HEALTH PSYCHOLOGY BULLETIN

EDITORIAL HISTORY

Weight-status Related Differences in Reflective and Impulsive Determinants of Physical Activity in Youngsters (8-18 years old)

Gill A. ten Hoor, Guy Plasqui, Gerjo Kok, Annemie MWJ Schols, Robert AC Ruiter, Stef PJ Kremers, Gjalt-Jorn Y Peters, Anita CE Vreugdenhil

This document contains the editorial history, organized into three sections. This first section, section 0, provides background information about the paper and the review procedure. Section 1 is organized chronologically and contains the editorial communication and peer review history. Section 2 contains the successive preprints and is organized anti-chronologically.

DOI of article:	10.5334/hpb.14
DOI of this editorial history:	10.5334/hpb.14.pr1
Article submitted:	2018-01-18
Revision 1 submitted:	2018-07-18
Revision 2 submitted:	2020-05-21
Article accepted:	2020-05-22
Executive editor:	Derwin Chan
Senior editor:	Martin Hagger
Peer reviewer A:	Nicola Black
Peer reviewer B:	Tracy Tang

Cite this document as:

ten Hoor, G. A., Plasqui, G., Kok, G., Schols, A. M. W. J., Ruiter, R., A. C., Kremers, S. P. J., Peters, G.-J. Y., Vreugdenhil, A. C. E. (authors); Black, N., & Tang, T. (reviewers); Chan, D., & Hagger, M. (editors) (2020) Editorial history for 'Weight-status Related Differences in Reflective and Impulsive Determinants of Physical Activity in Youngsters (8-18 years old)'. *Health Psychology Bulletin*, 4(1).
<https://doi.org/10.5334/hpb.14.pr1>

Paper abstract

Objective To investigate associations between weight status and physical activity, psychosocial impulsive, and reflective determinants of exercise behavior in youngsters (8–18 years old), distinguishing between strength exercises and aerobic exercises.

Method Cross-sectional survey of 133 youngsters (89 girls – 59 youngsters who are being treated for obesity in an outpatient lifestyle intervention program, plus 74 youngsters from the general population). In order to identify reflective determinants, participants completed questionnaires. For the impulsive determinants, participants completed two computerized reaction time sorting-tasks ('Implicit Association Tests').

Results Exercise intentions, including those for aerobic and strength exercises, were positively correlated with BMI z-scores. Youngsters with a higher BMI z-score often reported that their friends think they should exercise and were more confident that they could exercise more if they wanted to. No other determinants, including impulsive determinants, were correlated with BMI z-scores.

Conclusion In terms of reflective determinants, few differences were found between youngsters with higher BMI z-scores as compared to youngsters with lower BMI z-scores. There was no significant correlation between BMI z-score and the impulsive determinants of aerobic versus strength exercise. This suggests that youngsters, independent from weight status feel that they could be reached by the same kind of physical activity intervention.

Background

This peer review history is published under Health Psychology Bulletin's peer review policy. Peer review at Health Psychology Bulletin (HPB) is blind, but upon acceptance of an article, the entire peer review history is made public. This policy has two aims. First, it makes the reviews citable, rewarding reviewers for their reviews, incentivizing thorough, thoughtful reviews, and stimulating constructive, considerate reviews and responses. Second, to yield the best of both worlds in terms of design of the review procedure. The common procedure of shielding authors' and peer reviewers' identities aims to prevent undue harshness or leniency. However, this anonymity also protects reviewers who make unreasonable requests or statements that are inconsistent with the literature, and authors who refuse to respond adequately to reviewers' requests. These risks are ameliorated by unblinding and publishing the peer review procedure upon paper acceptance.

Health Psychology Bulletin

Health Psychology Bulletin (HPB) is an official journal of the European Health Psychology Society (EHPS). It implements a number of innovative practices such as this peer review procedure, a strong full disclosure policy, a two-tiered review procedure, and explicitly welcoming null findings, replications, and reports of lessons learned such as failed manipulations or measurement instruments, as well as regular articles.

Section 1: editorial correspondence

This section is comprised of the editor–author correspondence followed by the review reports in chronological order.

Editor/Author Correspondence

Section Editor
2018-03-20 12:54 PM

Subject: [HPB] Editor Decision - "Differences in Reflective and Impulsive Determinants of Physical Activity Between Overweight and Normal Weight Youngsters "

Dear Dr Gill A. ten Hoor,

After review, we have reached a decision regarding your submission to Health Psychology Bulletin, "Differences in Reflective and Impulsive Determinants of Physical Activity Between Overweight and Normal Weight Youngsters ". Our decision is to request revisions of the manuscript prior to acceptance for publication.

The full review information should be included at the bottom of this email. There may also be a copy of the manuscript file with reviewer comments available once you have accessed the submission account. A summary of the requested edits from the editorial team can be found below. Please consider these points and revise the file accordingly:

Editorial Revision Requests:

Major revisions:

A few points below are important to attend in the revision:

1. The paper needs a better alignment between the study title, aim/ scope, hypothesis, analysis being used, results, and conclusion.
2. A clearer definition of the classification of overweight and normal weight should be provided.
3. Provide the rationales behind the use of z-score of BMI rather than simply BMI. Also I believe it is important to discuss the limitation of using BMI for classification of obesity.
4. A thorough proofreading may help improve the clarity and consistency of the paper.
5. When you submit the revision, please kindly remove the authors' identifiers for a blind review. I have done that for you in the first review, but please kindly make sure that in the submission.

To access your submission account, follow the below instructions:

- 1) login to the journal webpage with username and password
- 2) click on the submission title
- 3) click 'Review' menu option
- 4) download Reviewed file and make revisions based on review feedback
- 5) upload the edited file
- 6) Click the 'notify editor' icon and email the confirmation of re-submission and any relevant comments to the journal.

Please ensure that your revised files adhere to our author guidelines, and that the files are fully copyedited/proofed prior to upload. Please also ensure that all copyright permissions have been attained. This is the last opportunity for major editing, therefore please fully check your file prior to re-submission.

If you have any questions or difficulties during this process, please do contact us.

Please could you have the revisions submitted by [GIVE 2 WEEK DEADLINE]. If you cannot make this deadline, please let us know as early as possible.

Kind regards,

Derwin Chan
University of Hong Kong
derwin.chan@hku.hk

Reviewer 1:

General Comments:

The article titled "Differences in reflective and impulsive determinants of physical activity between overweight and normal weight youngsters" provides good theoretical background as to why this research is needed. Their argument is well-laid out and provides insight as to why results should be split between aerobic versus strength-related exercises in obese/overweight. Despite their compelling argument on sedentary behaviour being a top contributor to obesity in child/adults in addition to both reflective and impulsive determinants, their statistical

analysis does not directly answer their original aim of the study, of which being “to measure whether different determinants influence physical activity in general, and aerobic and strength exercises in particular, in youngsters with and without obesity”. Instead of a correlational analysis, it would be perhaps useful to use other tests that can signify a significant difference between the groups of youngsters (normal weight, overweight and obese) and aerobic v. strength exercise.

A second concern regarding the current article is that there needs to be a clear distinction and consistency between the terms of non-overweight (or sometimes referred to as normal weight), obese and overweight. According to BMI scale, there is a clear distinction between the three, however in the current study, because as the title suggests “overweight and normal weight youngsters”, perhaps it is better to be consistent with the BMI scale results and say overweight, obese, and non-overweight. It is easier to understand if this stays consistent throughout the article as well. It could also additionally benefit the article if there was a bit more attention on details such as brackets, run-ons and capitalizations within the article. In general, this seems to be a thought-out article with a good structure, however can also benefit from condensed writing and avoiding repetitiveness.

Specific Comments:

- Perhaps you can also add in line numbers?
- Page 1, please add the term “school-based” for the meta-analysis evidence
- Page 1 Reference of “Faigenbaum” is missing opening brackets
- Introduction, Aerobic and strength exercises: Sentence starting with “Instead...” could be reworded
- Page 4: “These youngsters are stronger in an absolute sense that normal weight youngsters and....” Could you provide a source?
- Page 4: It is suggested “of relevance here is whether overweight youngsters have enough experience ...”, perhaps consider deleting because this current study does not measure previous experiences with weights/aerobic exercise as well?
- Page 5, last sentence: “our sample consists of youngsters who are being treated...” perhaps this should be in the method section rather than the introduction?
- Page 6, before materials and methods: Perhaps you should add in “overweight”. It would also be a good area to define each of these words, obesity, normal weight and overweight.
- Page 6, under materials and methods: not too sure whether this section is important, perhaps consider deleting or shortening.
- Page6, under participants, before “To recruit a group”, missing period
- Page 8, I think it is better to insert Figure 1 legend here as it gives a more accurate explanation to the readers on how the IAT is actually carried out. Some bits here were repetitive as well; perhaps consider shortening?
- Page 8, under the questionnaire, I found it a bit confusing that “unless otherwise stated” a 100 point visual analogue scale was used, perhaps you can clarify that other than BMI, how often they exercise and self-image the remaining measures were rated on at 100-point visual analogue scale.
- Page 10: IAT D-score is capitalized
- Page 10: In order for your results to answer your hypothesis, I believe that you will need to differentiate and determine whether there is a difference between the psychological determinants when split by different groups of weight or different exercises; as I quote the introduction “it is essential to identify these determinants and also to pinpoint possible differences between overweight and non-overweight youngsters”. To my understanding, a correlational analysis cannot reveal whether there are significantly different determinants of physical activity within overweight/obese/normal weight individuals. But rather, can only look at the relationship strength of the determinants on BMI.

Reviewer 2:

The authors present a very interesting investigation into the reflective and impulsive determinants of physical activity amongst normal and overweight/obese children and teens. The key issue I see with the paper in its current form relates to its internal consistency:

(1) There is an apparent discrepancy between the stated aim, the analyses conducted, and the conclusions drawn.

Aim: From the paper: “In the current study, we investigated associations between physical activity and psychosocial determinants in overweight and non-overweight youngsters.” To me, this reads as though the authors will examine the association between (reflective and impulsive) determinants and physical activity levels, amongst each of overweight and non-overweight individuals (e.g., using correlation/regression analyses). Given some of the information in the introduction, I would also think that the authors were going to compare the predictors of physical activity between the two groups (overweight/non-overweight; e.g., using regression analyses with weight status, determinant, and weight status * determinant interaction term as predictors).

Analyses: In contrast, the analyses present the correlations/differences scores between the determinants and BMI z-score. This appears to answer the question of whether BMI is associated with each of the determinants, but says nothing about whether these determinants impact physical activity.

Conclusions: Following this, there are a number of sections in the discussion that appear to draw conclusions that

do not follow from the analyses conducted. These include: "Our study demonstrates that there are at least no negative correlations with strength exercises in overweight youngsters."; "The determinants of physical exercise are not different for youngsters with and without overweight, suggesting that the same kind of interventions will be effective for both groups."; "Between overweight youngsters and normal weight youngsters, there are no significant differences in the impulsive determinants, suggesting they can be targeted by the same intervention."

The authors' hypothesised model appears to be: determinants → physical activity → weight status, but the authors draw conclusions about the determinants-physical activity relationship from examination of the determinants-weight status relationship. Implicit in this decision is that there is a strong relationship between physical activity and weight status. This implicit assumption is contradicted by the findings presented. I suggest examining the relationship between the determinants and physical activity. If interested in whether the determinants differ by weight status, I suggest examining the interaction effect mentioned above. If this suggestion is adopted, it should be noted in the limitations that past physical activity was used as a proxy for future physical activity.

Additional issues are as follows:

- (2) a. Greater rationale for the use of the BMI z-score, rather than simply the BMI, is needed. There may have been a logical reason for this but, as it stands, this reason is not clear to the reader. Additionally, as BMI is quite widely used and understood, the z-score has the unintended impact of making the results less easily interpretable.
- b. It is not clear how the z-score was calculated. As the variables BMI and SDS (is SDS the z-score?) are not perfectly correlated in the supplied dataset, it seems the z-score is not a simple transformation of BMI. Is this right? It is also noted in the paper that BMI z-score ≥ 1 = overweight/obese, but in the dataset 26.7% of participants with a z-score ≥ 1 have a BMI < 25. Are different values being used to categorise overweight because the sample are children/teens? Clarification on the calculation of the z-score might address both of these issues/questions.
- c. There appear to be 28 participants in the dataset who are underweight (if SDS < 0 = underweight), but these were not mentioned in the paper. Were these participants grouped with the normal weight participants?
- (3) There is inconsistent terminology throughout regarding whether the authors are investigating overweight, obese, or both overweight and obese children and teens. Please clarify.
- (4) Introduction: At times, the rationale for the current study was unclear. This primarily relates to issue (1), raised above. Once issue (1) has been addressed, I suggest trying to clarify the argument in the introduction, particularly in the final two paragraphs.
- (5) General: Throughout, the authors refer to differences between the normal weight and overweight/obese participants; however, analyses were conducted using a continuous variable (BMI z-score) rather than a dichotomous variable (weight status). Perhaps this could be addressed somewhere by, for example, providing a rationale for why the continuous variable is the most appropriate (if the authors think it is the most appropriate).

Smaller issues/suggestions are as follows:

- (6) Abstract: I would suggest 'dual-process' as a keyword, if the authors have any to spare.
- (7) Introduction: This sentence is a bit unclear and could be reworded for clarity: "A person's behavior is determined by the relative strength of impulsive and reflective determinants in the sense that stronger determinants gain advantage over weaker ones".
- (8) Participants: Please clarify which measure is being reported after the $\pm$ signs – SD/SE?
- (9) The implicit association test: Please provide a bit more explanation on how the d-600 difference score is calculated, and how it can be interpreted.
- (10) PBC and intention: For each of PBC and intention, please clarify whether these were measured with a single item that assessed all three of physical activity, aerobic exercises, and strength exercises (i.e., one item total for each of PBC and intention), or whether these were measured with three items, one each for physical activity, aerobic exercises, and strength exercises (i.e., three items total for each of PBC and intention).
- (11) Analyses: Please clarify why 80% CIs were chosen, rather than 95% CIs. The rationale for this might be provided in the cited references, but for the naïve reader, this is not clear.
- (12) Limitations: Currently states that the quasi-experimental design is a limitation but I think the limitation the authors are describing more accurately relates to the sampling strategy.
- (13) Future research: Suggested that objective measures of physical activity should be used. This seems like it should fall in the limitations section.
- (14) Conclusion: This sentence is unclear: "One difference is that youngsters with higher BMI z-scores have more positive psychosocial correlations with exercise" and appears to contrast with the results: "No correlation between BMI z-score and self-reported physical activity was found ($r = -.01[-.18, .16]$, $p = .91$)". Please clarify the meaning of the first sentence.
- (15) General: There are a number of typos throughout; I suggest proof-reading more thoroughly. Examples are missing full stops that make sentences appear to run together, additional and missing parentheses, missing commas, "Liao et al.m 2012" on p.4, spelling error: "Craynest", and a few sentences that are a bit unclear for undetermined reasons. More generally (not specific to this manuscript), I'd also suggest the use of a reference manager to reduce the number of in-text referencing errors and to make referencing easier.
- (16) General: It would be nice to see an overview document in your supplemental materials zip, to help the reader navigate the different items.

Author
2018-07-18 02:38 PM

Health Psychology Bulletin
<http://healthpsychologybulletin.com>

Subject: Weight-status Related Differences in Reflective and Impulsive Determinants of Physical Activity in Youngsters (8-18 years old).

Dear Dr. Chan,

Hereby we want to inform you that we resubmitted our manuscript titled "Weight-status Related Differences in Reflective and Impulsive Determinants of Physical Activity in Youngsters (8-18 years old)."

under 'Summary' we updated the meta-data, and uploaded the response to reviewers-letter, the updated additional materials, and a file with the new manuscript (with all track changes accepted). under 'resubmission' we uploaded the revised manuscript file (with track changes).

with best wishes,

Gill

Editor
2018-08-31 11:28 AM

Health Psychology Bulletin
<http://healthpsychologybulletin.com>

Subject: [HPB] Editor Decision - "Weight-status Related Differences in Reflective and Impulsive Determinants of Physical Activity in Youngsters (8-18 years old)."

[This is a test by GJ Peters to try to resolve an issue he was notified about by D Chan)

After review, we have reached a decision regarding your submission to Health Psychology Bulletin, "Weight-status Related Differences in Reflective and Impulsive Determinants of Physical Activity in Youngsters (8-18 years old)". Our decision is to request revisions of the manuscript prior to acceptance for publication.

The full review information should be included at the bottom of this email. There may also be a copy of the manuscript file with reviewer comments available once you have accessed the submission account. A summary of the requested edits from the editorial team can be found below. Please consider these points and revise the file accordingly:

Editorial Revision Requests:

Major revisions:

[XXXX EDITOR TO INSERT LIST OF MAJOR REVISIONS HERE, IF ANY XXXX]

Minor revisions:

[XXXX EDITOR TO INSERT LIST OF MINOR REVISIONS HERE, IF ANY XXXX]

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Please ensure that your revised files adhere to our author guidelines, and that the files are fully copyedited/proofed prior to upload. Please also ensure that all copyright permissions have been attained. This is the last opportunity for major editing, therefore please fully check your file prior to re-submission.

