Author’s response to reviews

Title: Clustering of health-related behaviors, health outcomes and demographics in Dutch adolescents: a cross-sectional study.

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Author's response to reviews: see over
Subject: Submission revised manuscript

Dear editor,

Please find enclosed the revised manuscript of our original research paper entitled: “Clustering of health-related behaviors, health outcomes and demographics in Dutch adolescents: a cross-sectional study”.

First of all, we appreciate the positive feedback of the reviewers and that they find the paper to be a valuable addition to the literature. We addressed all provided suggestions and points of critique. In this document we elaborated upon how we integrated the feedback, and where these changes are to be found in this revised version of the paper.

We hope we sufficiently integrated all the reviewers’ feedback and we thank you in advance for considering our work for publication,

With kind regards, also on behalf of my coauthors,

Yours sincerely,

Vincent Busch
Feedback reviewer: 1

1. In the ‘Measures’ section, I think there should be a reference to the international HBSC as the items used are developed in the international group.

Response:
We have added such a reference to the methods section.

Revised section:
Added reference (#36)

Placement in text:
Methods – Measures

2. There is not a consistent nomenclature of the variables, e.g. page 6: ‘recent behavior’ is not used again in table 3 and page 7: ‘excessive use’ is called ‘weekly time ...’ in table 3.

Response:
We have checked the nomenclature of all behaviors and variables and corrected some inconsistencies.

Revised section:
Revisions made throughout the entire document.

Additional/revised text to clarify the measures:
“All behaviors that were included regarded “Recent behaviors”, meaning that one indicated to partake in a certain behavior in the month prior to filling out the questionnaire. With regard to bullying this concerned three months prior to filling in the survey. The questions regarding psychosocial problems and self-efficacy were more general, without indicating a certain period of time in which the behaviors had to have taken place. The included health-related behaviors were alcohol use, drug use, smoking, physical exercise, nutrition, sexual behavior, screen time (watching television, (online) gaming and internet use) and peer bullying. Most items were surveyed in similar fashion to those of the Dutch HBSC questionnaire; these are summarized in Table 1. The items that differed from the HBSC questionnaire format are discussed in more detail below.”

Additional revision:
Text in Table 3 revised.

Placement in text:
Throughout the document.

3. A more clear description of the cut-off point for health-related behaviors could be useful in the text.

Response:
We elaborated upon the cut-off points of the different behaviors now in the text (Methods-Measures)
Revised section:
Throughout the Methods section.

Placement in text:
Methods- Measures

4. More or less the same – not being familiar with CIUS and VAT, I miss a description of the contents of these scales. I noticed that there is an example in table 2, so at least a reference to table 2 is needed.

Response:
We added a short description regarding the contents of the CIUS and VAT surveys in order to elaborate on what concepts they aim to measure.

Revised section:
Added to the already present description of the CIUS and VAT is the following:

“The CIUS and VAT both represent a measurement of the core elements of compulsive or addictive behavior that are applicable to Internet use (e.g. loss of control, withdrawal symptoms, coping) [23]. These measures focus particularly on the compulsive and impulse control elements of Internet use and video game playing. To illustrate, issues such as whether one finds it difficult to stop using the Internet/playing video games, whether one rushes through homework to get to using the Internet/video games or whether others say one should spend less time on the Internet/playing video games are questioned by both surveys [22, 23]. Both the VAT and CIUS consist of 14 questions with a five-point Likert scale, used to evaluate compulsive behavior, respectively for compulsive videogame playing (CVP) and compulsive internet use (CIU). A mean score higher than 3.0 points indicates compulsive behavior”

Placement in text:
Methods- Measures - Screen time: watching television, internet use and videogame playing

5. I also need a more thorough description of how the authors use the factors found by PCA to create the clusters by the two step cluster analysis.

Response:
We elaborated more extensively on the factor- and cluster analysis in the Methods (the yellow texts are the revised sections).

