

## PEER REVIEW HISTORY

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### ARTICLE DETAILS

<b>TITLE (PROVISIONAL)</b>	Development and validation of the Global Adolescent And Child Physical Activity Questionnaire (GAC-PAQ) in 14 countries: Study protocol
<b>AUTHORS</b>	Larouche, Richard; Rostami Haji Abadi, Mahdi; Aubert, Salomé; Bhawra, Jasmin; Brazo-Sayavera, Javier; Carson, Valerie; Colley, Rachel; Nyström, Christine; Esliger, Dale; Harper-Brown, Ryan; Gonzalez Cifuentes, Silvia Alejandra; Jáuregui, Alejandra; Katewongsa, Piyawat; Khadilkar, Anuradha; Kira, Geoff; Kuzik, Nicholas; Liu, Yang; Lof, Marie; Loney, Tom; Manyanga, Taru; Mwase-Vuma, Tawonga; Oyeyemi, Adewale; Reilly, John; Richards, Justin; Roberts, Karen; Sarmiento, Olga; Silva, Diego Augusto Santos; Smith, Melody; Subedi, Narayan; Vanderloo, Leigh M.; Widyastari, Dyah Anantalia; Wilson, Oliver; Wong, S; Tremblay, Mark

### VERSION 1 – REVIEW

<b>REVIEWER</b>	Sobh, Zahraa Alexandria University, forensic medicine and clinical toxicology
<b>REVIEW RETURNED</b>	02-Dec-2023

<b>GENERAL COMMENTS</b>	<p>Thank you for inviting me to review the study protocol (Development and validation of the Global Adolescent And Child Physical Activity Questionnaire (GAC-PAQ) in 14 countries: Study protocol). This international study consists of eight stages; the first three stages were finished. Currently, the authors are conducting stage 4 (Stage 4. Cognitive interviews in 14 countries).</p> <ul style="list-style-type: none"> <li>• The idea is good, and the significance of the study [research gap and research questions ] was mentioned at the end of the introduction.</li> <li>• The methods of the current study protocol are perfect, and all essential elements of sound methodology were carefully addressed, including ethical considerations, selection of countries, sampling methods, Sample Size Justification, and validation.</li> <li>• The language and manner of presentation are excellent.</li> </ul> <p>I have some comments to enhance the study protocol further.</p> <p><input type="checkbox"/> Major issues:</p> <p><b>ETHICS AND DISSEMINATION:</b> On page 25, it was mentioned that [Ethical approval has been or will be obtained for all stages requiring human participants from institutional review boards of all institutions with researchers involved in data collection]. Currently, the authors are conducting stage 4, including cognitive interviews that need ethical approval. So, it is advisable to mention the ethics committee(s) that approved the conduction of this step and other ongoing steps (mention IRB, FWA, and protocol registration numbers).</p>
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	<p>☐ Minor issues:</p> <ul style="list-style-type: none"> <li>-Adding a PRISMA flow diagram of the conducted systematic reviews is better.</li> <li>-(Strengths and Limitations of this Study). This section seems to be paragraphs rather than bullet points; summarising it is better.</li> <li>-The introduction and aim within the structured abstract contain numbering [1), 2), 3) ]. These numbers are better to be removed and written as a continuous paragraph.</li> </ul>
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<b>REVIEWER</b>	Phiri, Yohane Vincent Abero University at Buffalo School of Public Health and Health Professions, Epidemiology and Environmental Health
<b>REVIEW RETURNED</b>	05-Dec-2023

