**Author’s response to reviews**

**Title:** Impact of snus use in teenage boys on tobacco use in young adulthood. A cohort from the HUNT Study Norway.

**Authors:**

Liv Grøtvedt (liv.grotvedt@fhi.no)

Lisa Forsén (lisa.forsen@fhi.no)

Inger Ariansen (inger.ariansen@fhi.no)

Sidsel Graff-Iversen (sidsel.graff-iversen@fhi.no)

Turid Lingaas Holmen (turid.lingaas.holmen@ntnu.no)

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**Author’s response to reviews:**

Reviewer 1
Thank you for very useful comments!
Repetition in the definition of outcome variables in the section “Tobacco use Measures” and in “Statistics” were consolidated by deleting one sentence on the lines 80-82 on page 6 in Methods. Figure 2 may be seen as a duplication of Table 2, but with the categories “smoking only” and “dual use” combined. We agree, especially as the comments mainly refers to Figure 2, and not to Table 2. However, we would like to replace Table 2 with the same table, but divided in two age groups (previous Additional file 3), now imbedded in the text as a new Table 2. The main reason is that it may be convenient to see the exact numbers, and to be able to separate between “smoking only” and “dual use” at follow-up. New information about the age differences is added, and as this table is already commented in the text, thus it will be easier to follow the description of age groups.
See Results, lines 193-202, page 11-12.
A comment to our own results was added in the Discussion in lines 301-304, page 16, about the low RR of the dual users to become non-users of tobacco in adulthood, compared to the smokers and snus users. Thank you for reminding us to highlight this result!

Reviewer 2

**GENERAL COMMENTS:**
Major drawback, as the data are over 10 years old – could limit the generalization of the study to 2019. Still relevant to today’s tobacco control discussions?
Yes, we agree that it is very important to address the relevance of our study. See new text in Discussion in lines 367-376, page 18-19 in the revised manuscript.

**TITLE:**
The word “cohort” should be included in the title.
New title:
Impact of snus use in teenage boys on tobacco use in young adulthood. A cohort from the HUNT Study Norway
ABSTRACT:
Is the RR from tobacco to no tobacco necessary, given it is practically the inverse of the RRs presented earlier?
Thank you for giving us the opportunity to rethink about the separate outcome of “no tobacco use”.
We have two arguments for the usefulness of this outcome.
First, we think that an easy accessible outcome will increase the readability of the article. The reader would have to calculate the inverse RRs from the three RRs of baseline snus users, smokers and dual users to become tobacco users. As we have two different tobacco outcomes, namely current smoking/dual use and current snus use, the reader will have to merge them into one outcome (?) to be able to calculate an inverse value of RR for no tobacco use at follow-up.
Another reason for us to keep the RRs from ever tobacco to no tobacco is the comment from reviewer 1 regarding the high nicotine dependency among dual users, which is clearly demonstrated by the significant lower RR for adolescent dual users to become non-users (0.24) than either smokers (0.52) or snus users (0.49) to become non-users.

INTRODUCTION:
Why did the snus rates start to increase in Norway from the 1990s?
This is an interesting question, but we do not have a simple answer. The increase in snus use is probably a combination of different reasons. The restrictions of smoking may be one reason. However, the main restriction that possibly lead to increased snus use came later (2004), as smoking was banned in restaurants and bars. A shift from the slightly unappetizing loose moist snus (masculine, but not nice looking) to the more usable and modern portion snus with flavors may have contributed to increased use.
We have added one sentence; see Background, lines 21-23, page 4.

METHODS:
I would encourage the authors to include data on females in an appendix…
Data on females are included in Additional file 1. We appreciate the opportunity to publish data on females. The girls in Young-HUNT1 were mainly smokers, and it is of interest to know to what degree they may have started to use snus instead of cigarettes, or in addition to cigarettes, as young adults. The appendix highlights the main features of the transition in female tobacco use.
Results from the females were commented in

Research approach from ever use to current use. Can the authors justify only testing “ever to current use” instead of “current to current use”?
We agree that this should be commented on, and we have added one sentence in Methods (lines 78-80, page 6) and one sentence in Discussion (lines 338-340, page 17).
We started our analyses with “current to current use”. In these analyses we included the
adjustment for “former smoking” and “former snus use” as covariates in all analyses. Repeated analyses with a more detailed tobacco variable gave the idea to include also previous tobacco use among adolescents at the time of the baseline survey. Ever use will also include earlier tobacco use, and those starting early may be more vulnerable to continue their tobacco use into adulthood. Our results in the new table 2, first column, show that younger tobacco users at wave 1 had lower prevalence of “no tobacco” use in adulthood than the older age group of tobacco users at wave 1. We think that ever use of tobacco at wave 1 is more correctly adjusting for earlier tobacco use than the inclusion of separate variables for former smoking and former snus use.