If you have any questions or difficulties during this process, please do contact us.

Please could you have the revisions submitted by [GIVE 2 WEEK DEADLINE]. If you cannot make this deadline, please let us know as early as possible.

Kind regards,

Dr Gjalte-Jorn Peters
Open University of the Netherlands
gjalte-jorn@behaviorchange.eu

Health Psychology Bulletin
<http://healthpsychologybulletin.com>

Editor
2018-09-03 10:50 AM

Subject: [HPB] Editor Decision - "Weight-status Related Differences in Reflective and Impulsive Determinants of Physical Activity in Youngsters (8-18 years old)."

Dear Dr Gill A. ten Hoor,

After review, we have reached a decision regarding your submission to Health Psychology Bulletin, "Weight-status Related Differences in Reflective and Impulsive Determinants of Physical Activity in Youngsters (8-18 years old)". Our decision is to request revisions of the manuscript prior to acceptance for publication.

The full review information should be included at the bottom of this email. There may also be a copy of the manuscript file with reviewer comments available once you have accessed the submission account. A summary of the requested edits from the editorial team can be found below. Please consider these points and revise the file accordingly:

Editorial Revision Requests:

Major revisions:

[XXXX EDITOR TO INSERT LIST OF MAJOR REVISIONS HERE, IF ANY XXXX]

Minor revisions:

[XXXX EDITOR TO INSERT LIST OF MINOR REVISIONS HERE, IF ANY XXXX]

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If you have any questions or difficulties during this process, please do contact us.

Please could you have the revisions submitted by [GIVE 2 WEEK DEADLINE]. If you cannot make this deadline, please let us know as early as possible.

Kind regards,

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Health Psychology Bulletin
<http://healthpsychologybulletin.com>

Section Editor
2018-10-23 03:09 AM

Subject: [HPB]"Weight-status Related Differences in Reflective and Impulsive Determinants of Physic

Dear Gill,

I am glad to let you know that the second round of peer review has been completed. The reviewers and I believe that your manuscript has been improved from the previous submission, but there are still some critical issues that are not completely resolved, and a few new issues emerged. The authors should pay attention particularly on the

transparency and clarity of the study aim/objectives and the results, and be consistent throughout the manuscript. For instance, it is important to align the study design (e.g. classification of weight groups) and analysis to the study aim, and there needs to have more better justification of how the study design or even the analysis addressed the research questions in the study. Some minor errors are still present in the paper and they warrant a more careful proofreading. I hope you may find our comments useful for preparing a revision of your manuscript.

Cheers,
Derwin.

Reviewer A:

Overview

The authors have sufficiently addressed some of the issues raised previously, including the explanations of the IAT, questionnaires, d-600, z-score, and some methodological choices. Other issues have not been sufficiently addressed. A few new issues were also noticed, now that the aim of the study is a bit clearer. Overall, I suggest that the authors take some time to gain a more holistic perspective towards the paper and the revisions required. Small, specific edits to the manuscript were previously made in response to reviewer/editor suggestions but it is not clear that authors sufficiently considered all issues raised in the context of the paper as a whole.

Key issues

1. Internal consistency/clarity of paper remains a key issue.

My understanding of the focus of the paper:

- The goal of this paper was to determine whether normal-weight and overweight/obese children and teenagers report different levels of psychosocial constructs that have previously been linked to physical activity (PA). Assumption: all measured constructs are significant determinants of PA (assumption presumably based on past research; not the aim of the current research). Therefore, the question of interest to the researchers must be how much 'room for change' there is on each construct, for each of normal-weight and overweight/obese children and teens. E.g., if attitude is a significant predictor of PA, but one group already holds very positive attitudes and the other holds negative attitudes, then it might only be effective to target attitude amongst the group who hold negative attitudes (which could be shifted to positive). Is this understanding correct?

Issues to address:

- If the above-described, 'room for change' interpretation is correct, this needs to be clearer in all sections of the manuscript. In the discussion, this would require consideration of the mean levels and variance of each determinant within each group, and any significant differences between these groups. If the interpretation is incorrect, it is, at present, difficult to determine which of the introduction, analyses, and/or discussion needs revision.

- Lines 164-166, 170-171, and one author response ("we do examine the relationship between the determinants and physical activity; in fact, we look at how this relationship changes with BMI-z") still suggest that differences by weight status in the relationship between determinants and PA will be examined. It is not clear where in the manuscript these analyses appear and most of the other author responses suggest that this was not the aim and will not be examined.

2. The sampling strategy appears to be a key limitation of this study. While it is briefly mentioned in the limitations section, it is unduly dismissed ("as the data showed, there was no indication of a sampling bias") and incompletely considered in the discussion more generally. Given there are only 18 overweight/obese participants from the general population sample, it seems likely that the tests used in the crude matching procedure were underpowered. Therefore, finding few significant differences cannot be considered a strong basis for dismissing any sampling biases.

- The lifestyle program could reasonably be expected to raise the participants' self-efficacy for PA (i.e., through experience of PA) and their perception that their friends (e.g., from the program) think they should engage in PA. Resultantly, an increase in intention might also be expected. These effects could be driving the observed relationships between z-BMI and each of SN, PBC, and intention. Inspection of the patterns of means in Table 1 suggests this is not the case for SN but could well be the case for PBC and intention. In both cases, it seems that the program effect might be driving most of these observed effects, but that some association might remain in the absence of this program effect. This should be better considered in the discussion when interpreting these observed associations.

3. The analysis

- It is not clear why tests of strength of association (correlations) rather than tests of difference were chosen when the study aim appears to be to examine differences between groups. The authors noted in their responses that they had addressed this, but the choice to use correlation analyses remains unsupported in the manuscript. The authors have added a section on BMI being a continuous variable (lines 126-129), but this does not sufficiently justify the analysis choice in relation to the study aims.

Smaller issues

Concepts

4. The introduction sets up the importance of PA as a means to addressing overweight/obesity, but if this were the only reason to encourage PA then it would not be relevant to compare levels of determinants across normal-weight and overweight/obese people (the apparent aim of the study); it would only be important to examine determinants amongst overweight/obese people. Please strengthen the rationale (e.g., do the authors think that PA is important for everyone but want to know whether approaches to increasing PA should be tailored depending on weight status? Do the authors want to know if previous research on determinants of PA amongst normal weight individuals generalises to overweight/obese individuals?).
5. The discussion concludes that very few correlations were seen, but in fact the authors found correlations between BMI-z and most (3/5) of the examined reflective determinants.
6. Line 429: As noted in the previous review, it is not clear how the quasi-experimental design is a limitation. Do the authors mean that the fact that individuals were not randomly assigned to weight status is a limitation? It is not clear why this would be a limitation, as the authors are not trying to draw causal inferences about the impact of weight status on determinants.

Clarity/Completeness

7. Lines 75-79: the correlations with intention are missing.
8. Sentence on lines 155-157: currently reads as though the authors will compare the strength of IA towards strength exercises with that towards aerobic exercises. Should be clarified.
9. 159: heading does not match paragraph (which is introducing the current study)
10. 247: "taken into account for calculating" is unclear/vague. Should this be "used to calculate"?
11. 271-274: Currently seems to imply that the demographics were measured on 100-point scales. Supplemental materials suggest this is not the case. Please clarify in text.
12. Crude matching: lines 310-312 and 325-326 imply statistical comparison of overweight/obese participants from each of the general and treatment samples (two groups), but lines 327-333 imply these were also statistically compared with the normal weight participants (three groups). The former seems appropriate for the matching question, but the latter does not (in fact, it overlaps with the primary RQ). Please clarify. It is also unclear what statistical test was used.
13. 331-332: I was not able to locate additional file 1, so have not been able to appraise the pattern of results. Please clarify where this can be found. Note that it did look like there were some differences between samples in Table 1, and I have raised this as an issue in point 2, above.
14. 397: use of the word 'correlations' is incorrect/unclear.
15. 412-414 is unclear. No tests of difference between strength and aerobic exercises amongst overweight participants were conducted?
16. 424-425: I raised this sentence as not following from the analyses conducted in the previous review and the authors noted that this had been addressed. The sentence remains largely unchanged in the resubmitted manuscript (has not been addressed).
17. Sentences on lines 435-442 seem unrelated to the study aims. Could remove or clarify.
18. Relevance of sentence on lines 452-454 is unclear. Suggest better integrate/explain or remove.
19. Self-image correlations are missing from figure 3.

Conciseness

20. Two sentences on lines 160-164 currently repeat earlier sentences about specific studies rather than synthesise/introduce current study. Something like 'previous research has found X but has not yet considered Y' might be better.
21. Sentences in lines 306-309 are now covered in detail in earlier sections. Could be removed.
22. Sentence on line 359-360 is a repetition of sentence on line 354-357 and could be removed.
23. Sentences on lines 443-44 and 447-448 seem to be the same limitation (subjective measurement) and could be combined. The first one probably needs more clarification too, as it seems to relate to the additional document (describing problems in measuring physical activity), which most readers will not read.

Grammar and typos

24. As with the previous version, many typos/punctuation issues were present and reduced readability (e.g., missing/extra periods parentheses, commas, spaces etc.). See, e.g., lines 96, 121, 171, 186, 190, 193, 257-258, 319, 365, 370, 398, 399, 428, 448. Note that most of these were picked up automatically by Microsoft Word's spelling and grammar checker. If the authors are using Word perhaps check the settings to see if it is picking up all issues.
25. Commas in compound predicates occurred a few times. For these, remove the comma or add a subject for the second verb (see <https://docs.microsoft.com/en-us/style-guide/punctuation/commas> for explanation). Lines 77, 194, 204, 437.

Reviewer B:

General Comments:

The authors made a good attempt at addressing the comments and provided quotations of edits. However, when the paper was re-read, some of the uncertainties identified in the first round of editing, still remained. First of all, (according to comment 3 of the Editorial Revision request), the authors had clarified why the z-score calculation was needed as an indicator of weight class and subsequent difference analysis was done based upon BMI z-score. But they could have further clarified why the z-score was used during subsequent correlational analysis as compared to just directly using the BMI.

Secondly, the article still needs further proofreading, minor mistakes such as fragments (L125) missing end-brackets (L175), double full-stops (L171, 186), missing spaces (L121) and inconsistencies in "z-score" (L460) still needs to be addressed. It is also important that the article avoids the word "determinants", especially in the introduction, as this can throw the reader off to the subsequent cross sectional design (we cannot be sure about the causal relationship between the variables).

More importantly, I believe that there needs to be further transparency and explanation of the data. Currently, the aim of the study was "to investigate weight-status related differences in psychosocial impulsive and reflective determinants of exercise behaviour in youngsters distinguishing between strength exercises and aerobic exercises". However, it is unclear why subsequent participants had such an imbalanced number of participants per group (i.e. underweight had a total of 3, normal weight, 55, overweight, 18, and obese 57), perhaps the authors can also further mention this in their limitations?

Moreover, during analysis as indicated via Table1, "normal weight" comprised of general population of underweight and normal weight (two groups), and "overweight" comprised of General population overweight + obese (two groups) and overall intervention program group comprised of normal weight, overweight and obese (three groups). I believe that further justification regarding these groupings of participants is needed. Additionally, consistency regarding the groupings, general public v. intervention program participants should be consistent, resulting in four groups? Maybe the authors can justify this?

Specific Comments:

L392: Perhaps I have overlooked, but this significant result was not in the results section? Perhaps you can include this there with the relevant correlation coefficient, p-value and confidence intervals.

Line 398: Insert "with" after "youngsters"

L431: not sure this was a good explanation as there are a total of 57 from the intervention group and only 18 from the general public?

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Section Editor
 2019-07-29 06:38 AM

Subject: [HPB] Editor Decision - "Weight-status Related Differences in Reflective and Impulsive Determinants of Physical Activity in Youngsters (8-18 years old)."

Dear Dr Gill A. ten Hoor,

After review, we have reached a decision regarding your submission to Health Psychology Bulletin, "Weight-status Related Differences in Reflective and Impulsive Determinants of Physical Activity in Youngsters (8-18 years old)". Our decision is to request revisions of the manuscript prior to acceptance for publication.

The full review information should be included at the bottom of this email. There may also be a copy of the manuscript file with reviewer comments available once you have accessed the submission account. A summary of the requested edits from the editorial team can be found below. Please consider these points and revise the file accordingly:

Editorial Revision Requests:

Major revisions:

I am glad to let you know that the second round of peer review has been completed. The reviewers and I believe that your manuscript has been improved from the previous submission, but there are still some critical issues that are not completely resolved, and a few new issues emerged. The authors should pay attention particularly on the transparency and clarity of the study aim/objectives and the results, and be consistent throughout the manuscript. For instance, it is important to align the study design (e.g. classification of weight groups) and analysis to the study aim, and there needs to have more better justification of how the study design or even the analysis addressed the research questions in the study. Some minor errors are still present in the paper and they warrant a more careful proofreading. I hope you may find our comments useful for preparing a revision of your manuscript.

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that your manuscript has been improved from the previous submission, but there are still some critical issues that are not completely resolved, and a few new issues emerged. The authors should pay attention particularly on the transparency and clarity of the study aim/objectives and the results, and be consistent throughout the manuscript. For instance, it is important to align the study design (e.g. classification of weight groups) and analysis to the study aim, and there needs to have more better justification of how the study design or even the analysis addressed the research questions in the study. Some minor errors are still present in the paper and they warrant a more careful proofreading. I hope you may find our comments useful for preparing a revision of your manuscript.

Reviewer A:

Overview

The authors have sufficiently addressed some of the issues raised previously, including the explanations of the IAT, questionnaires, d-600, z-score, and some methodological choices. Other issues have not been sufficiently addressed. A few new issues were also noticed, now that the aim of the study is a bit clearer. Overall, I suggest that the authors take some time to gain a more holistic perspective towards the paper and the revisions required. Small, specific edits to the manuscript were previously made in response to reviewer/editor suggestions but it is not clear that authors sufficiently considered all issues raised in the context of the paper as a whole.

Key issues

1. Internal consistency/clarity of paper remains a key issue.

My understanding of the focus of the paper:

- The goal of this paper was to determine whether normal-weight and overweight/obese children and teenagers report different levels of psychosocial constructs that have previously been linked to physical activity (PA). Assumption: all measured constructs are significant determinants of PA (assumption presumably based on past research; not the aim of the current research). Therefore, the question of interest to the researchers must be how much 'room for change' there is on each construct, for each of normal-weight and overweight/obese children and teens. E.g., if attitude is a significant predictor of PA, but one group already holds very positive attitudes and the other holds negative attitudes, then it might only be effective to target attitude amongst the group who hold negative attitudes (which could be shifted to positive). Is this understanding correct?

Issues to address:

- If the above-described, 'room for change' interpretation is correct, this needs to be clearer in all sections of the manuscript. In the discussion, this would require consideration of the mean levels and variance of each determinant within each group, and any significant differences between these groups. If the interpretation is incorrect, it is, at present, difficult to determine which of the introduction, analyses, and/or discussion needs revision.

- Lines 164-166, 170-171, and one author response ("we do examine the relationship between the determinants and physical activity; in fact, we look at how this relationship changes with BMI-z") still suggest that differences by weight status in the relationship between determinants and PA will be examined. It is not clear where in the manuscript these analyses appear and most of the other author responses suggest that this was not the aim and will not be examined.

2. The sampling strategy appears to be a key limitation of this study. While it is briefly mentioned in the limitations section, it is unduly dismissed ("as the data showed, there was no indication of a sampling bias") and incompletely considered in the discussion more generally. Given there are only 18 overweight/obese participants from the general population sample, it seems likely that the tests used in the crude matching procedure were underpowered. Therefore, finding few significant differences cannot be considered a strong basis for dismissing any sampling biases.

- The lifestyle program could reasonably be expected to raise the participants' self-efficacy for PA (i.e., through experience of PA) and their perception that their friends (e.g., from the program) think they should engage in PA. Resultantly, an increase in intention might also be expected. These effects could be driving the observed relationships between z-BMI and each of SN, PBC, and intention. Inspection of the patterns of means in Table 1 suggests this is not the case for SN but could well be the case for PBC and intention. In both cases, it seems that the program effect might be driving most of these observed effects, but that some association might remain in the absence of this program effect. This should be better considered in the discussion when interpreting these observed associations.

3. The analysis

- It is not clear why tests of strength of association (correlations) rather than tests of difference were chosen when the study aim appears to be to examine differences between groups. The authors noted in their responses that they had addressed this, but the choice to use correlation analyses remains unsupported in the manuscript. The authors have added a section on BMI being a continuous variable (lines 126-129), but this does not sufficiently justify the analysis choice in relation to the study aims.

