PEER REVIEW HISTORY

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ARTICLE DETAILS

| TITLE (PROVISIONAL) | To what extent is socioeconomic status associated with not taking up and dropout from cardiac rehabilitation: A population-based follow-up study |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------|
| AUTHORS             | Svendsen, Marie Louise; Bitsch, Birgitte; Stapelfeldt, Christina; Ravn, Maiken; Palner, Sanne; Maribo, Thomas |

VERSION 1 – REVIEW

| REVIEWER          | Salzwedel, Annett              |
|-------------------|--------------------------------|
| UNIVERSITY OF POTSDAM | 16-Feb-2022                   |

| GENERAL COMMENTS  | Congratulations to the authors for this straight, well-designed, structured and well-written work. As I understand it, you analyzed registry data to explore the linkage between several indicators of socioeconomic status (SES) such as educational level, family income and living situation and occupational status and cardiac rehabilitation (CR) uptake. You found clear associations between most of the chosen SES indicators and particularly the non-participation in CR in appr. 2,000 patients hospitalized for ischemic heart disease and referred for CR in 2017-2018. This work contributes to the evidence in this field. I have only a few comments. I hope this can help. - Can you justify the time-setting (2017-2018)? - How was the variance explanation of the applied models pronounced? One can assume that there are a lot of additional confounders, especially if one takes into account that a quarter of patients did not take up the CR and a further quarter dropped out of CR. This issue can also be discussed. Did you consider regional factors in the concept of social status and deprivation? - You cited the 2016 CVD prevention guidelines (ref. 4). Current guidelines were published in 2021 (https://academic.oup.com/eurheartj/article/42/34/3227/6358713?login=false). Please consider referencing the current guidelines. - You categorized the occupational status into employment, age-related pension and social benefits. This coverage seems incomplete to me. What about students or housewives/housemen? - Please provide information about the usual CR programme in Denmark (setting, centre-based?, supervised?, volume, frequency, content). This may help to interpret the results of the study. |
| REVIEWER          | Azevedo, Ana                   |
| UNIVERSITY OF PORTO MEDICAL SCHOOL, DEPARTMENT OF HYGIENE AND EPIDEMIOLOGY | 23-Feb-2022                   |
**GENERAL COMMENTS**

This paper addresses an important social and health issue. The study design is adequate for the objectives and the authors make sensible use of available routine data.

4. Are the methods described sufficiently to allow the study to be repeated?
   It is not clear if the patients could be enrolled in only 1 or 2 of the 3 activities.
   Is the Charlson comorbidity index automatically calculated in the database or did the authors compute it themselves using the list of codes?

6. Are the outcomes clearly defined?
   The definition of dropout is not clear. It is contradictory in its present form. The authors say: "yes" if the patient did not complete at least one of the three activities, including missing values on all three, and "no" if the patient completed one or more of the three CR activities. If the patient completed one and did not complete two of them, he fits both these conditions ("yes" because he completed at least one and "no" because he completed one or more...). The fact that follow up time is said to end when there is completion of at least one of the three activities (top of page 9) must be in accordance with the revised definition of outcomes. Also, it is not clear how the authors dealt with missing values in some but not all outcomes.

10. Are the results presented clearly?
    Figure 1 needs improvement to show more clearly how many patients were excluded due to missing data, how many were considered for outcome "non-participation" and how many were considered for outcome "dropout". If this intends to be a real flowchart, the box with "dropout" should appear before the outcomes, not after them. The 1568 who attended the first meeting include some non-participants - were these considered for the analysis of dropouts or not?
    How can someone who attended the closing meeting ever be a dropout?
    Page 13, line 20 - when the number of completed sessions is presented, it would be useful to know how many were planned/prescribed.
    When the authors say 4% of the non-participants died, it doesn't make sense to write "(data not shown)" because this is describing a result.
    How many participants died?

**MINOR ISSUES:**

Page 9: tertiles are the cut-off points, the limits of the categories, not the groups in each category.

Is being Danish the ethnicity or nationality?

Please check the format of the authors list in reference #3.

Please recheck spelling. For example:

page 4: "ARTICLE SUMMERY" should read "ARTICLE SUMMARY"

page 7, line 25: "n" missing in immigrants

page 7, line 50: "r" missing in through

Do not present standard deviations with ore precision (decimal places) than the mean of the same variable.

Page 21, line 37 - it is redundant to say "systematic selection bias". Bias is a systematic error by definition.

**REVIEWER**

Andersen, Ingelise
This descriptive paper investigates whether SES indicators are associated with CR utilization based on 2018 patients from the Central Denmark Region. Unsurprisingly, the authors find that indicators of SES are important markers of CR utilization.