Revised section:
“All statistical analyses were performed with SPSS v20. First, Principal Component Analysis (PCA) was used to identify underlying behavioral patterns from the described health behaviors. Varimax rotation was used and respondents were included by pairwise deletion in the PCA. Using the Varimax rotation method minimizes the number of variables that have high loadings on each factor and, as such, simplifies the interpretation of the factors. The extraction of factors in the analysis was based on the Scree Test, a factor loading of at least 0.30 after rotation (based on sample size and number of tested variables [44,45]) and conceptual meaningfulness [44]. In a follow-up analysis, we also assessed the number of factors to extract by parallel analysis [46], which compares Eigenvalues of factors from real data with factors from random data. This ensures that factors explain more than random data. Furthermore, two criteria were tested: the Kaiser-Meyer-Olkin Measure of Adequacy
(KMO), a measure of sampling adequacy (threshold: KMO >0.60) and Bartlett's test of sphericity, which is used to test the null hypothesis that the variables in the population correlation matrix are uncorrelated (threshold: p<0.05). This PCA produced standardized factor scores via regression techniques.

Subsequently, a Two Step Cluster Analysis (TCA) was used to identify groups of adolescents with similar behavior and health outcomes [45]. The behavioral patterns (i.e. the factor scores derived from the PCA) were used as input variables in the TCA, together with the socio-demographics age, gender, school level, ethnicity, socio-economic status and health outcomes (being overweight, GSE problems and psychosocial problems) [44,45]. A Two-Step Cluster Analysis is used here, due to the mixture of categorical and continuous variables. As stated by Norušis, other cluster analysis approaches will not suffice, since they rely on either continuous or categorical data (hierarchical clustering) or on a preset number of clusters to be distilled (K-means cluster analysis), whereas the TCA can perform an exploratory cluster analysis using a combination of different types of variables [47].

Placement in text:
Methods- Statistical Analysis

6. The four components described at page 10 should have the same numbers in table 3 and 4. Furthermore, are these components the final ones used in table 4?

Response:
We revised this numbering error, so that the numbering in tables and text is now synchronized. To be more clear on the use of the components, we named them more illustratively.

Revised section:
n/a
Placement in text:
Throughout the manuscript.

7. I am not a statistician and can as such not judge the statistical methods used. But I have some questions for the methods used. Can the same items be included in more than one factor? What impact does that have? Items in the same factor with very high loadings might measure the same concept, e.g. weekly time playing videogame and compulsive videogame playing. Is it correct to keep both items in the factor? Or should they rather be combined into a single measure?

Response:
From a statistical point of view it is correct to have such high factor loadings without having to combine/merge different elements [44-45]. When based on theory, it is allowed to have certain elements be part of multiple factors [44-45]. Excessive screen time use is associated with both sedentary behavior and compulsive gaming.

Triggered by the reviewers comments, we elaborated more upon the deduced factor scores and addressed the topics of overlapping loadings (‘cross-loadings’) in multiple factors shortly in the Results and more extensively in the Discussion.

In addition, we performed a ‘parallel analysis’ [46] (as described above) to double-check the results of the Scree Test, which made us decide to distill four factors from the fourteen behaviors. So, this Parallel Analysis gave similar results and we kept the four factors that we initially got from the PCA with the scree test.

Revised section:
In results:

“The first factor consisted of the high-risk behaviors alcohol use, drug use and smoking, and was thus termed risk-prone behavior. The second factor consisted of bullying, being bullied and compulsive PC/Internet use, termed the bully behavior factor. Thirdly, the different aspects of screen time use (i.e. its compulsive component and its excessive use component) formed a separate factor. The fourth factor consisted of the components low physical activity, poor nutrition habits combined with excessively watching TV and using the PC/Internet. This particular aspect of screen time use was related to poor physical exercise and nutrition patterns, whereas the compulsiveness of screen time use had no correlation with those behaviors. This fourth factor was thus termed the sedentary behavior factor. Due to theoretical considerations, and because both loaded above 0.30 in the PCA, compulsive PC/Internet use was included in both factor 2 and factor 3: Excessive PC/Internet use and excessively watching TV were also included in two different factors (further elaboration upon these considerations is presented in the Discussion)”