Smaller issues

Concepts

4. The introduction sets up the importance of PA as a means to addressing overweight/obesity, but if this were the only reason to encourage PA then it would not be relevant to compare levels of determinants across normal-weight and overweight/obese people (the apparent aim of the study); it would only be important to examine determinants amongst overweight/obese people. Please strengthen the rationale (e.g., do the authors think that PA is important for everyone but want to know whether approaches to increasing PA should be tailored depending on weight status? Do the authors want to know if previous research on determinants of PA amongst normal weight individuals generalises to overweight/obese individuals?).
5. The discussion concludes that very few correlations were seen, but in fact the authors found correlations between BMI-z and most (3/5) of the examined reflective determinants.
6. Line 429: As noted in the previous review, it is not clear how the quasi-experimental design is a limitation. Do the authors mean that the fact that individuals were not randomly assigned to weight status is a limitation? It is not clear why this would be a limitation, as the authors are not trying to draw causal inferences about the impact of weight status on determinants.

Clarity/Completeness

7. Lines 75-79: the correlations with intention are missing.
8. Sentence on lines 155-157: currently reads as though the authors will compare the strength of IA towards strength exercises with that towards aerobic exercises. Should be clarified.
9. 159: heading does not match paragraph (which is introducing the current study)
10. 247: "taken into account for calculating" is unclear/vague. Should this be "used to calculate"?
11. 271-274: Currently seems to imply that the demographics were measured on 100-point scales. Supplemental materials suggest this is not the case. Please clarify in text.
12. Crude matching: lines 310-312 and 325-326 imply statistical comparison of overweight/obese participants from each of the general and treatment samples (two groups), but lines 327-333 imply these were also statistically compared with the normal weight participants (three groups). The former seems appropriate for the matching question, but the latter does not (in fact, it overlaps with the primary RQ). Please clarify. It is also unclear what statistical test was used.
13. 331-332: I was not able to locate additional file 1, so have not been able to appraise the pattern of results. Please clarify where this can be found. Note that it did look like there were some differences between samples in Table 1, and I have raised this as an issue in point 2, above.
14. 397: use of the word 'correlations' is incorrect/unclear.
15. 412-414 is unclear. No tests of difference between strength and aerobic exercises amongst overweight participants were conducted?
16. 424-425: I raised this sentence as not following from the analyses conducted in the previous review and the authors noted that this had been addressed. The sentence remains largely unchanged in the resubmitted manuscript (has not been addressed).
17. Sentences on lines 435-442 seem unrelated to the study aims. Could remove or clarify.
18. Relevance of sentence on lines 452-454 is unclear. Suggest better integrate/explain or remove.
19. Self-image correlations are missing from figure 3.

Conciseness

20. Two sentences on lines 160-164 currently repeat earlier sentences about specific studies rather than synthesise/introduce current study. Something like 'previous research has found X but has not yet considered Y' might be better.
21. Sentences in lines 306-309 are now covered in detail in earlier sections. Could be removed.
22. Sentence on line 359-360 is a repetition of sentence on line 354-357 and could be removed.
23. Sentences on lines 443-44 and 447-448 seem to be the same limitation (subjective measurement) and could be combined. The first one probably needs more clarification too, as it seems to relate to the additional document (describing problems in measuring physical activity), which most readers will not read.

Grammar and typos

24. As with the previous version, many typos/punctuation issues were present and reduced readability (e.g., missing/extra periods parentheses, commas, spaces etc.). See, e.g., lines 96, 121, 171, 186, 190, 193, 257-258, 319, 365, 370, 398, 399, 428, 448. Note that most of these were picked up automatically by Microsoft Word's spelling and grammar checker. If the authors are using Word perhaps check the settings to see if it is picking up all issues.
25. Commas in compound predicates occurred a few times. For these, remove the comma or add a subject for the second verb (see <https://docs.microsoft.com/en-us/style-guide/punctuation/commas> for explanation). Lines 77, 194, 204, 437.

Reviewer B:

General Comments:

The authors made a good attempt at addressing the comments and provided quotations of edits. However, when the paper was re-read, some of the uncertainties identified in the first round of editing, still remained. First of all, (according to comment 3 of the Editorial Revision request), the authors had clarified why the z-score calculation was needed as an indicator of weight class and subsequent difference analysis was done based upon BMI z-score. But they could have further clarified why the z-score was used during subsequent correlational analysis as compared to just directly using the BMI.

Secondly, the article still needs further proofreading, minor mistakes such as fragments (L125) missing end-brackets (L175), double full-stops (L171, 186), missing spaces (L121) and inconsistencies in "z-score" (L460) still needs to be addressed. It is also important that the article avoids the word "determinants", especially in the introduction, as this can throw the reader off to the subsequent cross sectional design (we cannot be sure about the causal relationship between the variables).

More importantly, I believe that there needs to be further transparency and explanation of the data. Currently, the aim of the study was "to investigate weight-status related differences in psychosocial impulsive and reflective determinants of exercise behaviour in youngsters distinguishing between strength exercises and aerobic exercises". However, it is unclear why subsequent participants had such an imbalanced number of participants per group (i.e. underweight had a total of 3, normal weight, 55, overweight, 18, and obese 57), perhaps the authors can also further mention this in their limitations?

Moreover, during analysis as indicated via Table1, "normal weight" comprised of general population of underweight and normal weight (two groups), and "overweight" comprised of General population overweight + obese (two groups) and overall intervention program group comprised of normal weight, overweight and obese (three groups). I believe that further justification regarding these groupings of participants is needed. Additionally, consistency regarding the groupings, general public v. intervention program participants should be consistent, resulting in four groups? Maybe the authors can justify this?

Specific Comments:

L392: Perhaps I have overlooked, but this significant result was not in the results section? Perhaps you can include this there with the relevant correlation coefficient, p-value and confidence intervals.

Line 398: Insert "with" after "youngsters"

L431: not sure this was a good explanation as there are a total of 57 from the intervention group and only 18 from the general public?

To access your submission account, follow the below instructions:

- 1) login to the journal webpage with username and password
- 2) click on the submission title
- 3) click 'Review' menu option
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Please ensure that your revised files adhere to our author guidelines, and that the files are fully copyedited/proofed prior to upload. Please also ensure that all copyright permissions have been attained. This is the last opportunity for major editing, therefore please fully check your file prior to re-submission.

If you have any questions or difficulties during this process, please do contact us.

Please could you have the revisions submitted by [GIVE 2 WEEK DEADLINE]. If you cannot make this deadline, please let us know as early as possible.

Kind regards,

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Health Psychology Bulletin
<http://healthpsychologybulletin.com>

Subject: Weight-status Related Differences in Reflective and Impulsive Determinants of Physical Activity in Youngsters (8-18 years old).

Author
2020-05-21 03:28 PM

Editorial Revision Requests

1	The paper needs a better alignment between the study title, aim/ scope, hypothesis, analysis being used, results, and conclusion.	Thank you for your feedback. We are confident that the improvements we implemented improved the manuscript substantially. Throughout the paper, we made sure that there is a better alignment between title, aim/scope, hypothesis, analysis, results, and conclusion (see also our response to the reviewers below).
2	A clearer definition of the classification of overweight and normal weight should be provided.	<p>We clarified our aim to “Weight-status related differences in reflective and impulsive determinants of physical activity in youngsters (8-18 years old).</p> <p>In the methods section we added: <i>“Each child’s BMI was recoded into an age and gender specific BMI z-score and compared to the national reference population (Cole, Bellizzi, Flegal & Dietz, 2000; Cole, Flegal, Nicholls, & Jackson, 2007. Using the cut off points as defined by the WHO Growth reference 5-18 years, weight status was determined (BMI z-score <1 = normal weight, > 1= overweight/obese.”</i></p> <p>Also, under ‘participants’ and ‘analysis’ in the methods section, we added a better explanation.</p>
3	Provide the rationales behind the use of z-score of BMI rather than simply BMI. Also I believe it is important to discuss the limitation of using BMI for classification of obesity.	<p>We realise now that this was insufficiently clearly explained. This also connects to issue #2. Also, in our discussion we added <i>“Body weight adjusted for height (BMI) and related z-scores in children are commonly used to determine whether an individual has a healthy or unhealthy weight, and can be seen as a good and simple tool for risk estimates in large populations (Ten Hoor et al., 2018b). However, it is not the right tool for individual metabolic and mental health evaluations (Bogin, Varela Silva, 2012) and might have stigmatizing effects on one’s health in later life (Hunger, Tomiyama, 2014). Other methods to determine body composition are more accurate to evaluate health, but these measures are more difficult to apply in larger study populations.</i></p> <p>[...]</p> <p><i>Third, in future studies, measuring actual body composition might be of additional value.”</i></p>
4	A thorough proofreading may help improve	We thoroughly proofread our paper to improve

	the clarity and consistency of the paper.	clarity and consistency (see also our response to the reviewers below).
5	When you submit the revision, please kindly remove the authors' identifiers for a blind review. I have done that for you in the first review, but please kindly make sure that in the submission.	We removed all author identifiers for the current resubmission. Our apologies for the inconvenience caused earlier.

Reviewer 1:

6	The article titled "Differences in reflective and impulsive determinants of physical activity between overweight and normal weight youngsters" provides good theoretical background as to why this research is needed. Their argument is well-laid out and provides insight as to why results should be split between aerobic versus strength-related exercises in obese/overweight.	Thank you for your compliments and feedback. See our response to your feedback below.
7	Despite their compelling argument on sedentary behaviour being a top contributor to obesity in child/adults in addition to both reflective and impulsive determinants, their statistical analysis does not directly answer their original aim of the study, of which being "to measure whether different determinants influence physical activity in general, and aerobic and strength exercises in particular, in youngsters with and without obesity". Instead of a correlational analysis, it would be perhaps useful to use other tests that can signify a significant difference between the groups of youngsters (normal weight, overweight and obese) and aerobic v. strength exercise.	We clarified our aim to: 'Weight-status related Differences in Reflective and Impulsive Determinants of Physical Activity in Youngsters (8-18 years old).
8	A second concern regarding the current article is that there needs to be a clear distinction and consistency between the terms of non-overweight (or sometimes referred to as normal weight), obese and overweight. According to BMI scale, there is a clear distinction between the three, however in the current study, because as the title suggests "overweight and normal weight youngsters", perhaps it is better to be consistent with the BMI scale results and say overweight, obese, and non-overweight. It is easier to understand if this stays consistent throughout the article as well.	See also #7. We now talk about 'youngsters with higher and lower BMI z score' and corrected this throughout the paper.
9	It could also additionally benefit the article if	We re-read our paper and corrected this where

	there was a bit more attention on details such as brackets, run-ons and capitalizations within the article.	needed.
10	In general, this seems to be a thought-out article with a good structure, however can also benefit from condensed writing and avoiding repetitiveness.	We re-read our paper and corrected this where needed.
11	Perhaps you can also add in line numbers?	We added line numbers to the document
12	Page 1, please add the term “school-based” for the meta-analysis evidence	We added ‘school-based’
13	Page 1 Reference of “Faigenbaum” is missing opening brackets	We have added the missing opening bracket
14	Introduction, Aerobic and strength exercises: Sentence starting with “Instead...” could be reworded	We reworded this to: <i>“Strength exercises – defined as exercises where an individual is working against a wide range of resistive loads - may be easier for youngsters who are overweight or obese, and with that easier to comply with.”</i>
15	Page 4: “These youngsters are stronger in an absolute sense that normal weight youngsters and....” Could you provide a source?	We added a reference to this statement.
16	Page 4: It is suggested “of relevance here is whether overweight youngsters have enough experience ...”, perhaps consider deleting because this current study does not measure previous experiences with weights/aerobic exercise as well?	We deleted this sentence as suggested by the reviewer.
17	Page 5, last sentence: “our sample consists of youngsters who are being treated...” perhaps this should be in the method section rather than the introduction?	We put this in the methods section instead of the introduction.
18	Page 6, before materials and methods: Perhaps you should add in “overweight”. It would also be a good area to define each of these words, obesity, normal weight and overweight.	See also #7, #8.
19	Page 6, under materials and methods: not too sure whether this section is important, perhaps consider deleting or shortening.	We deleted a sentence, but additionally, we also added an explanation of BMI z-scores (as suggested by the editor).
20	Page6, under participants, before “To recruit a group”, missing period	The missing period was added.
21	Page 8, I think it is better to insert Figure 1 legend here as it gives a more accurate explanation to the readers on how the IAT is actually carried out. Some bits here were repetitive as well; perhaps consider shortening?	We moved the legend of Figure 1 to the main text, to make the IAT procedure more clear. We removed repetitions.
22	Page 8, under the questionnaire , I found it a bit confusing that “unless otherwise stated” a 100 point visual analogue scale was used, perhaps you can clarify that other than BMI,	We changed this as suggested by the reviewer.

	how often they exercise and self-image the remaining measures were rated on at 100-point visual analogue scale.	
23	Page 10: IAT D-score is capitalized	We made sure that d-600 is written the same throughout the text.
24	Page 10: In order for your results to answer your hypothesis, I believe that you will need to differentiate and determine whether there is a difference between the psychological determinants when split by different groups of weight or different exercises; as I quote the introduction "it is essential to identify these determinants and also to pinpoint possible differences between overweight and non-overweight youngsters". To my understanding, a correlational analysis cannot reveal whether there are significantly different determinants of physical activity within overweight/obese/normal weight individuals. But rather, can only look at the relationship strength of the determinants on BMI.	This is a good point, and it clearly shows where we inadvertently confused readers. We have now tried to make this clearer, as you will have read in our responses to #2, #7, #8.

Reviewer 2

25	The authors present a very interesting investigation into the reflective and impulsive determinants of physical activity amongst normal and overweight/obese children and teens.	Thank you.
26	The key issue I see with the paper in its current form relates to its internal consistency:	We agree that there were some issues with this. We corrected this based on all the feedback by the editor and reviewers.
27	There is an apparent discrepancy between the stated aim, the analyses conducted, and the conclusions drawn.	Thank you for this observation. We have corrected this, as you may have read in point #2, and relatedly, points #7, #8.
28	Aim: From the paper: "In the current study, we investigated associations between physical activity and psychosocial determinants in overweight and non-overweight youngsters." To me, this reads as though the authors will examine the association between (reflective and impulsive) determinants and physical activity levels, amongst each of overweight and non-overweight individuals (e.g., using correlation/regression analyses). Given some of the information in the introduction, I would also think that the authors were going to compare the predictors of physical activity between the two groups (overweight/non-	This relates again to our earlier unclear explanation of the procedures we used. We now clarified this (again, see #2, #7, #8).

	overweight; e.g., using regression analyses with weight status, determinant, and weight status * determinant interaction term as predictors).	
29	Analyses: In contrast, the analyses present the correlations/differences scores between the determinants and BMI z-score. This appears to answer the question of whether BMI is associated with each of the determinants, but says nothing about whether these determinants impact physical activity.	Actually, this is the other way around; we sought to study whether determinant structures were associated to BMI-z. This would enable tailoring interventions; we did not mean to imply we considered determinants of physical activity to be predictors of BMI-z. See also #2, #7, #8 for an explanation of how we tried to clarify this.
30	Conclusions: Following this, there are a number of sections in the discussion that appear to draw conclusions that do not follow from the analyses conducted. These include: "Our study demonstrates that there are at least no negative correlations with strength exercises in overweight youngsters."; "The determinants of physical exercise are not different for youngsters with and without overweight, suggesting that the same kind of interventions will be effective for both groups."; "Between overweight youngsters and normal weight youngsters, there are no significant differences in the impulsive determinants, suggesting they can be targeted by the same intervention."	This has been corrected. See also #2, #7, #8.
31	The authors' hypothesised model appears to be: determinants -> physical activity -> weight status, but the authors draw conclusions about the determinants-physical activity relationship from examination of the determinants-weight status relationship. Implicit in this decision is that there is a strong relationship between physical activity and weight status. This implicit assumption is contradicted by the findings presented. I suggest examining the relationship between the determinants and physical activity. If interested in whether the determinants differ by weight status, I suggest examining the interaction effect mentioned above. If this suggestion is adopted, it should be noted in the limitations that past physical activity was used as a proxy for future physical activity.	We apologise for the confusion. We do not assume a causal link between physical activity and weight status (or more accurately, BMI-z score). We study the determinants of physical activity because we assume that a lack thereof (i.e. a sedentary lifestyle) leads to unhealthy outcomes. However, this latter link is not the subject of this study. This is a study to examine potentially differential determinant structures. This also explains the second point of this reviewer; we examine the association of determinant relevance with BMI-z, not because we think that these determinants predict BMI-z, but because we expect that the determinant structures may differ as a function of BMI-z. Therefore, we do not assume a strong relationship between weight status and physical activity. Quite the contrary; such a strong relationship would render our research question largely trivial. Note that we do examine the

		relationship between the determinants and physical activity; in fact, we look at how this relationship changes with BMI-z. We hope we managed to explain this sufficiently clearly in the changes we made in response to points #2, #7, #8.
32	Greater rationale for the use of the BMI z-score, rather than simply the BMI, is needed. There may have been a logical reason for this but, as it stands, this reason is not clear to the reader. Additionally, as BMI is quite widely used and understood, the z-score has the unintended impact of making the results less easily interpretable.	For growing children and adolescents, BMI is not a good measure, and therefore BMI is recoded into a gender and age specific BMI z-score (as compared to national reference data). We added this to the methods section: <i>Each child's BMI was recoded into an age and gender specific BMI z-score and compared to the national reference population (Cole, Bellizzi, Flegal & Dietz, 2000; Cole, Flegal, Nicholls, & Jackson, 2007. For descriptive purposes, we used the cut off points as defined by the WHO Growth reference 5-18 years, to determine weight status (BMI z-score <1 = normal weight, > 1= overweight/obese.</i>
33	It is not clear how the z-score was calculated. As the variables BMI and SDS (is SDS the z-score?) are not perfectly correlated in the supplied dataset, it seems the z-score is not a simple transformation of BMI. Is this right? It is also noted in the paper that BMI z-score ≥ 1 = overweight/obese, but in the dataset 26.7% of participants with a z-score ≥ 1 have a BMI < 25. Are different values being used to categorise overweight because the sample are children/teens? Clarification on the calculation of the z-score might address both of these issues/questions.	See #32. The BMI z-score is not based on the study sample, but based on national reference data.
34	There appear to be 28 participants in the dataset who are underweight (if $SDS < 0$ = underweight), but these were not mentioned in the paper. Were these participants grouped with the normal weight participants?	See also #32. A bmi z-score < -2 can be seen as underweight (n=4). We added: "Of this group, 4 were underweight (BMI z-score below -2); 53 were normal weight, 13 overweight (17.6%), and 5 were obese (6.7%).
35	There is inconsistent terminology throughout regarding whether the authors are investigating overweight, obese, or both overweight and obese children and teens. Please clarify.	We made sure that we consequently talk about overweight and obesity.
36	Introduction: At times, the rationale for the current study was unclear. This primarily relates to issue (1), raised above. Once issue (1) has been addressed, I suggest trying to clarify the argument in the introduction, particularly in the final two paragraphs.	This has been corrected. See also #2, #7, #8.
37	General: Throughout, the authors refer to	This has been corrected. See also #2, #7, #8.