Specific comments:
The strengths and limitations mentioned are trivial:
The strengths do not differ from the strengths related to Danish register research.
The dropout rate is similar to previous studies also from Denmark.
The limitations like unmeasured confounding is a problem in all population based studies.

p.5 l 31ff it is said that SES indicators have an effect of cardiovascular health. When you talk about effect you talk about causation. Whether SES cause CVD is debatable and thoroughly discussed by among others Johan Mackenback in a number of books and papers. However, it is well documented that SES indicators are associated with cardiovascular health. The mechanisms are usually explained by a number of mediators.

It would be relevant with some theoretical information on why you chose those four indicators and why you include all four. Among the activities in CR you include three. Why these three??

In a paper by Pedersen et al European Journal of Cardiovascular Nursing, 17(4), 345–355 it is shown that patients to a smaller degree participate in the activities exercise and patient educational program. It would improve the paper with a table showing in which parts of the program the patients participate.

Results:
A descriptive table is missing including how many patients participated in the different elements of CR. In addition, for the ease of the reader table 1 should include a column showing the n and % of participants in each SES group.

Since the aim is to investigate the association between SES and participation in CR a table showing the OR between SES and participation would be obvious. Tables 2 and 3 are insufficient. This would qualify the discussion by showing whether the social gradient differ between participation, drop out and non-attendance.

In the analyses, it is not clear to me why you do not control for all the SES variables – as proposed by Galobardes et al.

Discussion
p.21 l 12. What does all phases of CR mean?
In the discussion, you refer to some of your own unpublished papers. However, since there are published papers on the same topic it would be more relevant to refer to peer-reviewed papers. A discussion on how the four SES indicators contribute to the result is warranted.

P 22 last line it is said that the study provides new evidence. However, it is a bit difficult to find the novelty in the paper. Social inequality in CR rehabilitation is well documented, also in research from Denmark. To keep this statement you need to prove in the discussion in which way the paper brings new information.
VERSION 1 – AUTHOR RESPONSE

REVIEWER: 1
Dr. Annett Salzwedel, University of Potsdam
Comments to the Author:
Congratulations to the authors for this straight, well-designed, structured and well-written work. As I understand it, you analyzed registry data to explore the linkage between several indicators of socioeconomic status (SES) such as educational level, family income and living situation and occupational status and cardiac rehabilitation (CR) uptake. You found clear associations between most of the chosen SES indicators and particularly the non-participation in CR in appr. 2,000 patients hospitalized for ischemic heart disease and referred for CR in 2017-2018. This work contributes to the evidence in this field.
I have only a few comments. I hope this can help.

1. Can you justify the time-setting (2017-2018)?

The inclusion period was restricted by several factors.

Firstly, transfer of cardiac rehabilitation from hospitals to the primary healthcare setting was implemented on 1 January 2017 in the Central Denmark Region. The inclusion period in this study was advanced by nine months (i.e. 1/9 2017) to avoid the running-in period and potential variation between the providers of cardiac rehabilitation. This was described in the main document in the Discussion - Generalisability.

Secondly, the patients were included during the period 1/9 2017 – 29/12 2018 based on the identification of ICD-10 codes for ischemic heart disease and a referral for rehabilitation registered in the National Patient Register (Figure 1 in this response). The inclusion period ended by ultimo 2018 because the National Patients Register was converted to a new data format in 2019, and data was only available until 31/12 2018 at the time of data application.

Furthermore, due to the covid pandemic from 2020 onwards, information about cardiac rehabilitation in the primary health care setting is supposed to be different from the other years.

We hope that these elaborations are sufficient to clarify the time-setting.

2. How was the variance explanation of the applied models pronounced? One can assume that there are a lot of additional confounders, especially if one takes into account that a quarter of patients did not take up the CR and a further quarter dropped out of CR. This issue can also be discussed.

Thank you for raising this important point. We are fully aware that the quarter of patients who did not take up the cardiac rehabilitation may have influenced the baseline profile of the patients who were analysed regarding dropout. Therefore, we analysed these as two separate study populations in the study design. Table 1 in the main document describes the baseline characteristics of the patients who were referred from hospital to rehabilitation and followed up regarding the uptake of cardiac rehabilitation (study population 1), and Table 1 in the Supplementary Material displays the baseline characteristics of the patients who participated in the initial cardiac rehabilitation meeting and were followed up regarding dropout (study population 2). Despite some differences in the baseline profiles between the two study populations, they are very similar. We have elaborated on this in the main document, and deleted some text in the same paragraph to limit the word count, please see the Discussion – Strengths and limitations.

We hope these elaborations are sufficient to clarify the variance explanation of the applied models.
Logistic regression does not have an equivalent to the R-squared that is found in ordinary least square regression; i.e., the R-square that indicates the proportion of the variance in the dependent variable that the independent variables explain collectively. Therefore, we did not report on the variance in the main document, but do state the overall uncertainty of the point estimates by reporting the 95% confidence intervals.

