of the RAND-36 mental health scale has shown to be sufficiently reliable (Van der Zee & Sanderman, 1993).”

“This questionnaire was found to be adequately reliable and valid in a Dutch sample of adult employees (Wendel-Vos, Schuit, Saris, & Kromhout, 2003).”

The authors resort to “effect”-terms, despite their cross-sectional design (e.g. pg 10, last para, and conclusion, pg 12). Causal terms can surely be used with cross-sectional data, but this requires that the causal mechanism behind an association is obvious, or at least based

We replaced “effect” with “b” and “association”. We agree that inferences on causality cannot be made based on this study.

“However, since the b’s were very small, it is considered that greater statistical power would not lead to relevant results.”

“It is possible that the participants did not perform enough MVPA to show an association with MH or WE.”
on very sound theoretical arguments or previous observations. For the associations observed here, I find it hard to argue for a unidirectional causal model.

Further related to their sample, I think the authors need to expand on their description of the sample to warrant their comments on generalizability on pg 12. At present, it is a bit hard to know which other professions and sectors one should not generalize these results to.

More details in relation to the generalizability have been presented.

“Finally, it should be taken into account that the sample consisted of mainly higher educated participants in scientific professions. Barkhuizen and Rothmann (2006) found that higher educated workers were more engaged than their lower educated colleagues. However, our sample of highly educated workers were averagely engaged, with a slightly higher mean 4.1(SD = 0.8) than the a UWES-17 mean of a Dutch sample (n=2313) of 3.8 (SD=1.1) (Schaufeli & Bakker 2003). Differences in mean levels of engagement between various occupational groups might be significant, but relatively small and they almost never exceed the size of one standard deviation (Schaufeli & Bakker, 2003). Thus, these results might be representative for other highly educated workers in scientific professions. Nevertheless, it is not recommended to fully generalize the results to different professions; it could be argued the relationship between physical activity and work engagement is different for professions that require for example more physical activity at work.”

On pg 6, it is somewhat confusing that there is a sub-heading on “physical activity”, and then two sub-headings on self-reported PA and objective PA.

The level of the subheadings has been changed. ‘Physical activity’ is in italic, the other two subheadings are standard. The other two subheadings have now been named ‘self-report’ and ‘accelerometry’.

I suppose “SB” on pg 5 is short for sedentary behaviours, but that should be spelled out in full first time.

Sedentary behaviour has now been spelled out.

It is not fully clear to me when the authors use the term “MVPA” and when they use “PA”?

In general sense, we used physical activity. To test our hypothesis, we measured moderate to vigorous physical activity. To make this more clear, we spelled out physical activity and have only abbreviated moderate to vigorous physical activity (MVPA).

The last two sentences in the conclusion were very unclear to me.

The last two sentences of the conclusion have been removed.