	<p>differences between the normal weight and overweight/obese participants; however, analyses were conducted using a continuous variable (BMI z-score) rather than a dichotomous variable (weight status). Perhaps this could be addressed somewhere by, for example, providing a rationale for why the continuous variable is the most appropriate (if the authors think it is the most appropriate).</p>	
38	<p>Abstract: I would suggest 'dual-process' as a keyword, if the authors have any to spare.</p>	<p>We added 'dual-process' to the key words.</p>
39	<p>Introduction: This sentence is a bit unclear and could be reworded for clarity: "A person's behavior is determined by the relative strength of impulsive and reflective determinants in the sense that stronger determinants gain advantage over weaker ones".</p>	<p>We rephrased this to: "A person's behavior is determined by the relative strength of impulsive and reflective determinants in the sense that stronger determinants influence behavior more than the weaker ones"</p>
40	<p>Participants: Please clarify which measure is being reported after the $\pm$ signs – SD/SE?</p>	<p>This is the SD. We added this between brackets (twice).</p>
41	<p>The implicit association test: Please provide a bit more explanation on how the d-600 difference score is calculated, and how it can be interpreted.</p>	<p>This (including the entire IAT) is now explained in the text under "The implicit association test".</p> <p>See also #21.</p> <p>We added: "For the first IAT, a calculated difference score < 0 reflected a more positive implicit reaction to physical inactivity compared to physical activity. A score > 0 reflected a more positive implicit reaction to physical activity compared with physical inactivity. A score of 0 reflects no, or ambivalent preferences for both physical activity and physical inactivity. For the second IAT, a score < 0 means a more positive association with aerobic exercises, and a score > 0 a more positive association with strength exercises."</p>
42	<p>PBC and intention: For each of PBC and intention, please clarify whether these were measured with a single item that assessed all three of physical activity, aerobic exercises, and strength exercises (i.e., one item total for each of PBC and intention), or whether these were measured with three items, one each for physical activity, aerobic exercises, and strength exercises (i.e., three items total for each of PBC and intention).</p>	<p>These were measured with one item for physical activity, one item for aerobic exercises, and one item for strength exercises.</p> <p>We corrected this to make this more understandable. (one questions → a total of three questions)</p>
43	<p>Analyses: Please clarify why 80% CIs were chosen, rather than 95% CIs. The rationale for this might be provided in the cited</p>	<p>We have now made our main consideration explicit, by adding "as well as to prevent reading of the confidence intervals as 'significance testing</p>

	references, but for the naïve reader, this is not clear.	boundaries', a problem of 95% confidence intervals".
44	Limitations: Currently states that the quasi-experimental design is a limitation but I think the limitation the authors are describing more accurately relates to the sampling strategy.	We added "(and then specifically our sampling strategy)."
45	Future research: Suggested that objective measures of physical activity should be used. This seems like it should fall in the limitations section.	We agree. Therefore we combined the paragraphs into 'limitations and implications for future research"
46	Conclusion: This sentence is unclear: "One difference is that youngsters with higher BMI z-scores have more positive psychosocial correlations with exercise" and appears to contrast with the results: "No correlation between BMI z-score and self-reported physical activity was found ($r=-.01[-.18, .16]$, $p=.91$)". Please clarify the meaning of the first sentence.	We corrected this to "Based on the reflective determinants, differences between normal weight youngsters and youngsters who are overweight or obese are small. Exercise intentions, including those for aerobic and strength exercises, were positively correlated with BMI z-scores. Youngsters with a higher BMI z-score often reported that their friends think they should exercise, and were more confident that they could exercise more if they wanted to. No other determinants, including impulsive determinants, were correlated with BMI z-scores, suggesting that children and adolescents with a different weight status can be targeted by the same intervention."
47	General: There are a number of typos throughout; I suggest proof-reading more thoroughly. Examples are missing full stops that make sentences appear to run together, additional and missing parentheses, missing commas, "Liao et al.m 2012" on p.4, spelling error: "Craynest", and a few sentences that are a bit unclear for undetermined reasons. More generally (not specific to this manuscript), I'd also suggest the use of a reference manager to reduce the number of in-text referencing errors and to make referencing easier.	We proof-read our entire manuscript to correct all typos and referencing errors.
48	General: It would be nice to see an overview document in your supplemental materials zip, to help the reader navigate the different items.	We have added an overview document in our supplemental materials zip to help readers navigate the different items.

Response to editorial and reviewer comments: second revision

#	Reviewer feedback	Response
1	The authors should pay attention particularly on the transparency and clarity of the study aim/objectives and the results, and be consistent throughout the manuscript. For instance, it is important to align the study design (e.g. classification of weight groups) and analysis to the study aim, and there needs to have more better justification of how the study design or even the analysis addressed the research questions in the study.	<p>We agree that our study aim was sometimes a bit cryptic and not consistent throughout the manuscript. We have formulated the study aim now as:</p> <p><i>“To investigate associations between weight status and physical activity, psychosocial impulsive and reflective determinants of exercise behavior in youngsters (8-18 years old), distinguishing between strength exercises and aerobic exercises.”</i></p> <p>This was improved/alligned in the abstract, the revised introduction, and the start of the methods and discussion section</p>
2	Some minor errors are still present in the paper and they warrant a more careful proofreading.	The paper has been proofread thoroughly, and errors (including the one's indicated by the reviewers) are corrected.
3	<p>Internal consistency/clarity of paper remains a key issue.</p> <p>My understanding of the focus of the paper:</p> <ul style="list-style-type: none"> - The goal of this paper was to determine whether normal-weight and overweight/obese children and teenagers report different levels of psychosocial constructs that have previously been linked to physical activity (PA). Assumption: all measured constructs are significant determinants of PA (assumption presumably based on past research; not the aim of the current research). Therefore, the question of interest to the researchers must be how much 'room for change' there is on each construct, for each of normal-weight and overweight/obese children and teens. E.g., if attitude is a significant predictor of PA, but one group already holds very positive attitudes and the other holds negative attitudes, then it might only be effective to target attitude amongst the group who hold negative attitudes (which could be shifted to positive). Is this understanding correct? 	<p>See also #1. We also revised the introduction completely to make the goals of this study more clear.</p> <p>The main goal was to investigate whether determinants (potentially relevant to PA – not the goal of this study) differed depending on weight status. If this was the case, then different approaches/interventions are needed.</p>
4	If the above-described, 'room for change' interpretation is correct, this needs to be clearer in all sections of the manuscript. In the	See also responses #1 and #3. By reformulating/clarifying the goal of this study, and completely revising the

	discussion, this would require consideration of the mean levels and variance of each determinant within each group, and any significant differences between these groups. If the interpretation is incorrect, it is, at present, difficult to determine which of the introduction, analyses, and/or discussion needs revision.	introduction (to our opinion, this was the section that needed most improvement), the understandability of this paper has been improved.
5	Lines 164-166, 170-171, and one author response (“we do examine the relationship between the determinants and physical activity; in fact, we look at how this relationship changes with BMI-z”) still suggest that differences by weight status in the relationship between determinants and PA will be examined. It is not clear where in the manuscript these analyses appear and most of the other author responses suggest that this was not the aim and will not be examined.	Indeed, the aim was to investigate the relationship between A) weight status, and B) PA, and determinants of PA. This has now been made clearer in our reformulated aim of the study. If readers are interested in additional analyses, all data and syntax are enclosed.
6	The sampling strategy appears to be a key limitation of this study. While it is briefly mentioned in the limitations section, it is unduly dismissed (“as the data showed, there was no indication of a sampling bias”) and incompletely considered in the discussion more generally. Given there are only 18 overweight/obese participants from the general population sample, it seems likely that the tests used in the crude matching procedure were underpowered. Therefore, finding few significant differences cannot be considered a strong basis for dismissing any sampling biases.	We made sure that this limitation is more present in our discussion section: <i>“One of the key limitations of this study is that its design is quasi-experimental (and then specifically our sampling strategy). We recruited youngsters from two different settings in order to obtain a sufficient number of overweight and obese youngsters in the study (sampling bias). As previously mentioned, one possible explanation for the unexpected positive associations between physical activity determinants and BMI z-scores for all youngsters is that the determinants of participants from the clinic had been positively influenced by their program. Our crude matching procedure shows little indication of a sampling bias, but given there are only 18 overweight/obese participants from the general population sample, it seems likely that the tests used in the crude matching procedure were underpowered.”</i>
7	The lifestyle program could reasonably be expected to raise the participants’ self-efficacy for PA (i.e., through experience of PA) and their perception that their friends (e.g., from the program) think they should engage in PA. Resultantly, an increase in intention might also be expected. These effects could be driving the	Thank you for this interesting addition. We added this section to our discussion: <i>“An alternative explanation is that the lifestyle program could reasonably be expected to raise the participants’ self-</i>

	<p>observed relationships between z-BMI and each of SN, PBC, and intention. Inspection of the patterns of means in Table 1 suggests this is not the case for SN but could well be the case for PBC and intention. In both cases, it seems that the program effect might be driving most of these observed effects, but that some association might remain in the absence of this program effect. This should be better considered in the discussion when interpreting these observed associations.</p>	<p><i>efficacy for physical activity (i.e., through experience of physical activity) and their perception that their friends (e.g., from the program) think they should engage in physical activity. Resultantly, an increase in intention might also be expected. These effects could be driving the observed relationships between BMI z-score and subjective norm, perceived behavioral control, and intention. Inspection of the patterns of means in Table 1 suggests this is not the case for subjective norm but could well be the case for perceived behavioral control and intention. In both cases, it seems that the program effect might be driving most of these observed effects, but that some association might remain in the absence of this program effect."</i></p>
8	<p>The analysis</p> <ul style="list-style-type: none"> - It is not clear why tests of strength of association (correlations) rather than tests of difference were chosen when the study aim appears to be to examine differences between groups. The authors noted in their responses that they had addressed this, but the choice to use correlation analyses remains unsupported in the manuscript. The authors have added a section on BMI being a continuous variable (lines 126-129), but this does not sufficiently justify the analysis choice in relation to the study aims. 	<p>See also #1. We do believe this was a misunderstanding.</p>
9	<p>The introduction sets up the importance of PA as a means to addressing overweight/obesity, but if this were the only reason to encourage PA then it would not be relevant to compare levels of determinants across normal-weight and overweight/obese people (the apparent aim of the study); it would only be important to examine determinants amongst overweight/obese people. Please strengthen the rationale (e.g., do the authors think that PA is important for everyone but want to know whether approaches to increasing PA should be tailored depending on weight status? Do the authors want to know if previous research on determinants of PA amongst normal weight individuals generalises to overweight/obese individuals?).</p>	<p>In our completely revised introduction, we made it clearer that PA is indeed important for everyone, but that "<i>when it comes to physical activity, we have to bear in mind that overweight and obese youngsters are not 'general normal-weight' youngsters and hence different interventions might be needed (Ten hoor et al., 2014)</i>"</p>

10	The discussion concludes that very few correlations were seen, but in fact the authors found correlations between BMI-z and most (3/5) of the examined reflective determinants.	We do believe this is a misunderstanding: 10 correlations were not significant. Only significant correlations between weight status and 1) social norms of friends, 2) perceived behavioral control for exercise, and 3) intentions were found.
11	Line 429: As noted in the previous review, it is not clear how the quasi-experimental design is a limitation. Do the authors mean that the fact that individuals were not randomly assigned to weight status is a limitation? It is not clear why this would be a limitation, as the authors are not trying to draw causal inferences about the impact of weight status on determinants.	The quasi experimental design lead to a sampling bias. This has been made clearer in the discussion now, see #6.
12	Lines 75-79: the correlations with intention are missing.	These correlations are mentioned in the abstract: <i>“Exercise intentions, including those for aerobic and strength exercises, were positively correlated with BMI z-scores.”</i>
13	Sentence on lines 155-157: currently reads as though the authors will compare the strength of IA towards strength exercises with that towards aerobic exercises. Should be clarified.	Thank you – we agree that this was not completely clear: with clarifying the aims of our study (see #1), this has been resolved.
14	159: heading does not match paragraph (which is introducing the current study)	We revised the entire introduction. With that, this problem has been resolved.
15	247: “taken into account for calculating” is unclear/vague. Should this be “used to calculate”?	We changed this as suggested by the reviewer.
16	271-274: Currently seems to imply that the demographics were measured on 100-point scales. Supplemental materials suggest this is not the case. Please clarify in text.	This has been clarified in the text now: <i>“All items were measured on a 100-point visual analogue scale, except the demographics, BMI, how often they exercised, and self-image.”</i>
17	Crude matching: lines 310-312 and 325-326 imply statistical comparison of overweight/obese participants from each of the general and treatment samples (two groups), but lines 327-333 imply these were also statistically compared with the normal weight participants (three groups). The former seems appropriate for the matching question, but the latter does not (in fact, it overlaps with the primary RQ). Please clarify. It is also unclear what statistical test was used.	We agree that this was confusing. We now changed this section to: <i>“Youngsters participating in the outpatient lifestyle intervention program (COACH) might have been positively influenced by their program. Therefore (as a crude approximation of matching) before we executed correlational analyses for the total group, we split up the participants in three groups: the overweight and obese participants from COACH, the</i>

		<i>overweight and obese participants from the online panel (BMI z-score >1), and the rest of the general sample (BMI z-score ≥ 1). After that, we tested the differences between the three groups with regard to the demographic, reflective and impulsive determinants (see Table 1). The highest difference among the three subgroups has a p-value = .02 (uncorrected for multiple testing; see Additional File 1). We therefore concluded that there does not seem to be a systematic difference between the three subsamples."</i>
18	331-332: I was not able to locate additional file 1, so have not been able to appraise the pattern of results. Please clarify where this can be found. Note that it did look like there were some differences between samples in Table 1, and I have raised this as an issue in point 2, above.	We have submitted the additional file into the system, and we assume this will become available when published. This supplemental file can be made available via the editor.
19	397: use of the word 'correlations' is incorrect/unclear.	We changed this to 'associations'.
20	412-414 is unclear. No tests of difference between strength and aerobic exercises amongst overweight participants were conducted?	We deleted this sentence, as we indeed did not conduct additional analyses for this. Interested readers can see that the results are very similar in the results section (aerobic exercises ($r = .25$ [.08, .40], $p = .02$), and strength exercises ($r = .23$ [.06, .38], $p = .03$)).
21	424-425: I raised this sentence as not following from the analyses conducted in the previous review and the authors noted that this had been addressed. The sentence remains largely unchanged in the resubmitted manuscript (has not been addressed).	Our apologies. We now changed the sentence <i>"Our study demonstrates that there are at least no negative correlations with strength exercises in youngsters with a higher weight status."</i> Into <i>"At least, our study does not show negative correlations with strength exercises in youngsters with a higher weight status."</i>
22	Sentences on lines 435-442 seem unrelated to the study aims. Could remove or clarify.	We deleted this paragraph, but added the references to our third recommendation.
23	Relevance of sentence on lines 452-454 is unclear. Suggest better integrate/explain or remove.	We deleted this as suggested by the reviewer
24	Self-image correlations are missing from figure 3.	This has been explained in the text:

		<i>"There were no differences in BMI z-scores between the self-image groups (physical inactivity vs. physical activity: Cohen's $d=.01$ [-.34,.35], $p=.98$; aerobic vs. strength: Cohen's $d=.26$ [-0.12,.63], $p=.28$, note, these are not displayed in Figure 3 due to the different metrics)."</i>
25	Two sentences on lines 160-164 currently repeat earlier sentences about specific studies rather than synthesise/introduce current study. Something like 'previous research has found X but has not yet considered Y' might be better.	We changed the two sentences to decrease repetition: <i>"Trost et al. (2001) expected differences in physical activity determinants between youngsters who are and who are not obese, but found only a lower exercise self-efficacy for youngsters who are obese. Additionally, Craeynest et al. (2005) found no differences at all in reflective and impulsive attitudes."</i>
26	Sentences in lines 306-309 are now covered in detail in earlier sections. Could be removed.	We deleted this as suggested by the reviewer
27	Sentence on line 359-360 is a repetition of sentence on line 354-357 and could be removed.	We deleted this sentence as suggested by the reviewer.
28	Sentences on lines 443-44 and 447-448 seem to be the same limitation (subjective measurement) and could be combined. The first one probably needs more clarification too, as it seems to relate to the additional document (describing problems in measuring physical activity), which most readers will not read.	See #22.
29	As with the previous version, many typos/punctuation issues were present and reduced readability (e.g., missing/extra periods parentheses, commas, spaces etc.). See, e.g., lines 96, 121, 171, 186, 190, 193, 257-258, 319, 365, 370, 398, 399, 428, 448. Note that most of these were picked up automatically by Microsoft Word's spelling and grammar checker. If the authors are using Word perhaps check the settings to see if it is picking up all issues.	Our apologies – we made sure to correct all typos/punctuation issues as indicated by the reviewers, and proofread the paper multiple times to take out all those errors.
30	Commas in compound predicates occurred a few times. For these, remove the comma or add a subject for the second verb (see https://docs.microsoft.com/en-us/style-guide/punctuation/commas for explanation). Lines 77, 194, 204, 437.	Thank you for noting this – we fixed this as suggested.