In Discussion:

“Secondly, being bullied and being a perpetrator of bullying formed a behavioral component in the PCA. Compulsive Internet use also loaded significantly on this factor. Despite the fact that this behavior loaded stronger on another factor (namely on factor 3), it was also included in this bully behavior factor, due to theoretical considerations: previous research reported on the relationship between the internet use of adolescents and their bully behavior [50]. Compulsive screen time use when being bullied could possibly indicate a kind of ‘flight behavior’ to a relative anonymous online environment in which one would feel safer. Thus, in this context compulsive screen time use seems to be part of a distinctly different overarching behavior than in factor 3 (discussed below). Therefore, it was included two different factors, as is common practice in factor analyses when theoretical considerations are taken into account instead of solely looking at statistical considerations [45]. However, our choice is somewhat speculative due to the small amount of studies on this topic.”

(...)

“In the current study screen time behavior consisted of two aspects, namely excessive and compulsive screen time behaviors. Although these showed to be strongly inter-related (forming a separate behavioral pattern, i.e. factor 3) the associations of excessive and compulsive screen time behaviors to problematic health-related outcomes differed. Excessive screen time was significantly related to being overweight (Cluster 4, Table 3), while compulsive screen time was significantly more prevalent among students that also indicated psychosocial problems, problems with GSE and behaviors such as bullying/being bullied (behavioral factor 2) and risk-prone behaviors (behavioral factor 1) (Table 3). The findings related to excessive screen time behavior were in accordance with previous studies [18-19, 51]. However, no other clustering studies that integrated the compulsive aspect of these behaviors in adolescents were found, although previous research has shown that, separately, compulsive and excessive screen time behaviors differ in their relation to outcomes such as psychosocial problems [52], educational outcomes [53] or physical health indicators [24]. Therefore, based on these theoretical considerations, compulsive and excessive screen time behaviors they were included in different behavioral factor loadings (Table 2).”
8. As far as I know, the validity for SDQ reported by students only is very low, see Goodman et al. (2003). Using the strengths and difficulties questionnaire (SDQ) to screen for child psychiatric disorders in a community sample. I think there need to be a discussion of this.

Response:
In the revised version we elaborated more extensively upon use of the SDQ in the current setting. One of the SDQ's applications is to use it as a diagnostic tool for psychiatric symptoms. We, however, apply it to identify youth with psychosocial behavioral problems. We base this indeed on Goodman and on two more recent studies, namely those by Muris, Meesters & Van Den Bergh and of Van Widenfelt, Goodman & Treffers. We hope our elaboration on this topic in the Methods section is sufficient.

Revised section:
“psychosocial problems, which were measured by use of the Strengths and Difficulties Questionnaire (SDQ). This validated questionnaire measures emotional problems, conduct problems, hyperactivity, peer problems, and pro-social behavior, each composed of 5 items scored on a 3-point Likert-scale (0= “not true”, 1=“somewhat true” or 2=“certainly true”). Together, except for the pro-social score, they add up to a total SDQ-score of maximum 40 points [36-37]. A score of 15 of higher is defined as “(potentially) problematic”. The self-report SDQ’s reliability and validity to measure the described psychosocial problem behaviors were recently demonstrated in a comparable sample of Dutch youth [38]. Van Widenfelt, Goodman, Treffers and Goodman later also stated that both the parent and self-report version of the SDQ are acceptable in terms of internal consistency, inter-informant product-moment correlations and inter-informant correlations when compared to the “standards”, i.e. the Child Behavior Checklist (CBCL) and the Youth Self Report survey (YSR) [39].”

Placement in text:
Section: Methods – health outcomes

9. Finally, a suggestion for implication for practice – not only does this paper point to the fact that interventions should tackle clusters, but these analysis also indicate which groups of young people the interventions should target.