3. Did you consider regional factors in the concept of social status and deprivation?

In Denmark, society-wide health and social equity is promoted through free access to tax-financed services, including e.g. universal health care, education, unemployment insurance, and disability pensions.(1) Furthermore, Danish research suggests that in a comprehensive welfare state like Denmark, the impact of area-level relative deprivation may not be as strong as the individual level socioeconomic circumstances on e.g. alcohol use.(2) Therefore, we did not consider regional factors in the concept of social deprivation in this study.

We have discussed the potential impact of the comprehensive Danish welfare model on the study’s results throughout the main document; e.g., in relation to the relatively low proportion of non-participation and dropout observed in this study compared with other countries, please see the Discussion, paragraph 5. Furthermore, we have elaborated on spatial inequality, please see the Discussion – No uptake and dropout.

We hope that this clarifies our considerations about social deprivation on the regional level.

4. You cited the 2016 CVD prevention guidelines (ref. 4). Current guidelines were published in 2021 (https://academic.oup.com/eurheartj/article/42/34/3227/6358713?login=false). Please consider referencing the current guidelines.

Thank you for making us aware of this. We have now cited the current guidelines in the main document.(3)

5. You categorized the occupational status into employment, age-related pension and social benefits. This coverage seems incomplete to me. What about students or housewives/housemen?

Occupational status is based on the national socioeconomic classification (SOCIO13) which is defined by Statistic Denmark and based on the main source of income or employment for all Danish residents.(4, 5) Students and housewives/women are included in the category ‘Social benefit’. However, the major part of the category ‘Social benefit’ constitutes disability pension (n=137, 58%), social security (n=71, 30%), and unemployment (n=13, 5%). The residual occupational positions that are not included in this category are too rare to compose an independent category. We have detailed the description of the categories of occupational status in the main document, please see the Methods – Socioeconomic status.

6. Please provide information about the usual CR programme in Denmark (setting, centre-based?, supervised?, volume, frequency, content). This may help to interpret the results of the study.

A national survey among health care professionals responsible for cardiac rehabilitation in the hospitals and the primary health care settings in Denmark shows that the majority of the primary health care settings and hospitals provides the following core activities of cardiac rehabilitation: systematic referral, agreed personalised planning of the rehabilitation, physical exercise training, patient education, tobacco cessation, psychosocial support, detection of anxiety and depression, vocational support, and nutrition efforts.(6, 7) In the Central Denmark Region (the setting for our study), transfer of cardiac rehabilitation from hospitals to the primary healthcare setting was
implemented on 1 January 2017 and systematically supported by a quality improvement database on CR.(8) Specifically for the primary healthcare setting in the Central Denmark Region, the national survey shows that cardiac rehabilitation is organised as demonstrated in Table 1.(6)

A description of the organisation of cardiac rehabilitation in the Central Denmark Region was added to the main document to assist the interpretation of the results, please see Methods – Setting and participants. Furthermore, a short amendment was made in the Discussion – Generalisability.

REVIEWER: 2
Dr. Ana Azevedo, University of Porto Medical School Comments to the Author:
This paper addresses an important social and health issue. The study design is adequate for the objectives and the authors make sensible use of available routine data.

7. Are the methods described sufficiently to allow the study to be repeated? It is not clear if the patients could be enrolled in only 1 or 2 of the 3 activities.

Thank you for pointing this out. The specific rehabilitation activities were decided at the initial cardiac rehabilitation meeting based on agreed personalised planning of the rehabilitation according to the patients' needs and acceptance. Thus, the patients were enrolled in all three activities if it was deemed relevant. We added a short description of this in the Methods – Outcomes.

8. Is the Charlson comorbidity index automatically calculated in the database or did the authors compute it themselves using the list of codes?

The authors computed the Charlson comorbidity index (CCI) by identifying the International Classification of Diseases, Tenth Revision diagnoses in The Danish National Registry of Patients for each patient up to 10 years before referral for rehabilitation. Danish research shows that the positive predictive value of identifying the conditions included in the CCI through The Danish National Registry of Patient is consistently high.(9) We have modified the description of the CCI in the Methods – Covariables.

9. Are the outcomes clearly defined? The definition of dropout is not clear. It is contradictory in its present form. The authors say: “yes” if the patient did not complete at least one of the three activities, including missing values on all three, and “no” if the patient completed one or more of the three CR activities. If the patient completed one and did not complete two of them, he fits both these conditions (“yes” because he completed at least one and “no” because he completed one or more...). The fact that follow up time is said to end when there is completion of at least one of the three activities (top of page 9) must be in accordance with the revised definition of outcomes. Also, it is not clear how the authors dealt with missing values in some but not all outcomes.