31	<p>The authors made a good attempt at addressing the comments and provided quotations of edits. However, when the paper was re-read, some of the uncertainties identified in the first round of editing, still remained. First of all, (according to comment 3 of the Editorial Revision request), the authors had clarified why the z-score calculation was needed as an indicator of weight class and subsequent difference analysis was done based upon BMI z-score. But they could have further clarified why the z-score was used during subsequent correlational analysis as compared to just directly using the BMI.</p>	<p>In our methods section, we clarified further what was meant by the BMI z-score to solve this misunderstanding:</p> <p><i>“Each child’s BMI was recoded into a BMI z-score (this is the BMI score but then age and gender specific, compared to the national reference population; Cole, Bellizzi, Flegal & Dietz, 2000; Cole, Flegal, Nicholls, & Jackson, 2007).”</i></p>
32	<p>Secondly, the article still needs further proofreading, minor mistakes such as fragments (L125) missing end-brackets (L175), double full-stops (L171, 186), missing spaces (L121) and inconsistencies in “z-score” (L460) still needs to be addressed. It is also important that the article avoids the word “determinants”, especially in the introduction, as this can throw the reader off to the subsequent cross sectional design (we cannot be sure about the causal relationship between the variables).</p>	<p>We proofread our paper, and corrected the minor mistakes.</p> <p>We use ‘determinant’ as a theoretical construct with the meaning of “determinants of the likelihood of performing specific behaviors” (Montano & Kasprzyk, 2015, p. 95). We never suggest that our study would provide evidence for a causal relationship, which would be very difficult anyway. In our view this is an acceptable use of the concept. To clarify this, we added <i>“To develop more effective intervention programs targeting youngsters who are overweight or obese, a detailed study of the psychosocial determinants (i.e. those psychological constructs theoretically assumed to cause behavior) of physical activity is warranted.”</i></p>
33	<p>More importantly, I believe that there needs to be further transparency and explanation of the data. Currently, the aim of the study was “to investigate weight-status related differences in psychosocial impulsive and reflective determinants of exercise behaviour in youngsters distinguishing between strength exercises and aerobic exercises”. However, it is unclear why subsequent participants had such an imbalanced number of participants per group (i.e. underweight had a total of 3, normal weight, 55, overweight, 18, and obese 57), perhaps the</p>	<p>The aim of this study has been clarified (see also #1, #3, #4).</p> <p>In our limitations section in the discussion, the imbalanced numbers are explained (see also #6).</p>

	authors can also further mention this in their limitations?	
34	<p>Moreover, during analysis as indicated via Table1, “normal weight” comprised of general population of underweight and normal weight (two groups), and “overweight” comprised of General population overweight + obese (two groups) and overall intervention program group comprised of normal weight, overweight and obese (three groups). I believe that further justification regarding these groupings of participants is needed. Additionally, consistency regarding the groupings, general public v. intervention program participants should be consistent, resulting in four groups? Maybe the authors can justify this?</p>	<p>The grouping was done as crude approximation of matching and not part of our main analyses. We changed the first paragraph of the results section to make this clearer (see also #17).</p> <p><i>“Youngsters participating in the outpatient lifestyle intervention program (COACH) might have been positively influenced by their program. Therefore (as a crude approximation of matching) before we executed correlational analyses for the total group, we split up the participants in three groups: the overweight and obese participants from COACH, the overweight and obese participants from the online panel (BMI z-score >1), and the rest of the general sample (BMI z-score ≤1). After that, we tested the differences between the three groups with regard to the demographic, reflective and impulsive determinants (see Table 1). The highest difference among the three subgroups has a p-value=.02 (uncorrected for multiple testing; see Additional File 1). We therefore concluded that there does not seem to be a systematic difference between the three subsamples.”</i></p> <p>In the first paragraph of our methods section we also describe:</p> <p><i>“Although use of the term ‘obesity’ implies dichotomization of youngsters into ‘obese’ and ‘non-obese’ youngsters, the underlying variable is continuous; in our study we will refer to this continuous underlying variable as weight status. For descriptive purposes, we used the cut off points as defined by the WHO Growth reference 5-18 years, to determine weight status (BMI z-score <1 = normal weight, > 1= Overweight/obese.”</i></p>
35	L392: Perhaps I have overlooked, but this significant result was not in the results section?	This is a misunderstanding: the ‘more in favor’ is about the three sentences after

	Perhaps you can include this there with the relevant correlation coefficient, p-value and confidence intervals.	<p>this statement. We now replaced the full stop with colon:</p> <p>“What we do find is that youngsters with a higher BMI z-score are more in favor of exercise than youngsters with lower BMI z-scores: higher BMI z-scores were correlated with more positive norms for exercise (friends). They were also associated with higher perceived behavioral control for exercise and higher intentions to exercise (both aerobic and strength exercises).”</p>
36	Line 398: Insert “with” after “youngsters”	We changed this as suggested by the reviewer.
37	L431: not sure this was a good explanation as there are a total of 57 from the intervention group and only 18 from the general public?	This has been corrected, see also #6, #7.

Section 2: manuscript iterations

This section is comprised of the manuscript preprints in anti-chronological order (i.e. the originally submitted manuscript is placed last, preceded by the revisions, with the penultimate version directly following this title page).

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Weight-status Related Differences in Reflective and Impulsive Determinants of Physical Activity ~~Between Overweight and Normal Weight~~in Youngsters (8-18 years old).

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ABSTRACT

Objective To investigate weight-status related differences in psychosocial impulsive and reflective determinants of exercise behavior among overweight and normal weight youngsters (8-18 years old), distinguishing between strength exercises and aerobic exercises.

Method Cross-sectional survey of 133 youngsters (89 girls). In order to identify reflective determinants, participants completed questionnaires. For the impulsive determinants, participants completed two computerized reaction time sorting-tasks ('Implicit Association Tests').

Results Exercise intentions, including those for aerobic and strength exercises, were positively correlated with BMI z-scores. Youngsters with obesity a higher BMI z-score more often reported that their friends think they should exercise, and were more confident that they could exercise more if they wanted to. No other determinants, including impulsive determinants, were correlated with BMI z-scores.

Conclusion In terms of reflective determinants, few differences were found between youngsters with higher BMI z-scores as compared to youngsters with lower BMI z-scores.

Youngsters with higher BMI z-scores had more positive psychosocial correlations with, and intentions to exercise. Comparing youngsters with and without obesity, tThere were was no significant differences correlation between BMI z-score and with regard to the impulsive determinants of aerobic versus strength exercise. This, suggesting that both groups youngsters, independent from weight status could be reached by the same kind of physical activity intervention.

Keywords: physical activity, reflective determinants, impulsive determinants, children and adolescents, overweight and obesity, strength exercises, dual process.

INTRODUCTION

~~In this paper, we investigate the psychosocial determinants of physical activity in overweight and normal weight youngsters.~~ Obesity has become a growing problem globally and is no longer a disease that affects adults only (Washington, 2008). In children and adolescents with obesity, not only metabolic and cardiovascular health is impaired (TNO, 2011), but psychological well-being is often decreased as well (Gately, Cooke, Butterly, Mackreth, & Carroll, 2000; Van der Baan, Nollet, Weller, Benninga, & Van Aalderen, 2010).

Three major factors contribute to childhood obesity: genetic predisposition, unfavorable environmental conditions, and an disturbed energy balance/imbalance of energy homeostasis (Ebbeling, Pawlak, & Ludwig, 2002). This is the result of a combination of a high energy intake and relatively low energy expenditure, due to a sedentary lifestyle (Kremers, Visscher, Seidell, Van Mechelen, & Brug, 2005). In line with these findings, physical activity programs have been introduced to combat overweight and obesity in children and adults. However, recent school-based meta-analyses show that these interventions have little effect on body weight or body mass index (BMI; Harris, Kuramoto, Schulzer, & Retallack, 2009), blood pressure (Guerra, Nobre, Silveira, & Taddei, 2013), or physical activity level (Metcalf, Henley, & Wilkin, 2012).

Aerobic and strength exercises

Youngsters (defined as 8-18 year olds) who are overweight or obese can often not compete with normal-weight youngsters when it comes to aerobic exercises-~~(~~Faigenbaum et al., 2009). ~~Instead,~~sStrength exercises – defined as exercises where an individual is working against a wide range of resistive loads ~~–,~~ may ~~well~~ be easier for youngsters who are overweight or obese, and ~~an exercise regime incorporating strength exercises may therefore~~

be-with that easier to comply with (Riddiford-Harland, Steele, & Baur, 2006; Colella, Morano, Robazza, & Bortoli, 2009; Ten Hoor, Plasqui, Schols & Kok, 2014; Ten Hoor et al., 2016). These youngsters are stronger in an absolute sense than normal weight youngsters and perform better in strength- related exercises than aerobic exercises (ten Hoor, 2017b). Furthermore, being better in strength exercises might trigger the intrinsic motivation to continue exercising (Ten Hoor et al., 2014; 2016). Of relevance here is whether overweight youngsters have enough experience with strength training to be aware that they are good in strength exercises and will enjoy them more than aerobic exercises (Ten Hoor et al., 2014; 2016).

Reflective and Impulsive Associations

To develop a more effective intervention programs targeting youngsters with-who are overweight or obeseobesity, a detailed study of the psychosocial determinants of physical activity is warranted. This is necessary because-as programs cannot directly target behavior, instead targeting individual and sometimes environmental determinants-are targeted instead (De Bourdeaudhuij et al., 2005; Peters, 2014). Our knowledge about the psychosocial determinants of physical activity in populations that are overweight or obese is limited, especially with respect to youngsters with-who are obesity (Liao et al.m 2012). It follows that it also remains unclear whether determinants of physical activity change depending on whether a youngster is obese or not. Note that although use of the term 'obesity' implies dichotomization of youngsters into 'obese' and 'non-obese' youngsters, the underlying variable is continuous. We will refer to this continuous underlying variable as weight status. Thus, it is not only essential to clearly map the identify these-determinants of physical activity, it is also important to establish whether the resulting determinant structure varies

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~~with weight status and also to pinpoint possible differences between overweight and non~~
~~overweight youngsters.~~

Behavior change programs are most effective when the new behavior is achievable (Montaño & Kasprzyk, 2015; Bartholomew et al., 2016) and rewarding (Ryan & Deci, 2002; Rhodes, Fiala, & Conner, 2009). So far, the few studies carried out that have investigated determinants of physical activity in youngsters with obesity have identified environmental factors, general quality of life, perceived competence (Morgan, Okely, Cliff, Jones, & Baur, 2008), attitudes (perceived benefits and barriers), social influences, and self-efficacy (Deforche, De Bourdeaudhuij, Tanghe, Hills, & Bode, 2004; Trost, Kerr, Ward, & Pate, 2001). However, all these determinants are so-called 'reflective' determinants, whereas contemporary dual process theories suggest that human behavior is a product of both reflective (rule based) as well as unconscious (impulsive) determinants (Strack & Deutch, 2004). A person's behavior is determined by the relative strength of impulsive and reflective determinants in the sense that stronger determinants ~~gain advantage over~~ influence behavior more than the weaker ones (Strack & Deutch, 2004). In order to understand physical activity behavior, it is necessary to measure both the reflective and impulsive determinants. Reflective determinants can be measured by self-reports and involve attitudes, norms, perceived behavioral control and self-image, influencing behavior through intention (Liao et al., 2012). Impulsive determinants are commonly measured indirectly, for example by means of reaction time tasks such as the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998), which do not rely on self-report but rather use reaction times to measure implicit associations, for example, between a concept and an evaluative dimension. Such automatic determinants have been shown to explain variance in behavior that remains unexplained by reflective measures (Strack & Deutsch, 2004). Craeynest, et al. (2005) reported no differences in implicit associations towards physical activity between youngsters with and without

obesity. However, no distinction was made between strength and aerobic exercises in their study. The question here is whether implicit associations will differ with regard to strength and aerobic exercises.

Youngsters with versus youngsters without obesity Weight status

Trost et al. (2001) expected differences in physical activity determinants between youngsters ~~with and without obesity~~ who are and who are not obese, but found only a lower exercise self-efficacy for youngsters ~~with who are obese~~ obesity. Craeynest et al. (2005) found no differences at all in reflective and impulsive attitudes towards food and physical activity between youngsters ~~with and without obesity~~ who are and who are not obese. ~~Our sample consists of youngsters who are being treated for obesity in an outpatient lifestyle intervention program, plus youngsters from the general population.~~ The aim of this study was to measure whether different determinants influence physical activity in general, and aerobic and strength exercises in particular, ~~in youngsters with and without obesity~~ depending on a youngster's weight status. In other words, we explored whether the determinant structures of physical activity were stable over, or varied with, weight status.

MATERIALS AND METHODS

In the current study, we investigated associations between weight status, physical activity and psychosocial determinants ~~in overweight and non-overweight youngsters~~. We included measures of strength and aerobic exercises (Ten Hoor et al., 2014; 2016), and impulsive and reflective determinants (Houben & Wiers, 2008). ~~Finally, we compared the determinants of physical activity in overweight youngsters with those of normal weight youngsters (Trost et al., 2001; Craeynest et al., 2005).~~ Each child's BMI was recoded into an age and gender specific BMI z-score and compared to the national reference population (Cole,

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[Bellizzi, Flegal & Dietz, 2000; Cole, Flegal, Nicholls, & Jackson, 2007. For descriptive purposes, we used the cut off points as defined by the WHO Growth reference 5-18 years, to determine weight status \(BMI z-score <1 = normal weight, > 1= overweight/obese.](#)

All research materials, data, syntax files, and output files are available in Additional File 1.

Participants

Our sample consists of youngsters who are being treated for obesity in an outpatient lifestyle intervention program, plus youngsters from the general population. In total, 133 youngsters between 8-18 years old participated in this study (89 girls). Fifty-nine youngsters were recruited from the [REDACTED] Centre for Overweight Adolescent and Children's [REDACTED]. (44% of the total study population; Mean age ($\pm$ SD)=12 $\pm$ 3 years; Mean BMI z-score=3.3). From these youngsters, 2 were normal weight (BMI z-score between 0-1 – see also 'analysis'), 5 were overweight (BMI z-score between 1-2), and 52 were obese (BMI z-score > 2: cut off points as defined by the WHO growth reference 5-19 years) To recruit a group representative of the general population, 74 youngsters (mean age =15 $\pm$ 2 years; BMI z-score ($\pm$ SD)=0.2 $\pm$ 1.2) were randomly recruited through [REDACTED] online panel ([http://\[REDACTED\]](#)). Of this group, 3 were underweight (BMI z-score below -2); 563 were normal weight, 13 overweight (17.6%), and 5 were obese (6.7%). The [REDACTED] panel consists of 16.000 individuals, and is representative of the [REDACTED] population (ISO [REDACTED] quality label, certifying that the panel can be used for social-scientific research). There were only a few individuals younger than 12 years old on [REDACTED] panel, whereas the age of the youngsters with obesity ranged from 8-18 years old.

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Procedure

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In our cross-sectional study, participants were invited to participate in a short, online computerized task and to complete a questionnaire (~10 minutes). At the beginning of the study, participants were informed about the procedures but not about the content or aim of the study, in order to minimize social desirability effects. The youngsters from [REDACTED] and their parents were informed about the study in a letter, and invited to participate during their monthly visit to the outpatient clinic. After parental approval was obtained, the online panel ([REDACTED]) group received an invitation to participate via e-mail. After first providing informed consent (by clicking on the appropriate button for the online panel; for the [REDACTED] group by signing the informed consent form), two implicit association tasks (IATs) were performed to measure whether participants had a stronger implicit association with 1) 'physical activity' as compared to 'no physical activity' and 2) 'strength exercises' as compared to 'aerobic exercises' (see Measures). Findings by Houben and Wiers (2008) showed that IAT outcomes do not vary systematically with respect to setting or assessment software.