Response:
We thank the reviewer for this tip. We re-wrote the Conclusions section to be more explicit on why the findings of the current study are valuable and what they mean for current public health practice.

Revised section:
“The results show that health-related behaviors tend to cluster, indicating that specific behavioral patterns underlie individual health behaviors. This resulted in the deduction of four distinct behavioral patterns, namely 1) Risk-prone behavior (alcohol and drug use, smoking and early sexual activity), 2) Bully behavior (bullying, being bullied and compulsive Internet use), 3) Problematic screen time use (excessively watching television and compulsively and excessively playing video games and using the Internet), and 4) Sedentary behavior (low physical exercise, poor nutritional habits and excessively watching television, playing videogames and using the Internet). Subsequent, four clusters of adolescents were identified; multi-problem behavior was associated with problematic physical and psychosocial health outcomes, as opposed to those exerting relatively few unhealthy behaviors. These associations were relatively independent of demographics such as ethnicity, gender and socio-economic status. Overall, this study adds to the current knowledge on how
health behaviors cluster within individuals and that certain combinations of behaviors can be used to target high-risk individuals, which were shown to be of significantly higher risk of poorer physical and psychosocial health outcomes.

Additionally, the findings of this study have significant implications for future school-based prevention programs. As Wiefferink et al. suggested, such knowledge on health behavioral clustering can be used to design more effective and feasible school based interventions using Transfer-oriented Learning [61]. Transfer-oriented Learning is said to take place when students apply independently and flexibly what they have learned in a context different to that in which they learned it [61]. This means for example that, if resisting peer pressure would be an important tool to prevent youth from starting smoking, such a skill can also be learnt to be applied in a different context, e.g. when teaching students to resist drug use or to partake in unprotected sex; certain common determinants can be transferred to teachings on different topics. Although a specific behavioral context is still needed to teach knowledge, attitudes and skills, Transfer Learning does facilitate more feasible school-based interventions, because topics can be integrated, which lightens the load on the curriculum. Also, it would increase the outreach that school-based interventions could have when multiple behaviors are targeted simultaneously. Given these developments, it is a positive development to see school based interventions move towards a comprehensive, whole school approach that would facilitate a clustered approach to improving health behaviors among children and adolescents [30]. To improve upon current practices in this area, research on the clustering of health behaviors is vital, since it is necessary to identify common determinants across different types of health behaviors. This study therefore adds significantly to the current knowledge.

Placement in text:
Conclusions.
Feedback reviewer: 2

1. In the background of the study more attention should be paid to what clustering actually means and what the specific benefits are.

Response:
We revised the beginning of the introduction to integrate the rationale of being interested in the clustering of health behaviors, and the synergistic effects, more explicitly and thoroughly.

Revised section:
“Recent studies show that several of such health-related behaviors influence each other in a clustered fashion instead of acting independently on one’s health [3-7]. Such clustering has important implications for research and practice due to the resulting synergistic effects, meaning that particular behaviors share a certain variance, resulting in the fact that changing one behavior affects prevalence of another [8, 9]. Certain behaviors increase the likelihood of being involved in other risk behaviors [10], e.g. alcohol users are more likely to partake in smoking use than non-drinkers [9]. Such synergistic effects have been shown to increase disease risk to a level greater than either factor alone [3-5, 8-9]. Therefore, interventions that target correlated behaviors are thought to be more effective than tackling these via separate interventions. The underlying hypothesis behind this is that on top of the health risks that come from a certain behavior, one’s mindset and decision-making processes are affected by partaking in a certain behavior. By that rationale, involvement in a certain behavior may influence the likelihood of being involved in other risk behaviors; alcohol users are more likely to also be smokers for example [9].

This has important implications for preventive interventions, because “if there is covariance between these behaviors, then programs that fail to engage multiple risk behaviors are unlikely to be successful or to generate lasting effects.” [11]. When behavior A and B cluster, then intervention on behavior A might affect behavior B, even though that was not directly targeted. Conversely, when behavior B is left out, intervening on behavior A might be less effective than a combined approach. Interventions that simultaneously tackled clustered health behaviors have been shown to be more effective as well as less costly [6, 10, 12].