Thank you for making us aware of the unclarity. Accordingly, we have revised the description of dropout in the main document. Furthermore, we state specific numbers in the main document and refer the Figure 1 in order to clarify the definition of the outcomes, please see the Methods – Outcomes. Furthermore, we deleted the specific numbers in the results because it more specifically refer to definition of the outcomes/the methods, please see the Results – No uptake.

10. Are the results presented clearly? Figure 1 needs improvement to show more clearly how many patients were excluded due to missing data, how many were considered for outcome "non-participation" and how many were considered for outcome "dropout". If this intends to be a real flowchart, the box with "dropout" should appear before the outcomes, not after them. The 1568 who attended the first meeting include some non-participants - were these considered for the analysis of dropouts or not?
Thank you for the valuable comment. We have revised figure 1 in order to clarify the patient flow in relation to the two study populations and the outcomes, please see pdf-file encompassing the figure. By detailing the description of outcome 1 (study population 1/no uptake), we provide the numbers necessary to calculate the total number of patients who participated in the initial cardiac rehabilitation meeting within (n=1,511) and not within (n=57) 90 days after the referral (study population 2/dropout). Furthermore, we corrected an error because only 870 patients (and not 781 patients) accepted to participate in patient education. Furthermore, we deleted a footnote to the figure because it was already described in the main text that one municipality (Samsoe) did not offer cardiac rehabilitation and was excluded, please see the section Figure legends.

11. How can someone who attended the closing meeting ever be a dropout?

In the Central Denmark Region, the result evaluations are accomplished at the closing cardiac rehabilitation meeting. Cardiac rehabilitation result evaluation is stated as part of the minimal process-based cardiac rehabilitation metrics by the European Association of Preventive Cardiology cardiac rehabilitation accreditation programme.(10) In the nationwide clinical quality database in Denmark (Danish Cardiac Rehabilitation Database), all outcome evaluations are assessed by six months after the start of rehabilitation, and accordingly, we assessed whether patients participated in the closing meeting within 180 days after the initial cardiac rehabilitation meeting. The data collected in the Danish Cardiac Rehabilitation Database are aligned with other European quality of care measures in order to make sure that data from Denmark can be compared to data from other European countries.(8)

In this study, among the 1,568 patients who participated in the initial cardiac rehabilitation meeting, 70% (n=1,198) of the patients participated in the closing meeting within 180 days, 3% (n=46) participated in the meeting later than 180 days, and 27% (n=424) of the patients did not participate in the closing meeting at all (defined by missing values on the closing meeting). We are aware that the 3% of the patients who participated in the closing meeting later than 180 days after the initial cardiac rehabilitation meeting not only may express poor quality of care, but also may express the clinically appropriate pathway of cardiac rehabilitation; e.g., because the rehabilitation was paused due to hospital admissions or other hindering factors. Unfortunately, we have no data to clarify this. However, by analysing a composite measure of dropout, patients who adhered to ≥ of planned sessions of physical exercise training or patient education were defined as not dropping out regardless of whether they participated in the closing meeting within 180 days.

12. Page 13, line 20 - when the number of completed sessions is presented, it would be useful to know how many were planned/prescribed.

Thank you for the valuable comment. We have included the number of the planned sessions in the main document, please see the Results – Participants.

13. When the authors say 4% of the non-participants died, it doesn't make sense to write "(data not shown)" because this is describing a result. How many participants died?

No participant died during follow-up. The number of deaths is stated to help the interpretation of the adverse outcomes; i.e., why the patients did not take up cardiac rehabilitation (study population 1) or dropped out from cardiac rehabilitation (study population 2).

We revised the main document now stating that we included information on the number of patients who died during follow-up, please see the Methods – Outcomes. Furthermore, we deleted (data not shown), please see the Results - No uptake and the Results – Dropout.
MINOR ISSUES:
14. Page 9: tertiles are the cut-off points, the limits of the categories, not the groups in each category.
Thank you for noticing this. We have revised the description, please refer to the Methods – Socioeconomic status.

15. Is being Danish the ethnicity or nationality?
Thank you for pointing this out. We have rephrased ethnicity to nationality throughout the manuscript.

16. Please check the format of the authors list in reference #3.
We have inserted the correct format of the authors. Furthermore, we revised reference 13 because erroneously, six authors instead of three were listed.

17. Please recheck spelling. For example: page 4: "ARTICLE SUMMERY" should read "ARTICLE SUMMARY"
The error has been corrected. Furthermore, we have made language revision throughout the manuscript. These revisions are marked in the main document and the Supplementary Material by using the track change function, but the exact position of the revisions are not described in this response. Please notify us if requested.