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On completion of the IATs, participants received a questionnaire in which demographics and reflective determinants were measured. Reflective determinants were measured after the IATs because these questions may influence impulsive determinants. Finally, the participants were thanked and debriefed. All study materials and methods were pilot tested to make sure that both the implicit tests and explicit questionnaires could be clearly understood. This study was approved by [REDACTED]

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Measures

The implicit association test

In this study, two Implicit Association Tests (IATs; [26]) were completed. The first measured whether participants implicitly preferred physical inactivity or physical activity. In the second IAT, we measured preferences for either aerobic, or strength exercises. The IAT is a computerized response latency measure that rests on the assumption that the more strongly two concepts are associated with each other, the faster and more accurately they can be paired together. In Figure 1(schematic display of seven computer screens) the IAT procedure is explained. The IAT consisted of five practice blocks, and two trial blocks. In the first practice block (first picture of Figure 1), participants learned to respond to attribute pictures (appearing in the center of the computer screen) by classifying these pictures into two categories. In this study, the attribute categories were a picture of a happy and sad emoticon, which were positioned on the left and right side at the top of a computer screen. The attribute pictures that appeared one by one in the center of the computer screen had to be classified into the attribute categories with either the left (E) or right (I) response key. In this way, pictures were linked to relevant concepts. The instruction for participants was to assign the pictures as quickly and as accurately as possible to the correct category by pressing the appropriate response key. The assignment of the left key (E) and right key (I) was counterbalanced across participants. With the practice blocks, all images were linked to the relevant concepts. In practice block 2 (picture 2), participants continued categorizing pictures, but now they had to sort pictures of physical activity and physical inactivity into the correct category (in the first IAT; in the second IAT, pictures of aerobic exercises and strength exercises were used). In practice block 3 (picture 3), and test block 4 (picture 4), youngsters continued to assign pictures to the correct category, but now the categories of block 1 and 2 were combined. Reaction times in block 4 were taken into account for calculating one's implicit association. In practice block 5 (picture 5), youngsters responded again to happy and sad emoticon, but now, the emoticons were mirrored (contrary to block 1,2,3,4, the happy emoticon was on the

right, and the sad emoticon on the left). In practice block 6 and test block 7 (picture 6 and 7), the pictures of physical activity and physical inactivity (or aerobic exercises and strength exercises in IAT 2) were added, but not mirrored. Where in block 3 and 4 the picture of aerobic exercises was combined with a sad emoticon, it was now combined with a happy emoticon. Where in block 3 and 4 the picture of physical activity (or strength exercises) was combined with a happy emoticon, this was now combined with a sad emoticon. Based on the difference in mean sorting reaction time between block 4 (happy/physically active vs. sad/physically inactive) and block 7 (sad/physically active vs. happy/physically inactive), a ~~d-600~~ difference score was calculated based on the d-600 algorithm (Greenwald, Nosek, & Banaji, 2003).

Based on the difference in mean sorting reaction time), corrected for incorrect responses, a ~~d-600~~ difference score was calculated based on the d-600 algorithm (Greenwald, Nosek & Banaji, 2003); see also SPSS syntax in additional file 1). For the first IAT, a calculated difference score < 0 reflected a more positive implicit reaction to physical inactivity compared to physical activity. A score > 0 reflected a more positive implicit reaction to physical activity compared with physical inactivity. A score of 0 reflects no, or ambivalent preferences for both physical activity and physical inactivity. For the second IAT, a score < 0 means a more positive association with aerobic exercises, and a score > 0 a more positive association with strength exercises.

[Insert Figure 1 here]

The Questionnaire

Demographics (gender, age, height, and weight), and reflective determinants of physical activity, strength exercises and aerobic exercises were measured using a self-report

questionnaire. All items were measured on a 100-point visual analogue scale, ~~unless~~
~~otherwise stated~~ except BMI, how often they exercised, and self-image. As needed, scores
were recoded such that a higher score reflected more agreement with the variable. Scores on
items that measured the same construct were averaged into one scale when the internal
consistency was sufficient ($\alpha > .60$). The questionnaire about the reflective determinants
contained the variables listed below, derived from the Reasoned Action Approach, and the
Integrated Behavioral Model (Montaño & Kasprzyk, 2015). For all questions, pictures were
added to make sure that the children understood what was meant by the question (see
Additional File 1: Complete Study Design).

Self-image. Questions were asked about self-image: 1) “do you see yourself more as a
physically active person” (score = 1) or “a non-physically active person” (score=2), and 2)
“do you see yourself more as someone more suited to aerobic exercises” (score=1) or
“strength exercises” (score=2).

Attitude. Participants’ evaluations of 1) physical activity, 2) physical inactivity, 3)
aerobic exercises, and 4) strength exercises, were each measured with two unipolar semantic-
differentials with the labels “unpleasant–pleasant” and “bad-good”.

Subjective norms. Two items measured the extent to which participants believed
important others think they should exercise: “My parents want me to exercise” and “My
friends want me to exercise”. Response categories ranged from “absolutely disagree” to
“absolutely agree”.

Perceived behavioral control and intention. For 1) physical activity, 2) aerobic
exercises, and 3) strength exercises, ~~one-a total of three~~ questions ~~were~~ asked about
perceived behavioral control ~~respectively~~: “If you want to, could you be: ~~1a~~) more physically
active ~~b2~~) carry out more aerobic exercises, and ~~e3~~) carry out more strength exercises”, and
~~one-three~~ questions about the intention: “Are you going to be ~~1a~~) more physically active, ~~b2~~)

carrying out more aerobic exercises, and e3) carrying out more strength exercises". Response categories ranged from "absolutely disagree" to "absolutely agree".

Physical activity behavior. Participants were asked to report: 1) how often they exercised per week and 2) how many hours they spent exercising every time they exercised. From these reports, we calculated how many hours per week were spent exercising.

Analyses

IBM SPSS statistics 20 was used for data preparation and R (R Core team, 2014) was used for data analysis. For each participant, a BMI z-score was calculated using national norm data (Cole, Bellizzi, Flegal, & Dietz, 2000; Cole, Flegal, Nicholls, & Jackson, 2007). To measure performance on the implicit association tests, d-600 scores were calculated using the d-600 algorithm (Greenwald et al., 2003; see also the SPSS syntax file in Additional File 1). First, as a crude approximation of matching, we examined the difference between participants who would be classified as overweight/obese (BMI z-score ≥ 1) in the general and clinical samples (World Health Organization, 2015). Subsequently, to examine whether determinants of physical activity differ ~~between youngsters with obesity and youngsters without obesity~~ depending on BMI z-score, correlations (and 80% confidence intervals) were computed between BMI z-scores and attitudes, subjective norms, perceived behavioral controls, intentions, and impulsive determinants. We report both 80% confidence intervals of effect sizes (following Cohen's (1990) recommendation as well as to prevent reading of the confidence intervals as 'significance testing boundaries', a problem of 95% confidence intervals) and Null Hypothesis Significance Testing (NHST) outcomes, based on the problems reported with NHST (e.g., (Masicampo & Lalande, 2012)) and pleas to remedy this problematic approach (e.g., Denis, 2003).

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RESULTS

Youngsters participating in the outpatient lifestyle intervention program () might have been positively influenced by their program. Therefore, before we executed correlational analyses, we first compared the overweight and obese participants from with overweight and obese participants from the online panel ([BMI z score >1](#)), as a crude approximation of matching. We divided the participants from the general sample into normal weight (BMI z-score<1) and overweight/obese (BMI z-score>=1) groups, and tested the differences between these two groups and the subsample from the clinic with regard to the demographic, reflective and impulsive determinants (see Table 1). The highest difference among the three subgroups has a p -value=.02 (uncorrected for multiple testing; see Additional File 1). We therefore concluded that there does not seem to be a systematic difference between the three subsamples.

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[insert Table 1 here]

Combining the sample with the participants from the general sample (from) resulted in a final sample where the BMI z-score was bimodally distributed (see Figure 2). No associations with BMI z-scores were found for gender (Cohen's d =.19 [-.17; .55], p =.30). Because the (mainly overweight and obese) participants from the clinic were younger than the participants from the online panel, BMI z-score decreased with age. Therefore, when computing the correlation coefficients with BMI z-score, all variables were first corrected for age (besides the already for age corrected BMI z-score). Interested readers can refer to the uncorrected scores and the analyses per subgroup in Appendix 1.

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[Insert Figure 2 here]

BMI z-scores were not correlated with attitudes towards physical activity ($r = -.05$ [-.22, .12], $p = .75$), physical inactivity ($r = .06$ [-.11, .23], $p = .71$), strength exercises ($r = -.02$ [-.19, .15], $p = .84$), or aerobic exercises ($r = -.09$ [-.26, .08], $p = .48$) (see Figure 3). Although BMI z-scores were unrelated to subjective norms of parents ($r = .16$ [-.01, .32], $p = .16$), they were related to subjective norms of friends ($r = .29$ [.13, .44], $p = .01$): the higher the BMI z-score, the higher the perceived expectations of friends that the youngster should exercise. BMI z-scores were not related to perceived behavioral control regarding strength exercise ($r = .11$ [-.06, .27], $p = .41$) or aerobic exercise ($r = .14$ [-.03, .30], $p = .25$), but a positive correlation with perceived behavioral control related to exercise in general was found ($r = .23$ [.06, .38], $p = .03$): As BMI z-scores increased, youngsters were more confident that they could be more physically active if they wanted to. Perceived behavioral control beliefs regarding strength exercise and aerobic exercise were not related to BMI z-score. BMI z-scores were positively correlated with the three intention measures: the higher the BMI z-score, the higher the intention to be more physically active ($r = .30$ [.14, .45], $p = .01$), more engaged in aerobic exercises ($r = .25$ [.08, .40], $p = .02$), and more engaged in strength exercises ($r = .23$ [.06, .38], $p = .03$). There were no differences in BMI z-scores between the self-image groups (physical inactivity vs. physical activity: Cohen's $d = .01$ [-.34, .35], $p = .98$; aerobic vs. strength: Cohen's $d = .26$ [-0.12, .63], $p = .28$, note, these are not displayed in Figure 3 due to the different metrics). BMI z-scores were not correlated to whether participants' reaction times implied stronger associations with either physical inactivity or physical activity (IAT1: $r = .09$ [-.21, .13], $p = .75$) or aerobic or strength exercise (IAT2: $r = .12$ [-.13, .21], $p = .75$). No correlation between BMI z-score and self-reported physical activity was found ($r = -.01$ [-.18, .16], $p = .91$) (See Figure 3).

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[Insert Figure 3 about here]

DISCUSSION

The focus of this study was to investigate the weight status related differences in reflective and impulsive determinants of (aerobic vs. strength-related) of physical activity in overweight youngsters, as compared to normal weight youngsters. Despite finding correlations between social norms of friends, perceived behavioral control for exercise, and all three intentions, our first finding is that there are not many significant correlations between BMI z-scores and either the measured reflective determinants, or impulsive determinants (IAT scores). This may imply that a) there really are very few correlations between physical activity determinants and weight status (Craeynest et al., 2005), or that b) explicitly expressed cognitions are influenced by social desirability effects (Larson, 2000). Regardless of whether the participant was recruited via the online panel or XXXXXXXXXX, participants with high BMI z-scores may well have been aware of the need for exercise and what is expected of them. However, the implicit measures which are not thought to be influenced by social desirability (Greenwald et al., 1998) did not show differences either, in line with the results of Craeynest et al. (2005). Moreover, inspection of the means for the three subpopulations (Table 1) does not suggest a systematic difference in terms of the youngsters participating in a lifestyle program giving more socially desirable answers than overweight/obese youngsters not in treatment.

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What we do find is that overweight youngsters with a higher BMI z-score are more in favor of exercise than youngsters with lower er BMI z-scores (with no differences found between aerobic and strength exercises). Higher BMI z-scores were correlated with more positive norms for exercise (friends). They were also associated with higher perceived behavioral control for exercise and higher intentions to exercise (both aerobic and strength

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exercises). Youngsters ~~with obesity~~ with a lower BMI z-score do not have more negative correlations with exercise than youngsters ~~without obesity~~ higher z-scores in terms of concepts from current theories on reflective determinants (e.g. Montaña & Kasprzyk, 2015). This is contrary to the findings of De Bourdeaudhuij, et al. (2005) who reported that adolescents who are overweight had less favorable psychosocial correlates related to physical activity as compared to adolescents of a normal weight (BMI cut off point=25). However, they also reported that the strength of associations between psychosocial variables and total physical activity were comparable in overweight/obese and normal weight adolescents. When we analyzed our data without correcting the BMI for age and gender, we again found few differences, but they are in the same direction as those found by De Bourdeaudhuij et al. (2005). In their sample, BMI scores were not corrected for age and gender, which makes it harder to compare the results of the two samples (Flegal & Ogden, 2011). Moreover, in another study from the same research group (Craeynest et al., 2005) no differences were found in reflective or impulsive determinants between children with obesity and a matched control group.

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We did not find significant correlations between BMI z-scores and either of the two implicit measures, and only a few between BMI z-scores and reflective determinants. We expected to find a difference between strength and aerobic exercises for overweight youngsters, but we did not. One explanation for this is that in order for these youngsters to find out that they are better suited to strength exercises, they need to experience strength exercises more often (Ten Hoor et al., 2016). Targeting strength exercises might be more effective in the long-term, as this could reinforce the biological and psychological strengths of youngsters who are overweight/obese (Ten Hoor et al., 2014; 2016). Recently, other researchers have argued along the same lines (Schranz, Tomkison & Olds, 2013). The review by Schranz et al. (2013) about children and adolescents who are overweight provided

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empirical support for the (large) effects of strength training on muscle strength-, in addition to the small effects of strength training on body composition. However, the effect of strength training on psychosocial outcomes remains unclear because of the limited number of studies addressing this topic. Our study demonstrates that there are at least no negative correlations with strength exercises in ~~overweight~~ youngsters with a higher weight status.

Limitations ~~and~~ implications for future research

One limitation of this study is that its design is quasi-experimental (and then specifically our sampling strategy). We recruited youngsters from two different settings in order to obtain a sufficient number of overweight and obese youngsters in the study. As previously mentioned, one possible explanation for the unexpected positive associations between physical activity determinants and BMI z-scores for all youngsters is that the determinants of participants from the clinic had been positively influenced by their program. However, as the data showed, there was no indication of a sampling bias. Body weight adjusted for height (BMI) and related z-scores in children are commonly used to determine whether an individual has a healthy or unhealthy weight, and can be seen as a good and simple tool for risk estimates in large populations (Ten Hoor et al., 2018b). However, it is not the right tool for individual metabolic and mental health evaluations (Bogin, Varela Silva, 2012) and might have stigmatizing effects on one's health in later life (Hunger, Tomiyama, 2014). Other methods to determine body composition are more accurate to evaluate health, but these measures are more difficult to apply in larger study populations.

Implications for future

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~~no research~~

Based on this study, we can make several recommendations for further research. First, in future studies, objective measures of behavior should be used (see also De Bourdeaudhuij et al., 2005). Second, as there is a possibility that youngsters who are overweight or obese do not know that they are better in strength related exercises, determinants should be measured after youngsters have become exposed to and acquainted with these exercises (ten Hoor, 2018). LastThird, in future studies, measuring actual body composition might be of additional value. Lastly, to possibly achieve long-term behavior changes, evidence-based interventions should be developed, implemented, and evaluated (Bartholomew et al., 2016). The determinants of physical exercise are not do not differ different for youngsters with and without overweightdepending on weight status, suggesting that the same kind of interventions will be effective for both groups. Ward et al. (2006) suggested that interventions should be tailored to determinants of different activity levels, gender and ethnicity instead of BMI.

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Conclusion

Based on the reflective determinants, differences between normal weight youngsters and youngsters who are overweight or obese are small. Exercise intentions, including those for aerobic and strength exercises, were positively correlated with BMI z-scores. Youngsters with a higher BMI z score often reported that their friends think they should exercise, and were more confident that they could exercise more if they wanted to. No other determinants, including impulsive determinants, were correlated with BMI z-scores. One difference is that youngsters with higher BMI z scores have more positive psychosocial correlations with exercise, and intention to exercise. Between overweight youngsters and normal weight youngsters, there are no significant differences in the impulsive determinants, suggesting they

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that children and adolescents with a different weight status can be targeted by the same intervention.

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ACKNOWLEDGMENT

We would like to acknowledge Michiel Vestjens (Instrumentation, Faculty of Psychology and Neuroscience, Maastricht University) for programming the implicit measures and questionnaire. This project is sponsored by the Netherlands Organization for Health Research and Development (ZonMw; project number 525001004) (Grant nr 525001004).