Such intervention tailoring requires knowledge on the clustering characteristics of a broad scope of health behaviors. However, most past studies on health behavioral clustering focused on a relative small range of health behaviors.”

Placement in text:
Introduction

2. In conclusions it is stated that behaviors tend to cluster among adolescents, but other age groups were not included in the research. Also the conclusion that clustered unhealthy behaviors are associated with poor health is to be expected. What the clustering of behaviors contribute to this conclusion needs to be specified more.

Response:
We agree and we adjusted the conclusions accordingly. Also, we re-wrote the conclusions section more towards the practical implications for public health practice and school based interventions (please see for the Revised Section our response to your sixth comment).

Revised section:
Please see our response to Comment 6 of this reviewer.

**Placement in text:**

**Conclusions**

3. In 'Background' (p4) it is assumed that combined behaviors create higher health risk. This needs to be explained,

**Response:**

We revised the beginning of the introduction to integrate the rationale of being interested in the clustering of health behaviors, and the synergistic effects, more explicitly and thoroughly.

**Revised section:**

Please see the revised text/section as part of our answer to your first comment.

**Placement in text:**

**Introduction**

4 (page 10 and 11). I do not understand the difference between cluster 2 and cluster 3. Cluster 2 seems to include cluster 3. Please elaborate on this issue.

**Response:**

We acknowledge that our elaboration on this fell short in the original version. Therefore, similar to what we answered in response to remark 7 of the other reviewer, we elaborated more upon the deduced factor scores and addressed the topics of overlapping loadings in multiple factors shortly in the results and more extensively in both the results (where they are first introduced) and in the discussion (where they are interpreted more thoroughly).

**Revised section:**

**In results:**

“The first factor consisted of the high-risk behaviors alcohol use, drug use and smoking, and was thus termed risk-prone behavior. The second factor consisted of bullying, being bullied and compulsive PC/Internet use, termed the bully behavior factor. Thirdly, the different aspects of screen time use (i.e. its compulsive component and its excessive use component) formed a separate factor. The fourth factor consisted of the components low physical activity, poor nutrition habits combined with excessively watching TV and using the PC/Internet. This particular aspect of screen time use was related to poor physical exercise and nutrition patterns, whereas the compulsiveness of screen time use had no correlation with those behaviors. This fourth factor was thus termed the sedentary behavior factor. Due to theoretical considerations, and because both loaded above 0.30 in the PCA, compulsive PC/Internet use was included in both factor 2 and factor 3: Excessive PC/Internet use and excessively watching TV were also included in two different factors (further elaboration upon these considerations is presented in the Discussion)”

**In Discussion:**

“Secondly, being bullied and being a perpetrator of bullying formed a behavioral component in the PCA. Compulsive Internet use also loaded significantly on this factor. Despite the fact that this behavior loaded stronger on another factor (namely on factor 3), it was also included in this bully behavior factor, due to theoretical considerations: previous research reported on the relationship between the internet use of adolescents and their bully behavior...”
Compulsive screen time use when being bullied could possibly indicate a kind of ‘flight behavior’ to a relative anonymous online environment in which one would feel safer. Thus, in this context compulsive screen time use seems to be part of a distinctly different overarching behavior than in factor 3 (discussed below). Therefore, it was included in two different factors, as is common practice in factor analyses when theoretical considerations are taken into account instead of solely looking at statistical considerations [45]. However, our choice is somewhat speculative due to the small amount of studies on this topic."