18. Page 7, line 25: "n" missing in immigrants
The error has been corrected.

19. Page 7, line 50: "r" missing in through
The error has been corrected.

20. Do not present standard deviations with ore precision (decimal places) than the mean of the same variable.
We have rounded all means and standard deviations to one decimal place.

21. Page 21, line 37 - it is redundant to say "systematic selection bias". Bias is a systematic error by definition.
Thank you for noticing this. We have deleted the word ‘systematic’ in relation to bias.

REVIEWER: 3
Dr. Ingelise Andersen, Public Health Science Comments to the Author:
This descriptive paper investigates whether SES indicators are associated with CR utilization based on 2018 patients from the Central Denmark Region.
Unsurprisingly the authors find that indicators of SES are important markers of CR utilization.

SPECIFIC COMMENTS:
22. The strengths and limitations mentioned are trivial: The strengths do not differ from the strengths related to Danish register research. The dropout rate is similar to previous studies also from Denmark. The limitations like unmeasured confounding is a problem in all population based studies.
Thank you for drawing attention to this.

We have revised the strengths and limitations in the main document and stressed the principal parts of our study considering the international research because BMJ Open has an international audience. We hope that these amendments make the description of the study's strengths and limitations more pertinent.

Furthermore, we have specified that we compare the demonstrated proportions of no uptake and dropout with those of other countries, please see the Discussion – Strengths and limitations. To best of our knowledge, the numbers of no uptake and dropout in our study are relatively low compared with other countries.

23. p.5 l 31ff it is said that SES indicators have an effect of cardiovascular health. When you talk about effect you talk about causation. Whether SES cause CVD is debatable and thoroughly discussed by among others Johan Mackenback in a number of books and papers. However, it is well documented that SES indicators are associated with cardiovascular health. The mechanisms are usually explained by a number of mediators.

Thank you for pointing this out. We have rewritten the sentence and now use the wording ‘association’ instead of ‘effect’, please see the Introduction, paragraph 3.

24. It would be relevant with some theoretical information on why you chose those four indicators and why you include all four.

Thank you for bringing light to this interesting question.

There is no single best indicator of socioeconomic status that is relevant for all study aims, populations and settings and likewise, no consensus on which parameter to use in different situations.(11, 12) However, four measures of socioeconomic status have been consistently associated with cardiovascular health in high-income countries: income level, educational attainment, employment status, and neighbourhood socioeconomic factors.(12, 13) Furthermore, it has been proposed that the link between socioeconomic status and cardiovascular health is mediated partly by disparities in standards of care.(12, 13) Therefore, we those all four indicators of socioeconomic status to analyse social inequalities in standards of care; i.e., in our study cardiac rehabilitation promoted by Danish and international clinical guidelines.(14) To clarify this, we made an amendment in the Methods – Socioeconomic status.

Furthermore, each indicator of socioeconomic status measures conceptually different, but often interrelated aspects of socioeconomic status.(11) We analysed all indicators separately in order to assess their individual associations with non-utilisation of cardiac rehabilitation, but we are aware that the demonstrated associations cannot be interpreted in isolation. However, our study and a Danish study from 2021 suggest that disposable income has a stronger association with non-referral and non-utilisation of cardiac rehabilitation compared with e.g. a person's educational level which imply the relevance of studying each indicator of socioeconomic status separately.(12)

25. Among the activities in CR you include three. Why these three?? In a paper by Pedersen et al European Journal of Cardiovascular Nursing, 17(4), 345–355 it is shown that patients to a smaller degree participate in the activities exercise and patient educational program. It would improve the paper with at table showing in which parts of the program the patients participate

The three cardiac rehabilitation activities defining dropout; e.g., physical exercise training, patient education and the closing cardiac rehabilitation meeting, were selected based on the available
Strong evidence demonstrates that, among patients with ischemic heart disease, exercise-based cardiac rehabilitation reduces cardiovascular hospitalisations and mortality and improve health-related quality of life, and psychological- and education-based interventions may well improve health-related quality of life. Furthermore, cardiac rehabilitation result evaluation is stated as part of the minimal process-based cardiac rehabilitation metrics by the European Association of Preventive Cardiology cardiac rehabilitation accreditation programme. In the Central Denmark Region, the result evaluations are accomplished at the closing cardiac rehabilitation meeting and therefore, we included this in the definition of dropout. We made an amendment in the main document in order to clarify this, please see the Methods – Setting and participants, paragraph 1.

Furthermore, we included a table in the Supplementary Material showing in which parts of the cardiac rehabilitation program the patients accept to participate, please see the Supplementary Material – Supplementary Table 1. We have described the results in the main document, please see the Results – Participants. Furthermore, we corrected the revised table numbering of the Supplementary Tables throughout the manuscript.