COMPETING INTERESTS

The author(s) declare that they have no competing interests

ETHICS AND CONSENT

Participants were informed about the procedures and debriefed about the content and aim of the study afterwards, in order to minimize social desirability effects. The youngsters from the clinic and their parents signed informed consent during their monthly visit to the clinic. After parental approval was obtained, the online panel group received an invitation to participate via e-mail. The youngsters provided informed consent (by clicking on the appropriate button for the online panel). This study and consent procedure was approved by the Medical Ethics Committee of Maastricht University Medical Center+ (METC12-4-048), and the Research Ethics Board of the Faculty of Psychology and Neuroscience, Maastricht University (ECP-113-10-04-2012).

AUTHOR CONTRIBUTION

GtH conceived of, designed, and coordinated the study, contributed to the acquisition, performed the statistical analyses, and drafted the manuscript. GK participated in the design, analysis of the data, and revision of the manuscript. GJP participated in the statistical analyses and revision of the data. GP, SK, RR, and AS participated in the design of the study and

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revision of the manuscript. AV participated in the acquisition and the revision of the manuscript. All authors read and approved the final manuscript.

Appendix

Additional File 1. Research Material, Data, and SPSS Syntax.

Figure legends

Figure 1. Phases in the Implicit Association Task

The IAT consisted of five practice blocks, and two trial blocks. In the first practice block (first picture), participants learned to respond to attribute pictures (appearing in the center of the computer screen) by classifying these pictures into two categories. In this study, the attribute categories were a picture of a happy and sad emoticon, which were positioned on the left and right side at the top of a computer screen. The attribute pictures that appeared one by one in the center of the computer screen had to be classified into the attribute categories with either the left (E) or right (I) response key. In this way, pictures were linked to relevant concepts. The instruction for participants was to assign the pictures as quickly and as accurately as possible to the correct category by pressing the appropriate response key. The assignment of the left key (E) and right key (I) was counterbalanced across participants. With the practice blocks, all images were linked to the relevant concepts. In practice block 2 (picture 2), participants continued categorizing pictures, but now they had to sort pictures of physical activity and physical inactivity into the correct category (in the first IAT, in the second IAT, pictures of aerobic exercises and strength exercises were used). In practice block 3 (picture 3), and test block 4 (picture 4), youngsters continued to assign pictures to the correct category, but now the categories of block 1 and 2 were combined. Reaction times in block 4 were taken into account for calculating one's implicit association. In practice block 5 (picture 5), youngsters responded again to happy and sad emoticon, but now, the emoticons were mirrored (contrary to block 1,2,3,4, the happy emoticon was on the right, and the sad emoticon on the left). In practice block 6 and test block 7 (picture 6 and 7), the pictures of

~~physical activity and physical inactivity (or aerobic exercises and strength exercises in IAT 2) were added, but not mirrored. Where in block 3 and 4 the picture of aerobic exercises was combined with a sad emoticon, it was now combined with a happy emoticon. Where in block 3 and 4 the picture of physical activity (or strength exercises) was combined with a happy emoticon, this was now combined with a sad emoticon. Based on the difference in mean sorting reaction time between block 4 (happy/physically active vs. sad/physically inactive) and block 7 (sad/physically active vs. happy/physically inactive), a d-600 difference score was calculated based on the d-600 algorithm (Greenwald, Nosek, & Banaji, 2003).~~

Figure 2. BMI z-score Distribution of Recruited Population (8-18 Years Old)

Figure 3. (Age Corrected) Correlations Between the Reflective Determinants and BMI z-scores. The black line represents the confidence intervals for the age corrected correlations; grey lines represent the uncorrected confidence intervals.

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Table 1. Mean Scores of the Subsamples, and the Sample, as a Crude Approximation of Matching.

MEANS	normal weight	overweight	
N	56	18	59
Age (year)	15.82	15.17	12.14
Height (cm)	173.46	167.83	155.28
Weight (kg)	58.45	71.78	77.40
BMI z-score	-0.28	1.85	3.25
Self-image (1=no PA, 2 = PA)	1.54	1.44	1.64
Self-image (1 =aerobic. 2 = strength)	1.38	1.22	1.26
dD -600 (no PA – PA)*	-0.24	-0.24	-0.08
Dd -600 (Aerobic – Strength)*	0.02	0.10	0.07
Attitude PA (1-100)	72.86	76.06	77.56
Attitude no PA (1-100)	56.33	62.72	41.67
Attitude Aerobic (1-100)	74.16	74.28	76.00
Attitude Strength (1-100)	71.20	69.00	72.93
Subjective norm Parents (1-100)	56.38	70.94	70.98
Subjective norm Friends (1-100)	35.52	46.67	45.48
Perceived Behavioral Control PA (1-100)	65.39	74.72	81.17
Perceived Behavioral Control Aerobic (1-100)	73.95	79.61	81.38
Perceived Behavioral Control Strength (1-100)	69.84	73.94	71.50
Intention PA (1-100)	49.88	57.89	72.33
Intention Aerobic (1-100)	56.29	54.50	77.12
Intention Strength (1-100)	51.13	50.61	64.64
Physical activity level (h/week)	7.95	7.67	8.28

For the IAT Dd -600 scores: A calculated difference score < 0 reflects a more positive implicit association with physical inactivity as compared to physical activity. A score > 0

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reflects a more positive implicit association with physical activity as compared to physical inactivity. A score of 0 reflects no, or ambivalent preferences for both physical activity and physical inactivity. For the second IAT, a score < 0 reflects a more positive association with aerobic exercises, and a score > 0 reflects a more positive association with strength exercises. All the pictures used can be found in Additional File 1.

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3 **Weight-status Related Differences in Reflective and Impulsive Determinants of Physical**
4 **Activity in Youngsters (8-18 years old).**

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ABSTRACT

Objective To investigate weight-status related differences in psychosocial impulsive and reflective determinants of exercise behavior in youngsters (8-18 years old), distinguishing between strength exercises and aerobic exercises.

Method Cross-sectional survey of 133 youngsters (89 girls). In order to identify reflective determinants, participants completed questionnaires. For the impulsive determinants, participants completed two computerized reaction time sorting-tasks ('Implicit Association Tests').

Results Exercise intentions, including those for aerobic and strength exercises, were positively correlated with BMI z-scores. Youngsters with a higher BMI z-score often reported that their friends think they should exercise, and were more confident that they could exercise more if they wanted to. No other determinants, including impulsive determinants, were correlated with BMI z-scores.

Conclusion In terms of reflective determinants, few differences were found between youngsters with higher BMI z-scores as compared to youngsters with lower BMI z-scores. There was no significant correlation between BMI z-score and the impulsive determinants of aerobic versus strength exercise. This suggests that youngsters, independent from weight status could be reached by the same kind of physical activity intervention.

Keywords: physical activity, reflective determinants, impulsive determinants, children and adolescents, overweight and obesity, strength exercises, dual process.

INTRODUCTION

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Obesity has become a growing problem globally and is no longer a disease that affects adults only (Washington, 2008). In children and adolescents with obesity, not only metabolic and cardiovascular health is impaired (TNO, 2011), but psychological well-being is often decreased as well (Gately, Cooke, Butterly, Mackreth, & Carroll, 2000; Van der Baan, Nollet, Weller, Benninga, & Van Aalderen, 2010).

Three major factors contribute to childhood obesity: genetic predisposition, unfavorable environmental conditions, and an disturbed energy balance/imbalance of energy homeostasis (Ebbeling, Pawlak, & Ludwig, 2002). This is the result of a combination of a high energy intake and relatively low energy expenditure, due to a sedentary lifestyle (Kremers, Visscher, Seidell, Van Mechelen, & Brug, 2005). In line with these findings, physical activity programs have been introduced to combat overweight and obesity in children and adults. However, recent school-based meta-analyses show that these interventions have little effect on body weight or body mass index (BMI; Harris, Kuramoto, Schulzer, & Retallack, 2009), blood pressure (Guerra, Nobre, Silveira, & Taddei, 2013), or physical activity level (Metcalf, Henley, & Wilkin, 2012).

Aerobic and strength exercises

Youngsters (defined as 8-18 year olds) who are overweight or obese can often not compete with normal-weight youngsters when it comes to aerobic exercises (Faigenbaum et al., 2009). Strength exercises – defined as exercises where an individual is working against a wide range of resistive loads - may be easier for youngsters who are overweight or obese, and with that easier to comply with (Riddiford-Harland, Steele, & Baur, 2006; Colella, Morano, Robazza, & Bortoli, 2009; Ten Hoor, Plasqui, Schols & Kok, 2014; Ten Hoor et al., 2016). These youngsters are stronger in an absolute sense than normal weight youngsters and perform better in strength- related exercises than aerobic exercises (ten Hoor, 2017b).

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Furthermore, being better in strength exercises might trigger the intrinsic motivation to continue exercising (Ten Hoor et al., 2014; 2016).

Reflective and Impulsive Associations

To develop more effective intervention programs targeting youngsters who are overweight or obese, a detailed study of the psychosocial determinants of physical activity is warranted. This is necessary because programs cannot directly target behavior, instead targeting individual and sometimes environmental determinants (De Bourdeaudhuij et al., 2005; Peters, 2014). Our knowledge about the psychosocial determinants of physical activity in populations that are overweight or obese is limited, especially with respect to youngsters who are obese (Liao et al. 2012). It follows that it also remains unclear whether determinants of physical activity change depending on whether a youngster is obese or not. Note that although use of the term ‘obesity’ implies dichotomization of youngsters into ‘obese’ and ‘non-obese’ youngsters, the underlying variable is continuous. We will refer to this continuous underlying variable as weight status. Thus, it is not only essential to clearly map the determinants of physical activity, it is also important to establish whether the resulting determinant structure varies with weight status.

Behavior change programs are most effective when the new behavior is achievable (Montaño & Kasprzyk, 2015; Bartholomew et al., 2016) and rewarding (Ryan & Deci, 2002; Rhodes, Fiala, & Conner, 2009). So far, the few studies carried out that have investigated determinants of physical activity in youngsters with obesity have identified environmental factors, general quality of life, perceived competence (Morgan, Okely, Cliff, Jones, & Baur, 2008), attitudes (perceived benefits and barriers), social influences, and self-efficacy (Deforche, De Bourdeaudhuij, Tanghe, Hills, & Bode, 2004; Trost, Kerr, Ward, & Pate, 2001). However, all these determinants are so-called ‘reflective’ determinants, whereas

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contemporary dual process theories suggest that human behavior is a product of both reflective (rule based) as well as unconscious (impulsive) determinants (Strack & Deutch, 2004). A person's behavior is determined by the relative strength of impulsive and reflective determinants in the sense that stronger determinants influence behavior more than the weaker ones (Strack & Deutch, 2004). In order to understand physical activity behavior, it is necessary to measure both the reflective and impulsive determinants. Reflective determinants can be measured by self-reports and involve attitudes, norms, perceived behavioral control and self-image, influencing behavior through intention (Liao et al., 2012). Impulsive determinants are commonly measured indirectly, for example by means of reaction time tasks such as the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998), which do not rely on self-report but rather use reaction times to measure implicit associations, for example, between a concept and an evaluative dimension. Such automatic determinants have been shown to explain variance in behavior that remains unexplained by reflective measures (Strack & Deutsch, 2004). Craeynest, et al. (2005) reported no differences in implicit associations towards physical activity between youngsters with and without obesity. However, no distinction was made between strength and aerobic exercises in their study. The question here is whether implicit associations will differ with regard to strength and aerobic exercises.

Weight status

Trost et al. (2001) expected differences in physical activity determinants between youngsters who are and who are not obese, but found only a lower exercise self-efficacy for youngsters who are obese. Craeynest et al. (2005) found no differences at all in reflective and impulsive attitudes towards food and physical activity between youngsters who are and who are not obese. The aim of this study was to measure whether different determinants influence

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physical activity in general, and aerobic and strength exercises in particular, depending on a youngster's weight status. In other words, we explored whether the determinant structures of physical activity were stable over, or varied with, weight status.

MATERIALS AND METHODS

In the current study, we investigated associations between weight status, physical activity and psychosocial determinants.. We included measures of strength and aerobic exercises (Ten Hoor et al., 2014; 2016), and impulsive and reflective determinants (Houben & Wiers, 2008). Each child's BMI was recoded into an age and gender specific BMI z-score and compared to the national reference population (Cole, Bellizzi, Flegal & Dietz, 2000; Cole, Flegal, Nicholls, & Jackson, 2007). For descriptive purposes, we used the cut off points as defined by the WHO Growth reference 5-18 years, to determine weight status (BMI z-score <1 = normal weight, > 1 = overweight/obese).

All research materials, data, syntax files, and output files are available in Additional File 1.

Participants

Our sample consists of youngsters who are being treated for obesity in an outpatient lifestyle intervention program, plus youngsters from the general population. In total, 133 youngsters between 8-18 years old participated in this study (89 girls). Fifty-nine youngsters were recruited from the [REDACTED] Centre for Overweight Adolescent and Children's [REDACTED]. (44% of the total study population; Mean age ($\pm$ SD)=12 $\pm$ 3 years; Mean BMI z-score=3.3). From these youngsters, 2 were normal weight (BMI z-score between 0-1 – see also 'analysis'), 5 were overweight (BMI z-score between 1-2), and 52 were obese (BMI z-score > 2 : cut off points as defined by the WHO growth reference 5-19

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years) To recruit a group representative of the general population, 74 youngsters (mean age =15±2 years; BMI z-score ($\pm$ SD)=0.2±1.2) were randomly recruited through [REDACTED] online panel ([http://\[REDACTED\]](http://[REDACTED])). Of this group, 3 were underweight (BMI z-score below -2); 53 were normal weight, 13 overweight (17.6%), and 5 were obese (6.7%). The [REDACTED] panel consists of 16.000 individuals, and is representative of the [REDACTED] population (ISO [REDACTED] quality label, certifying that the panel can be used for social-scientific research). There were only a few individuals younger than 12 years old on [REDACTED] panel, whereas the age of the youngsters with obesity ranged from 8-18 years old.

Procedure

In our cross-sectional study, participants were invited to participate in a short, online computerized task and to complete a questionnaire (~10 minutes). At the beginning of the study, participants were informed about the procedures but not about the content or aim of the study, in order to minimize social desirability effects. The youngsters from [REDACTED] and their parents were informed about the study in a letter, and invited to participate during their monthly visit to the outpatient clinic. After parental approval was obtained, the online panel ([REDACTED]) group received an invitation to participate via e-mail. After first providing informed consent (by clicking on the appropriate button for the online panel; for the [REDACTED] group by signing the informed consent form), two implicit association tasks (IATs) were performed to measure whether participants had a stronger implicit association with 1) 'physical activity' as compared to 'no physical activity' and 2) 'strength exercises' as compared to 'aerobic exercises' (see Measures). Findings by Houben and Wiers (2008) showed that IAT outcomes do not vary systematically with respect to setting or assessment software.

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On completion of the IATs, participants received a questionnaire in which demographics and reflective determinants were measured. Reflective determinants were measured after the IATs because these questions may influence impulsive determinants. Finally, the participants were thanked and debriefed. All study materials and methods were pilot tested to make sure that both the implicit tests and explicit questionnaires could be clearly understood. This study was approved by [REDACTED]

Measures

The implicit association test

In this study, two Implicit Association Tests (IATs; [26]) were completed. The first measured whether participants implicitly preferred physical inactivity or physical activity. In the second IAT, we measured preferences for either aerobic, or strength exercises. The IAT is a computerized response latency measure that rests on the assumption that the more strongly two concepts are associated with each other, the faster and more accurately they can be paired together. In Figure 1(schematic display of seven computer screens) the IAT procedure is explained. The IAT consisted of five practice blocks, and two trial blocks. In the first practice block (first picture of Figure 1), participants learned to respond to attribute pictures (appearing in the center of the computer screen) by classifying these pictures into two categories. In this study, the attribute categories were a picture of a happy and sad emoticon, which were positioned on the left and right side at the top of a computer screen. The attribute pictures that appeared one by one in the center of the computer screen had to be classified into the attribute categories with either the left (E) or right (I) response key. In this way, pictures were linked to relevant concepts. The instruction for participants was to assign the pictures as

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quickly and as accurately as possible to the correct category by pressing the appropriate response key. The assignment of the left key (E) and right key (I) was counterbalanced across participants. With the practice blocks, all images were linked to the relevant concepts. In practice block 2 (picture 2), participants continued categorizing pictures, but now they had to sort pictures of physical activity and physical inactivity into the correct category (in the first IAT; in the second IAT, pictures of aerobic exercises and strength exercises were used). In practice block 3 (picture 3), and test block 4 (picture 4), youngsters continued to assign pictures to the correct category, but now the categories of block 1 and 2 were combined. Reaction times in block 4 were taken into account for calculating one's implicit association. In practice block 5 (picture 5), youngsters responded again to happy and sad emoticon, but now, the emoticons were mirrored (contrary to block 1,2,3,4, the happy emoticon was on the right, and the sad emoticon on the left). In practice block 6 and test block 7 (picture 6 and 7), the pictures of physical activity and physical inactivity (or aerobic exercises and strength exercises in IAT 2) were added, but not mirrored. Where in block 3 and 4 the picture of aerobic exercises was combined with a sad emoticon, it was now combined with a happy emoticon. Where in block 3 and 4 the picture of physical activity (or strength exercises) was combined with a happy emoticon, this was now combined with a sad emoticon. Based on the difference in mean sorting reaction time between block 4 (happy/physically active vs. sad/physically inactive) and block 7 (sad/physically active vs. happy/physically inactive), Based on the difference in mean sorting reaction time), corrected for incorrect responses, a difference score was calculated based on the d-600 algorithm (Greenwald, Nosek & Banaji, 2003); see also SPSS syntax in additional file 1). For the first IAT, a calculated difference score < 0 reflected a more positive implicit reaction to physical inactivity compared to physical activity. A score > 0 reflected a more positive implicit reaction to physical activity compared with physical inactivity. A score of 0 reflects no, or ambivalent preferences for both

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physical activity and physical inactivity. For the second IAT, a score < 0 means a more positive association with aerobic exercises, and a score > 0 a more positive association with strength exercises.