The RR s for smoking and snus use in adulthood were higher with current use than with ever use. The RR of smokers to become tobacco free was lower (not significant) for adolescent current smokers.

Tobacco use in adulthood according to adolescent ever tobacco use 11 years earlier. RR (CI).

<table>
<thead>
<tr>
<th>Current smoking/dual use as young adults*</th>
<th>Current snus only use as young adults*</th>
<th>No tobacco use as young adults**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted for age and family smoking</td>
<td>Adjusted for age and family smoking</td>
<td>Adjusted for age and family smoking</td>
</tr>
<tr>
<td>N =1046</td>
<td>N =984</td>
<td>N =1341</td>
</tr>
</tbody>
</table>

Ever tobacco use at baseline:

<table>
<thead>
<tr>
<th>Current tobacco use at baseline:</th>
<th>Also adjusted for previous smoking and snus use</th>
<th>Also adjusted for previous smoking and snus use</th>
<th>Also adjusted for previous smoking and snus use</th>
</tr>
</thead>
<tbody>
<tr>
<td>No tobacco</td>
<td>ref.</td>
<td>ref.</td>
<td>ref.</td>
</tr>
<tr>
<td>Snus use</td>
<td>2.15 (1.69-2.73)</td>
<td>2.78 (2.24-3.44)</td>
<td>0.49 (0.40-0.61)</td>
</tr>
<tr>
<td>Smoking</td>
<td>2.68 (2.15-3.34)</td>
<td>1.47 (0.98-2.22)</td>
<td>0.52 (0.40-0.68)</td>
</tr>
<tr>
<td>Dual use</td>
<td>3.61 (3.04-4.30)</td>
<td>3.14 (2.53-3.89)</td>
<td>0.24 (0.16-0.34)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current tobacco use at baseline:</th>
<th>Also adjusted for previous smoking and snus use</th>
<th>Also adjusted for previous smoking and snus use</th>
<th>Also adjusted for previous smoking and snus use</th>
</tr>
</thead>
<tbody>
<tr>
<td>No tobacco</td>
<td>ref.</td>
<td>ref.</td>
<td>ref.</td>
</tr>
<tr>
<td>Snus use</td>
<td>2.27 (1.74-2.96)</td>
<td>3.00 (2.43-3.70)</td>
<td>0.45 (0.35-0.57)</td>
</tr>
<tr>
<td>Smoking</td>
<td>3.33 (2.71-4.09)</td>
<td>1.80 (1.20-2.70)</td>
<td>0.32 (0.22-0.48)</td>
</tr>
<tr>
<td>Dual use</td>
<td>3.70 (3.10-4.42)</td>
<td>3.23 (2.51-4.12)</td>
<td>0.22 (0.14-0.35)</td>
</tr>
</tbody>
</table>

* Versus no current tobacco use  ** Versus any tobacco use

Validity of responses in both waves. Are some participants claiming to have been ever smokers in Wave 1 but never smokers in wave 2? How are these dealt with?
Regarding possible inconsistent data on smoking and snus use in the two waves, it was useful to do this extra analyses:
Participants in wave 2 may be previous tobacco users, even if they do not use tobacco in wave 1. They may have been smokers or snus users for some time during the 11 years between the surveys.

Smoking in the cohort of 1346 males.
8 participants in wave 2 states that they had never smoked, but answered in wave 1 that they smoked daily. 43 participants in wave 2 states that they had never smoked, but answered in wave 1 that they were occasional smokers. That means that 51 participants gave inconsistent answers about their smoking behavior in wave 1 and 2. Most of them were occasional smokers in wave 1.

Snus use in the cohort of 1346 males.
No participants in wave 2 stated that they had never used snus, but answered in wave 1 that they used snus daily. 53 participants in wave 2 stated that they had never used snus, but answered in wave 1 that they were occasional snus users. 25 participants in wave 2 stated that they had never used snus, but answered in wave 1 that they had quit snus use. That means that 78 participants gave inconsistent answers about their snus use in wave 1 and 2. Most of them were occasional snus users in wave 1 and the rest said that they had quit snus at wave 1.

Regarding both smoking and snus use, one explanation for the inconsistence may be that they used tobacco only for a short time period or very sporadically in wave 1, thus it may be an aspect of “overreporting” of tobacco use in adolescence. Another possible explanation is that they as adults have underreported in the direction of desirable adolescent behavior. A third possible explanation is that they may have forgotten their tobacco use, especially the occasional use, in adolescence.

The inconsistence between the answers in wave 1 and wave 2 may indicate an “overreporting” of tobacco use in adolescence. Generally, we are trusting the answers about current and former tobacco use given from the adolescents in the first survey. It would probably not improve the data from wave 1 if we based them on the answers from the same participants 11 years later. We are only using measures of current tobacco use at wave 2. Therefor the answers “never smoked” and “never used snus” will not affect the results from wave 2.

We have added some sentences about inconsistence in tobacco responses in Results, line 154-159, page 9, and in Discussion, line 341-347, page 17-18.