26. Results: A descriptive table is missing including how many patients participated in the different elements of CR.

Please see our response for the comment 24.

27. In addition, for the ease of the reader table 1 should include a column showing the n and % of participants in each SES group.

We have inserted a column as requested. Due to our rewording of the aim (please see our response for the comment 27), we have shown the n and % of the patients with no uptake and stated in a footnote that the inverse percentage, that adds up to 100%, represents the patients taking up cardiac rehabilitation in the specific category of the indicator of socioeconomic status, please see Table 1 in the main document. To ensure consistency, we have revised the Supplementary Table 2 accordingly (also, we corrected a linguistic error and a decimal number), please see the paragraph regarding Supplementary Table 2 in the Supplementary Material.

28. Since the aim is to investigate the association between SES and participation in CR a table showing the OR between SES and participation would be obvious. Tables 2 and 3 are insufficient. This would qualify the discussion by showing whether the social gradient differ between participation, drop out and non-attendance.

Thank you for making us aware of the ambiguity in the definition of the aim of the study. Erroneous, we stated that the aim was to examine whether indicators of socioeconomic status are associated with the ‘utilisation’ of CR, but the true aim was to examine whether indicators of socioeconomic status are associated with the ‘non-utilisation’ of cardiac rehabilitation defined ‘no uptake’ of and ‘dropout’ from CR. Accordingly, we have rephrased the aim of the study and now specifically state throughout the manuscript that the studied outcomes are defined by ‘no uptake’ of cardiac rehabilitation (changed from non-participation) and ‘dropout’ from cardiac rehabilitation. Thereby, all the individual ORs between the four indicators of socioeconomic status and not taking up (Table 2), dropout (Table 3) and non-attendance (Supplementary table 3) are displayed. We have marked the rephrasing of the outcomes in the main document and the Supplementary Material by using the track change function, but we do not state specifically in this response where the amendments have been made because of the large number of revisions. We are willing to do so if requested. Please be aware that the title of the study was changed due to the revisions.
29. In the analyses, it is not clear to me why you do not control for all the SES variables – as proposed by Galobardes et al,

Thank you for pointing this out. We did not control for all the indicators of socioeconomic status for several reasons. First, each indicator of socioeconomic status measures conceptually different, but often interrelated aspects of socioeconomic status. Therefore, by including all four indicators in the same statistical models, there will be high risk of introducing collinearity and thus, high risk that the analyses would yield model coefficients with large variances causing the point estimates to be unstable. Secondly, it is difficult to separate the ‘effects’ of collinear variables statistically and therefore, it will be problematic to control for the remaining three indicators apart from the one under study.

Please refer to our response for comment 23 for further details.

30. Discussion p.21 l 12. What does all phases of CR mean?

Thank you for noticing this. We are aware that the phases of cardiac rehabilitation are not unambiguously defined across countries; e.g., the pre-surgery phase is not always considered. Therefore, we believe that a more adequate description is ‘the cardiac rehabilitation pathway’. We have revised the main document accordingly, please see the Discussion – The indicators of socioeconomic status, paragraph 4, the Discussion – Generalisability, and the Conclusions.

31. In the discussion, you refer to some of your own unpublished papers. However, since there are published papers on the same topic it would be more relevant to refer to peer-reviewed papers.

Thank you for noticing this. From the time when submitting this manuscript, the papers has been accepted and assigned a doi. In the main document, we have rewritten the text to improve the language and reduce word count, and now refer to the articles in the reference list, please see the Discussion – Perspectives.

32. A discussion on how the four SES indicators contribute to the result is warranted.

In order to improve the transparency of the manuscript, we have inserted subheadings in the Discussion including Strengths and limitations, No uptake and dropout, The indicators of socioeconomic status, Perspectives, and Generalisability. In the paragraph The indicators of socioeconomic status, we discuss how the four indicators contribute to the results. We made several revisions under this subheading to clarify the interpretation of the results. Furthermore, we moved some text from the beginning of the discussion to this paragraph, please see the Discussion - The indicators of socioeconomic status.

33. P 22 last line it is said that the study provides new evidence. However, it is a bit difficult to find the novelty in the paper. Social inequality in CR rehabilitation is well documented, also in research from Denmark. To keep this statement you need to prove in the discussion in which way the paper brings new information.

Thank you for pointing this out. To best of our knowledge, until now most research on social inequality in cardiac rehabilitation has been conducted in hospital-based settings and primarily focused on the uptake of cardiac rehabilitation rather than dropout. However, we are aware of the existing research. Therefore, we revised the manuscript and now state that our study expands the sparse evidence that firstly, the SES indicators are important in the cross-sectoral referral process for CR and secondly, that the indicators are significant risk factors for dropout, please see the Discussion – The indicators
of socioeconomic status, paragraph 2.