[Insert Figure 1 here]

The Questionnaire

Demographics (gender, age, height, and weight), and reflective determinants of physical activity, strength exercises and aerobic exercises were measured using a self-report questionnaire. All items were measured on a 100-point visual analogue scale, except BMI, how often they exercised, and self-image. As needed, scores were recoded such that a higher score reflected more agreement with the variable. Scores on items that measured the same construct were averaged into one scale when the internal consistency was sufficient ($\alpha > .60$). The questionnaire about the reflective determinants contained the variables listed below, derived from the Reasoned Action Approach, and the Integrated Behavioral Model (Montaño & Kasprzyk, 2015). For all questions, pictures were added to make sure that the children understood what was meant by the question (see Additional File 1: Complete Study Design).

Self-image. Questions were asked about self-image: 1) “do you see yourself more as a physically active person” (score = 1) or “a non-physically active person” (score=2), and 2) “do you see yourself more as someone more suited to aerobic exercises” (score=1) or “strength exercises” (score=2).

Attitude. Participants’ evaluations of 1) physical activity, 2) physical inactivity, 3) aerobic exercises, and 4) strength exercises, were each measured with two unipolar semantic-differentials with the labels “unpleasant–pleasant” and “bad-good”.

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Subjective norms. Two items measured the extent to which participants believed important others think they should exercise: “My parents want me to exercise” and “My friends want me to exercise”. Response categories ranged from “absolutely disagree” to “absolutely agree”.

Perceived behavioral control and intention. For 1) physical activity, 2) aerobic exercises, and 3) strength exercises, a total of three questions were asked about perceived behavioral control: “If you want to, could you be: 1) more physically active 2) carry out more aerobic exercises, and 3) carry out more strength exercises”, and three questions about the intention: “Are you going to be 1) more physically active, 2) carrying out more aerobic exercises, and 3) carrying out more strength exercises”. Response categories ranged from “absolutely disagree” to “absolutely agree”.

Physical activity behavior. Participants were asked to report: 1) how often they exercised per week and 2) how many hours they spent exercising every time they exercised. From these reports, we calculated how many hours per week were spent exercising.

Analyses

IBM SPSS statistics 20 was used for data preparation and R (R Core team, 2014) was used for data analysis. For each participant, a BMI z-score was calculated using national norm data (Cole, Bellizzi, Flegal, & Dietz, 2000; Cole, Flegal, Nicholls, & Jackson, 2007). To measure performance on the implicit association tests, d-600 scores were calculated using the d-600 algorithm (Greenwald et al., 2003; see also the SPSS syntax file in Additional File 1). First, as a crude approximation of matching, we examined the difference between participants who would be classified as overweight/obese (BMI z-score ≥ 1) in the general and clinical samples (World Health Organization, 2015). Subsequently, to examine whether determinants of physical activity differ depending on BMI z-score, correlations (and 80% confidence

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intervals) were computed between BMI z-scores and attitudes, subjective norms, perceived behavioral controls, intentions, and impulsive determinants. We report both 80% confidence intervals of effect sizes (following Cohen's (1990) recommendation as well as to prevent reading of the confidence intervals as 'significance testing boundaries', a problem of 95% confidence intervals) and Null Hypothesis Significance Testing (NHST) outcomes, based on the problems reported with NHST (e.g., (Masicampo & Lalande, 2012)) and pleas to remedy this problematic approach (e.g., Denis, 2003).

RESULTS

Youngsters participating in the outpatient lifestyle intervention program () might have been positively influenced by their program. Therefore, before we executed correlational analyses, we first compared the overweight and obese participants from with overweight and obese participants from the online panel (BMI z score >1), as a crude approximation of matching. We divided the participants from the general sample into normal weight (BMI z-score<1) and overweight/obese (BMI z-score>=1) groups, and tested the differences between these two groups and the subsample from the clinic with regard to the demographic, reflective and impulsive determinants (see Table 1). The highest difference among the three subgroups has a p -value=.02 (uncorrected for multiple testing; see Additional File 1). We therefore concluded that there does not seem to be a systematic difference between the three subsamples.

[insert Table 1 here]

Combining the sample with the participants from the general sample (from) resulted in a final sample where the BMI z-score was bimodally distributed (see

Figure 2). No associations with BMI z-scores were found for gender (Cohen's $d=.19$ [-.17; .55], $p=.30$). Because the (mainly overweight and obese) participants from the [REDACTED] clinic were younger than the participants from the online panel, BMI z-score decreased with age. Therefore, when computing the correlation coefficients with BMI z-score, all variables were first corrected for age (besides the already for age corrected BMI z-score). Interested readers can refer to the uncorrected scores and the analyses per subgroup in Appendix 1.

[Insert Figure 2 here]

BMI z-scores were not correlated with attitudes towards physical activity ($r=-.05$ [-.22, .12], $p=.75$), physical inactivity ($r=.06$ [-.11,.23], $p=.71$), strength exercises ($r=-.02$ [-.19,.15], $p=.84$), or aerobic exercises ($r=-.09$ [-.26,.08], $p=.48$) (see Figure 3). Although BMI z-scores were unrelated to subjective norms of parents ($r=.16$ [-.01,.32], $p=.16$), they were related to subjective norms of friends ($r=.29$ [.13,.44], $p=.01$): the higher the BMI z-score, the higher the perceived expectations of friends that the youngster should exercise. BMI z-scores were not related to perceived behavioral control regarding strength exercise ($r=.11$ [-.06,.27], $p=.41$) or aerobic exercise ($r=.14$ [-.03,.30], $p=.25$), but a positive correlation with perceived behavioral control related to exercise in general was found ($r=.23$ [.06,.38], $p=.03$): As BMI z-scores increased, youngsters were more confident that they could be more physically active if they wanted to. Perceived behavioral control beliefs regarding strength exercise and aerobic exercise were not related to BMI z-score. BMI z-scores were positively correlated with the three intention measures: the higher the BMI z-score, the higher the intention to be more physically active ($r=.30$ [.14,.45], $p=.01$), more engaged in aerobic exercises ($r=.25$ [.08,.40], $p=.02$), and more engaged in strength exercises ($r=.23$ [.06,.38], $p=.03$). There were no

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differences in BMI z-scores between the self-image groups (physical inactivity vs. physical activity: Cohen's $d=.01$ $[-.34,.35]$, $p=.98$; aerobic vs. strength: Cohen's $d=.26$ $[-0.12,.63]$, $p=.28$, note, these are not displayed in Figure 3 due to the different metrics). BMI z-scores were not correlated to whether participants' reaction times implied stronger associations with either physical inactivity or physical activity (IAT1: $r=.09$ $[-.21,.13]$, $p=.75$) or aerobic or strength exercise (IAT2: $r=.12$ $[-.13,.21]$, $p=.75$). No correlation between BMI z-score and self-reported physical activity was found ($r=-.01$ $[-.18,.16]$, $p=.91$) (See Figure 3).

[Insert Figure 3 about here]

DISCUSSION

The focus of this study was to investigate the weight status related differences in reflective and impulsive determinants (aerobic vs. strength-related) of physical activity. Despite finding correlations between social norms of friends, perceived behavioral control for exercise, and all three intentions, our first finding is that there are not many significant correlations between BMI z-scores and either the measured reflective determinants, or impulsive determinants (IAT scores). This may imply that a) there really are very few correlations between physical activity determinants and weight status (Craeynest et al., 2005), or that b) explicitly expressed cognitions are influenced by social desirability effects (Larson, 2000). Regardless of whether the participant was recruited via the online panel or ████████, participants with high BMI z-scores may well have been aware of the need for exercise and what is expected of them. However, the implicit measures which are not thought to be influenced by social desirability (Greenwald et al., 1998) did not show differences either, in line with the results of Craeynest et al. (2005). Moreover, inspection of the means for the three subpopulations (Table 1) does

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not suggest a systematic difference in terms of the youngsters participating in a lifestyle program giving more socially desirable answers than overweight/obese youngsters not in treatment.

What we do find is that youngsters with a higher BMI z-score are more in favor of exercise than youngsters with lower BMI z-scores (with no differences found between aerobic and strength exercises). Higher BMI z-scores were correlated with more positive norms for exercise (friends). They were also associated with higher perceived behavioral control for exercise and higher intentions to exercise (both aerobic and strength exercises). Youngsters with a lower BMI z-score do not have more negative correlations with exercise than youngsters higher z-scores in terms of concepts from current theories on reflective determinants (e.g. Montaño & Kasprzyk, 2015). This is contrary to the findings of De Bourdeaudhuij, et al. (2005) who reported that adolescents who are overweight had less favorable psychosocial correlates related to physical activity as compared to adolescents of a normal weight (BMI cut off point=25). However, they also reported that the strength of associations between psychosocial variables and total physical activity were comparable in overweight/obese and normal weight adolescents. When we analyzed our data without correcting the BMI for age and gender, we again found few differences, but they are in the same direction as those found by De Bourdeaudhuij et al. (2005). In their sample, BMI scores were not corrected for age and gender, which makes it harder to compare the results of the two samples (Flegal & Ogden, 2011). Moreover, in another study from the same research group (Craeynest et al., 2005) no differences were found in reflective or impulsive determinants between children with obesity and a matched control group.

We did not find significant correlations between BMI z-scores and either of the two implicit measures, and only a few between BMI z-scores and reflective determinants. We expected to find a difference between strength and aerobic exercises for overweight

youngsters, but we did not. One explanation for this is that in order for these youngsters to find out that they are better suited to strength exercises, they need to experience strength exercises more often (Ten Hoor et al., 2016). Targeting strength exercises might be more effective in the long-term, as this could reinforce the biological and psychological strengths of youngsters who are overweight/obese (Ten Hoor et al., 2014; 2016). Recently, other researchers have argued along the same lines (Schranz, Tomkison & Olds, 2013). The review by Schranz et al. (2013) about children and adolescents who are overweight provided empirical support for the (large) effects of strength training on muscle strength, in addition to the small effects of strength training on body composition. However, the effect of strength training on psychosocial outcomes remains unclear because of the limited number of studies addressing this topic. Our study demonstrates that there are at least no negative correlations with strength exercises in youngsters with a higher weight status.

Limitations and implications for future research

One limitation of this study is that its design is quasi-experimental (and then specifically our sampling strategy). We recruited youngsters from two different settings in order to obtain a sufficient number of overweight and obese youngsters in the study. As previously mentioned, one possible explanation for the unexpected positive associations between physical activity determinants and BMI z-scores for all youngsters is that the determinants of participants from the clinic had been positively influenced by their program. However, as the data showed, there was no indication of a sampling bias. Body weight adjusted for height (BMI) and related z-scores in children are commonly used to determine whether an individual has a healthy or unhealthy weight, and can be seen as a good and simple tool for risk estimates in large populations (Ten Hoor et al., 2018b). However, it is not the right tool for individual

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metabolic and mental health evaluations (Bogin, Varela Silva, 2012) and might have stigmatizing effects on one's health in later life (Hunger, Tomiyama, 2014). Other methods to determine body composition are more accurate to evaluate health, but these measures are more difficult to apply in larger study populations. Based on this study, we can make several recommendations for further research. First, in future studies, objective measures of behavior should be used (see also De Bourdeaudhuij et al., 2005). Second, as there is a possibility that youngsters who are overweight or obese do not know that they are better in strength related exercises, determinants should be measured after youngsters have become exposed to and acquainted with these exercises (ten Hoor, 2018). Third, in future studies, measuring actual body composition might be of additional value.

Lastly, to possibly achieve long-term behavior changes, evidence-based interventions should be developed, implemented, and evaluated (Bartholomew et al., 2016). The determinants of physical exercise do not differ depending on weight status, suggesting that the same kind of interventions will be effective for both groups. Ward et al. (2006) suggested that interventions should be tailored to determinants of different activity levels, gender and ethnicity instead of BMI.

Conclusion

Based on the reflective determinants, differences between normal weight youngsters and youngsters who are overweight or obese are small. Exercise intentions, including those for aerobic and strength exercises, were positively correlated with BMI z-scores. Youngsters with a higher BMI z score often reported that their friends think they should exercise, and were more confident that they could exercise more if they wanted to. No other determinants, including impulsive determinants, were correlated with BMI z-scores, suggesting that

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463 children and adolescents with a different weight status can be targeted by the same
464 intervention.

465

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ACKNOWLEDGMENT

We would like to acknowledge Michiel Vestjens (Instrumentation, Faculty of Psychology and Neuroscience, Maastricht University) for programming the implicit measures and questionnaire. This project is sponsored by the Netherlands Organization for Health Research and Development (ZonMw; project number 525001004) (Grant nr 525001004).

COMPETING INTERESTS

The author(s) declare that they have no competing interests

ETHICS AND CONSENT

Participants were informed about the procedures and debriefed about the content and aim of the study afterwards, in order to minimize social desirability effects. The youngsters from the clinic and their parents signed informed consent during their monthly visit to the clinic. After parental approval was obtained, the online panel group received an invitation to participate via e-mail. The youngsters provided informed consent (by clicking on the appropriate button for the online panel). This study and consent procedure was approved by the Medical Ethics Committee of Maastricht University Medical Center+ (METC12-4-048), and the Research Ethics Board of the Faculty of Psychology and Neuroscience, Maastricht University (ECP-113-10-04-2012).

AUTHOR CONTRIBUTION

GtH conceived of, designed, and coordinated the study, contributed to the acquisition, performed the statistical analyses, and drafted the manuscript. GK participated in the design, analysis of the data, and revision of the manuscript. GJP participated in the statistical analyses and revision of the data. GP, SK, RR, and AS participated in the design of the study and

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625 revision of the manuscript. AV participated in the acquisition and the revision of the
626 manuscript. All authors read and approved the final manuscript.

627

628 **Appendix**

629 **Additional File 1.** Research Material, Data, and SPSS Syntax.

630

631 **Figure legends**

632 **Figure 1.** Phases in the Implicit Association Task

633 **Figure 2.** BMI z-score Distribution of Recruited Population (8-18 Years Old)

634 **Figure 3.** (Age Corrected) Correlations Between the Reflective Determinants and BMI z-

635 scores. The black line represents the confidence intervals for the age corrected correlations;

636 grey lines represent the uncorrected confidence intervals.

637

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638 Table 1. Mean Scores of the [REDACTED] Subsamples, and the [REDACTED] Sample, as a Crude
639 Approximation of Matching.

MEANS	normal weight	overweight	[REDACTED]
N	56	18	59
Age (year)	15.82	15.17	12.14
Height (cm)	173.46	167.83	155.28
Weight (kg)	58.45	71.78	77.40
BMI z-score	-0.28	1.85	3.25
Self-image (1=no PA, 2 = PA)	1.54	1.44	1.64
Self-image (1 =aerobic. 2 = strength)	1.38	1.22	1.26
d-600 (no PA – PA)*	-0.24	-0.24	-0.08
d-600 (Aerobic – Strength)*	0.02	0.10	0.07
Attitude PA (1-100)	72.86	76.06	77.56
Attitude no PA (1-100)	56.33	62.72	41.67
Attitude Aerobic (1-100)	74.16	74.28	76.00
Attitude Strength (1-100)	71.20	69.00	72.93
Subjective norm Parents (1-100)	56.38	70.94	70.98
Subjective norm Friends (1-100)	35.52	46.67	45.48
Perceived Behavioral Control PA (1-100)	65.39	74.72	81.17
Perceived Behavioral Control Aerobic (1-100)	73.95	79.61	81.38
Perceived Behavioral Control Strength (1-100)	69.84	73.94	71.50
Intention PA (1-100)	49.88	57.89	72.33
Intention Aerobic (1-100)	56.29	54.50	77.12
Intention Strength (1-100)	51.13	50.61	64.64
Physical activity level (h/week)	7.95	7.67	8.28

640 For the IAT d-600 scores: A calculated difference score < 0 reflects a more positive
641 implicit association with physical inactivity as compared to physical activity. A score > 0

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642 reflects a more positive implicit association with physical activity as compared to physical
643 inactivity. A score of 0 reflects no, or ambivalent preferences for both physical activity and
644 physical inactivity. For the second IAT, a score < 0 reflects a more positive association with
645 aerobic exercises, and a score > 0 reflects a more positive association with strength exercises.
646 All the pictures used can be found in Additional File 1.
647