What was the incentives to participate in Wave 2, if any?

The HUNT3 survey (2006-08) among adults was a large total population-based health examination survey in the county of Trøndelag, where 93 860 were invited; total participation rate 54%. The young adults in our Young-HUNT1 survey were, as far as they still lived in the county 11 years later, also invited to participate in HUNT3 from Young-HUNT1.

Strategies to recruit participants to HUNT3, included a non-participant survey, and information to the entire population in newspapers and other news channels. Still, perhaps the main incentive of participating in HUNT3, has been the health examination, including a health check for all participants. No special strategy was carried out to recruit the young adults 23-30 years of age.

We have included additional explanations to the participation in wave 2: Methods lines 35-39, page 4 and lines 42-49, page 5. Discussion lines 348-357, page 18.

Could missing be imputed?

We agree that non-response in wave 2 is of concern in our cohort study. Multiple imputation would involve the prediction of snus use and smoking in adulthood, based on the data from the adolescents. We are unsure if this would solve the problem of non-response, as the prediction also may introduce larger uncertainty in the results and probably not increase the precision.

Perhaps the most important variables for a non-response analysis will be the predictor-variables of tobacco use in light of attrition to follow-up, see Additional file 3. We have included extra analyses of non-response regarding our main sosiodemographic and behavioural variables form Table 1. See Additional file 2. The non-participants to the cohort population were found to have higher prevalence of parental divorce and family smoking compared to the cohort participants. Plans for further education in adolescence did not differ much between participants and non-participants to the cohort. However, altogether these non-response analyses may indicate lower
socioeconomic status among non-participants than among participants to the cohort. The results are described in Results, lines 139-153 and in Discussion, line 358 and lines 360-361 in addition to the previous discussion of non-response.

The authors have reported to mean age of participants in the methods—should only be mentioned in the results. Mean age is now only mentioned in Results, lines 135-136, page 8. It is removed from Methods l. 63-64, page 5.

RESULTS:
Key take home message for policymakers: Did more participants go from snus to cigarettes than from cigarettes to snus? 25% of snus users became smokers and 16% of smokers became snus users, indicating a net 9% increase in smoking due to snus. In addition, 31% of the dual users became snus only users, and 25% of the snus users became smokers or dual users, a net 6% increase in snus only use. However, just to illustrate my problem; how to calculate these transitions: The adolescent smokers only, increased from 8% in adolescence to 12% in adulthood. 16% went from smoke only to snus only and 20% went from smoke only to dual use, which constituted a net increase of 4% in smoking with concurrent snus use due to snus use. (It is perhaps not OK to count the transition from smoking to dual use as increase in smoking, even when it came in addition to the 30% who came from smoke and ended with smoke). The adolescent dual users, from 8% in adolescence to 15% in adulthood. 31% went from dual use to snus only and 18% went from dual use to smoke only, which constituted a net decrease of 13% in smoking due to snus use. (It is not quite OK to count the transition from dual use to smoking as an increase in smoking?) Dual use makes it difficult to do this calculations, and it may be quite confusing. I thought of making another appendix, with explanations, but probably almost nobody would have the patience to go deeply into this theme. Anyway, I think our keypoints are clearer than before, and the comparison with the girls was helpful to see the large increase in tobacco use among the boys.

Did the authors consider the number of cigarettes smoked at baseline and at follow up? Yes, we have considered the possibility of including number of cigarettes per day, as well as number of snus boxes consumed pr week. The inclusion of quantity of tobacco use was not applicable for two reasons. 1) Number of cigarettes per day were only given for daily smokers. Using quantity of smoking, we would have to separate daily and occasional tobacco use and thus increase the complexity of the study. 2) The participants in wave 2 came from both the main HUNT3 survey and from the non-responder survey mentioned in the methods. Due to the focus on core questions on health and lifestyle, the non-responder survey did not have questions about quantity of tobacco use, only “daily” and “occasional” use. Hence, we had not the possibility to compare number of cigarettes smoked in wave 1 and wave 2. One sentence is included in Methods, line 84-85, page 6.

DISCUSSION:
Policy implications!
Thank you of reminding us to be clear about policy implications. The large increase in tobacco use among the mainly snus using boys shows clearly that snus use did not help to reduce smoking in our study. Dual use is interesting, as it on the one side makes it easier to go to snus only use, but at the same time the majority stays to smoking or dual use. And the likelihood to quit is small among the dual users in our study. Regarding policy implications, it may be important to tell about these transitions in tobacco use, and to see it as a as a voice in the debate of the harm reduction. At least in our study snus use did not seem to reduce the harm of smoking. Other new nicotine products in other countries may show the same pattern of use as the boys in our study. Additional file 5 is changed to include smoking and snus use rates for both men and women in Norway in the age 16-24 years. It may be an alternative to include it in the manuscript instead of appendix.