ADDITIONAL REVISIONS

Please be aware that we deleted some text in the main document. The amendments in the revised main manuscript made it necessary to limit word count.

Therefore, the text mentioned below was deleted:

Methods – Outcomes:
‘Clinicians in the primary healthcare setting receive continuous feedback concerning their performance using quality measures, and annual reports are publicly available.(8, 17)’

Methods – Statistical methods:
‘Notably, the data distribution for the number of days from the initial CR meeting until the closing meeting was right skewed, while the data distributions for the completed sessions of physical exercise training and patient education were slightly left skewed.’

Discussion, paragraph 1:
‘and thus, augments the evidence of social inequality in the CR pathway.(12)’

Discussion – Strengths and limitations:
‘This was enabled by the Danish nationwide registration of tax-financed services within the universal healthcare, education, and social welfare.’

Discussion – Strengths and limitations:
‘The documentation of CR in the primary healthcare setting was systematically supported by education of the clinicians, registration manuals, and annual audits. Nevertheless, bias due to misclassification remains a concern due to the registration of data by numerous professionals in diverse primary healthcare settings. It is likely that such misclassification is non-differential and would bias the results towards the null, thereby decreasing the strength of associations.(18)’

Discussion – The indicators of socioeconomic status.
‘… and patient education (adjusted OR: 1.24, 95% CI: 0.79–1.97) versus high educational level’

REFERENCES
1. Schmidt M, Schmidt SAJ, Adelborg K, et al. The Danish health care system and epidemiological research: from health care contacts to database records. Clin Epidemiol 2019;11:563-91.
2. Bloomfield K, Berg-Beckhoff G, Seid AK, et al. Area-level relative deprivation and alcohol use in Denmark: Is there a relationship? Scand J Public Health 2019;47(4):428-38.
3. Visseren FLJ, Mach F, Smulders YM, et al. 2021 ESC Guidelines on cardiovascular disease prevention in clinical practice. Eur J Prev Cardiol 2022;29(1):5-115.
4. Baadsgaard M, Quitzau J. Danish registers on personal income and transfer payments. Scand J Public Health 2011;39(7 Suppl):103-5.
5. Statistic Denmark. SOCIO13. https://www.dst.dk/da/Statistik/dokumentation/Times/personindkomst/socio13 (4 October 2021).
6. Regionernes kliniske kvalitetsudviklingsprogram. Dansk hjerterehabilitering aarsrapport 2020, 1 juni 2020-31. maj 2021. Aarhus: Regionernes kliniske kvalitetsudviklingsprogram 2021. Contract No.: Report.
7. Cowie A, Buckley J, Doherty P, et al. Standards and core components for cardiovascular disease prevention and rehabilitation. Heart 2019;105(7):510-5.
8. Zwisler AD, Rossau HK, Nakano A, et al. The Danish Cardiac Rehabilitation Database. Clin
Epidemiol 2016;8:451-6.
9. Thygesen SK, Christiansen CF, Christensen S, et al. The predictive value of ICD-10 diagnostic coding used to assess Charlson comorbidity index conditions in the population-based Danish National Registry of Patients. BMC med res methodol 2011;11:83.
10. Abreu A, Frederix I, Dendale P, et al. Standardization and quality improvement of secondary prevention through cardiovascular rehabilitation programmes in Europe: The avenue towards EAPC accreditation programme: A position statement of the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology (EAPC). Eur J Prev Cardiol 2020: doi: 10.1177/2047487320924912.
11. Galobardes B, Shaw M, Lawlor DA, et al. Indicators of socioeconomic position (part 1). JECH 2006;60(1):7-12.
12. Graversen CB, Johansen MB, Eichhorst R, et al. Influence of socioeconomic status on the referral process to cardiac rehabilitation following acute coronary syndrome: a cross-sectional study. BMJ Open 2020;10(4):e036088.
13. Schultz WM, Kelli HM, Lisko JC, et al. Socioeconomic Status and Cardiovascular Outcomes: Challenges and Interventions. Circulation 2018;137(20):2166-78.
14. Visseren FLJ, Mach F, Smulders YM, et al. 2021 ESC Guidelines on cardiovascular disease prevention in clinical practice. Eur Heart J 2021;42(34):3227-337.
15. Anderson L, Taylor RS. Cardiac rehabilitation for people with heart disease: an overview of Cochrane systematic reviews. Cochrane Database of Systematic Reviews 2014;12:CD01127.
16. Rothman KJ, Greenland S, Lash TL. Modern epidemiology. Third edition. Lippincott Williams & Wilkins; 2008.
17. DEFACTUM. Opgørelse af kommunale hjerterehabiliteringsindikatorer. Rapportering af data fra HjerteKomMidt i den midtjyske region for perioden 1. januar 2018 til 31. december 2018. Aarhus: DEFACTUM; 2019. Contract No.: Report.
18. Rothman KJ, Greenland S, Lash TL. Modern epidemiology. Third edition. Lippincott Williams & Wilkins; 2008. p. 115.