(...) "In the current study screen time behavior consisted of two aspects, namely excessive and compulsive screen time behaviors. Although these showed to be strongly inter-related (forming a separate behavioral pattern, i.e. factor 3) the associations of excessive and compulsive screen time behaviors to problematic health-related outcomes differed. Excessive screen time was significantly related to being overweight (Cluster 4, Table 3), while compulsive screen time was significantly more prevalent among students that also indicated psychosocial problems, problems with GSE and behaviors such as bullying/being bullied (behavioral factor 2) and risk-prone behaviors (behavioral factor 1) (Table 3). The findings related to excessive screen time behavior were in accordance with previous studies [18-19, 51]. However, no other clustering studies that integrated the compulsive aspect of these behaviors in adolescents were found, although previous research has shown that, separately, compulsive and excessive screen time behaviors differ in their relation to outcomes such as psychosocial problems [52], educational outcomes [53] or physical health indicators [24]. Therefore, based on these theoretical considerations, compulsive and excessive screen time behaviors they were included in different behavioral factor loadings (Table 2)."

Results- principal components analysis & Discussion – Behavioral Factors

5. (page 12) Since cluster 3 differs from the other clusters, but the difference between cluster 2 and 3 is unclear, the conclusion needs to be revised

Response:
We integrated this in our revision that was part of the response to the last remark of this reviewer. We hope that this issue is clearer now that we elaborated upon the difference between clusters 2 and 3 as response to remark 4 of this reviewer.

Revised section:


Response:
We have re-written the conclusions paragraph, so that it more explicitly states why this study has significant implications for public health. We thank the reviewer for bringing up the suggested reference.

Revised section:
“the findings of this study have significant implications for future school-based prevention programs. As Wiefferink et al. suggested, such knowledge on health behavioral clustering can be used to design more effective and feasible school based interventions using Transfer-oriented Learning [61]. Transfer-oriented Learning is said to take place when students apply independently and flexibly what they have learned in a context different to that in which they learned it [61]. This means for example that, if resisting peer pressure would be an important tool to prevent youth from picking up smoking, such a skill can also be learnt to be applied more easily in a different context, e.g. when teaching students to resist drug use or partake in unprotected sex; certain common determinants can in such a way be transferred to teachings on different topics. Although a specific behavioral context is still needed to teach knowledge, attitudes and skills, Transfer Learning does facilitate more feasible school based interventions, because topics can be integrated, which lightens the load on the curriculum. Also, it would increase the outreach that school based interventions could have when multiple behaviors are targeted simultaneously. Given these developments, it is a positive development to see school based interventions move towards a comprehensive, whole school approach that would facilitate a clustered approach to improving health behaviors among children and adolescents [30]. To improve upon current practices in this area, research on the clustering of health behaviors is vital, since it is necessary to identify common determinants across different types of health behaviors. This study therefore adds significantly to the current knowledge.“

Placement in text:
Conclusions

Minor essential revisions
1. Under Background (p 4) the argument that almost never European population was researched, is in the context of this article not strong, and should be reconsidered. What is the impact of having only North-American samples?

Response:
We included this argument because when one would find e.g. a factor such as our “risk-prone behavior” factor, it would be important to know the origin of the study participants. For example, in some countries alcohol use among adolescents might be very socially accepted, while somewhere else this might not be the case; this would probably result in different behavioral cluster factors, given that in some countries alcohol use is thus not considered risk-prone behavior but rather normal behavior. However, the reviewer makes a valid point in that it is still not something that should be made a reason for performing the study. It is rather just something to take into account when interpreting study results. We therefore revised this section by deleting the argument.

2. Page 5: resiliency: change to resilience

Response:
We revised this.

3. Page 6: 'Measures': what do you mean with 'fairly representative sample?'

Response:
Since we cannot statistically test remarks about the sample’s representativeness we changed the wording on this.

4. Page 6: 'Measures': specify better what the differences are with HBSC
questionnaire

Response:
We agree and we elaborated on the differences and similarities with the HBSC.

Revised section:
"Most items were surveyed in similar fashion to those of the Dutch HBSC questionnaire; these are summarized in Table 1. The items that differed from the HBSC questionnaire format are discussed in more detail below"

Placement in text:
Methods- Measures

5. Page 16, line 11: skip the word 'was'

Response:
We revised this.

6. Page 17: line 3: 'indicates': change into 'indicate'

Response:
We revised this.