VERSION 2 – REVIEW

| REVIEWER       | Salzwedel, Annett |
|----------------|-------------------|
| REVIEW RETURNED| 29-Mar-2022       |

GENERAL COMMENTS
I think the authors have carefully revised the manuscript, which is now very clear. My comments have been sufficiently taken into account. I have no further comments.

| REVIEWER       | Andersen, Ingelise |
|----------------|---------------------|
| REVIEW RETURNED| 05-Apr-2022         |

GENERAL COMMENTS
The manuscript has absolutely improved by the revision. Even though I agree with the authors that the different SES indicators may cause collinearity if analyzed in the same model, I still think it is informative with an analysis including all four SES measurements. You do not get information on the total social gradient by only including one parameter. Furthermore, a correlation between the indicators would underscore the statement, that the variables are interrelated. Lastly, it is unusual not to include cohabitation status in all analyses.
REVIEWER: 1
Dr. Annett Salzwedel, University of Potsdam
Comments to the Author: I think the authors have carefully revised the manuscript, which is now very clear. My comments have been sufficiently taken into account. I have no further comments.

REVIEWER: 2
Dr. Ana Azevedo, University of Porto Medical School
Comments to the Author: None

REVIEWER: 3
Dr. Ingelise Andersen, Public Health Science
Comments to the Author: The manuscript has absolutely improved by the revision.

1. Even though I agree with the authors that the different SES indicators may cause collinearity if analyzed in the same model, I still think it is informative with an analysis including all four SES measurements. You do not get information on the total social gradient by only including one parameter. Furthermore, a correlation between the indicators would underscore the statement, that the variables are interrelated.

We made two sensitivity analyses including all four SES indicators in the adjusted logistic regression model in addition to age, sex, nationality, and Charlson Comorbidity Index: one sensitivity analysis focusing on not taking up cardiac rehabilitation, and one sensitivity analysis focusing on dropout from cardiac rehabilitation. As could be expected, these analyses showed that by mutual adjustment for the assumed interrelated aspects of socioeconomic status, the point estimates of each SES indicator changed towards the null. We have included two Supplementary Tables in the Supplemental Material and described the analyses and the results in the main document, please see the Methods – Statistical methods, paragraph 2, and the Results – Sensitivity analyses.

2. Lastly, it is unusual not to include cohabitation status in all analyses. We agree that it is often relevant to include marital status or cohabitant status in the analyses as a potential confounding factor. However, environmental factors including social support are well-established aspects of socioeconomic status in relation to cardiovascular health. In our study, we therefore addressed the indicator of socioeconomic status "Living alone" as a proxy for social support rather than addressing marital status; i.e., being single, married/in a civil partnership, separated, divorced, or widowed. (1, 2) We believe that including the variable "Living alone" in all analyses would be problematic because social support is recognised as an aspect of socioeconomic status in relation to cardiovascular health and each indicator of socioeconomic status is assumed to be interrelated aspects of socioeconomic status. (3) Furthermore, it is difficult to separate the ‘effects’ of collinear variables statistically and therefore, it will be problematic to control for cohabitation status when analysing the remaining indicators of socioeconomic status. (4) Therefore, we did not include cohabitation status in all the adjusted analyses. As a check, we repeated the adjusted logistic regression analyses focusing on not taking up cardiac rehabilitation with additional adjustment for cohabitation status, please see Table 1 below. Expectedly, we found that the point estimates of the association between each indicator of socioeconomic status and not taking up cardiac rehabilitation changed towards the null; however, to a less extend than the analyses including all indicators of socioeconomic status (please refer to our response, point 1 and the Supplementary Material.
Table 1. Associations between socioeconomic status and dropout from cardiac rehabilitation (CR) among participants in the initial CR meeting (n=1,568): adjustment for cohabitation status
Please see the uploaded file.

REFERENCES
1. Schultz WM, Kelli HM, Lisko JC, et al. Socioeconomic Status and Cardiovascular Outcomes: Challenges and Interventions. Circulation 2018;137(20):2166-78.
2. Pedersen CB. The Danish Civil Registration System. Scand J Public Health 2011;39(7 Suppl):22-5.
3. Galobardes B, Shaw M, Lawlor DA, et al. Indicators of socioeconomic position (part 1). J Epidemiol Community Health 2006;60(1):7-12.
4. Rothman KJ, Greenland S, Lash TL. Modern epidemiology. Third edition. Lippincott Williams & Wilkins; 2008.