<b>GENERAL COMMENTS</b>	<p>BMJ Open Review Comments:</p> <p>The study protocol represents work that is vital to the field. There is currently no standard method for assessing physical activity in adolescents and children that is suitable for both developed and developing countries. Most instruments for assessing children's physical activity have been developed and tested in developed countries. I sincerely recommend the publication of this work. However, below are some concerns:</p> <ol style="list-style-type: none"> <li>1. Abstract (lines 5–24) and introduction (page 7, lines 53–55, page 8, lines 1–15). The authors emphasize that the current Global PAQ is justified because most previously developed PAs were from high-income countries. Interestingly, the authors explain that the current study is designed to recruit participants from low- and middle-income countries to ensure that the Global PAQ captures socioeconomic and demographic characteristics of populations in developing countries, which may not have been the case in previous PAQs.</li> </ol> <p>LMICs have the least amount of access to ICT services. According to the 2019 Malawi National Household Survey on ICT, only 14.6 percent of the population had access to these services, including the internet and mobile phones. In urban areas, 40.7 percent of individuals had internet access, compared to only 9.3 percent in rural areas. Given this information, how do research teams in countries like Malawi plan to address any biases that may arise from participants using electronic devices while completing the questionnaire on the APP? Will schools be pre-enrolled in the main study? What criteria will be used to determine if a school is rural or urban in an LMIC country, considering that some peri-urban areas may share similarities with rural schools? Are regional differences within a country to be considered in the recruitment of the main study participants?</p> <ol style="list-style-type: none"> <li>2. Study design (Page 9, line 50): Stage 1 involved conducting a systematic review of the psychometric properties of physical activity questionnaires.</li> </ol> <p>This approach was commendable. It is of interest to know if the PAs employed in the LMIC were modified versions of those developed in developed countries. If so, were any meta-analysis results generated to evaluate the overall effect of the included studies, considering the socio-demographic characteristic and location of the study? Did the results suggest the need for PA based on region or SES? Are there any intentions to distribute</p>
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	<p>these findings as proof for validating the main research? Additionally, students in LMICs must walk longer distances to reach schools. Was this variable investigated in the meta-analysis? How was it taken into account in the development of the new questionnaire?</p> <p>1. Table 2. Stages of the Global Adolescent and Child Physical Activity Questionnaire (GAC-PAQ) (Page 13 Line 29/30).</p> <p>You mentioned that 63 out of a total of 137 experts (46%) responded to your invitation to assess the content validity of the Global PAQ. Was the invitation accompanied by a form to determine the reasons for their non-participation in the assessment? Since the response rate was below 50%, it is important to investigate why the contacted individuals chose not to participate.</p> <p>2. Supplementary File 2. Global Adolescent and Children Physical Activity Questionnaire (GAC-PAQ) draft used for cognitive interviews.</p> <p>Would it be possible to include pictures and diagrams in the GAC PAQ that accurately represent the reality in disadvantaged societies, particularly if the questionnaire is to be given to students in LMIC? The pictures and diagrams in supplementary file 2 currently show what you would typically observe in high-income schools. It may be beneficial to collaborate with local partners in order to accurately depict the intended activities of the targeted audience.</p>
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<b>REVIEWER</b>	Ling, Fiona Northumbria University
<b>REVIEW RETURNED</b>	03-Feb-2024

<b>GENERAL COMMENTS</b>	<p>This manuscript describes the protocol for the development and validation of GAC-PAQ. I highly commend the rigor of the proposed project, from sampling considerations (eg. cultural appropriateness/sensitivity, inclusion of LMIC) to app design (eg. app accessibility, PPI) to variable considerations, and not least the clarity of the manuscript. The project will contribute significantly to global comparisons of PA, as well as potential influential factors of PA that might, or might not be, cultural-specific. Below are some points for improvement –</p> <p>1. Whilst there is a plan in place for the administration of the questionnaires in the validation phase, it is not clear if the final version of the GAC-PAQ is designed to be self-administered, or an administrator will be required to facilitate its completion. If it is designed to be self-administered (which could be more likely outside of school setting), how can the researchers ensure that the youngest children can comprehend the instructions, questions and responses without support from adults? And if GAC-PAQ is not designed to be self-administered, there needs to be specific instructions that the completion of GAC-PAQ must be facilitated by an ‘administrator’, at least for the youngest age group.</p> <p>2. How will GAC-PAQ be scored?</p> <p>3. Figure 2 shows that convergent validity will be ascertained by examining the children and parent responses. Please indicate this</p>
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	<p>in the manuscript, as this justifies the sample size calculation for the child-parent dyad.</p> <p>4. Under 'Stage 3 Assessment of content validity' (p15), should the socio-demographic information include sex, and not gender? As the project is very specific about the difference between the 2 terminologies, it makes me wonder which is more appropriate for the purpose of this assessment.</p>
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### VERSION 1 – AUTHOR RESPONSE

Reviewer: 1

Dr. Zahraa Sobh, Alexandria University

Comments to the Author:

Dear Editor

Thank you for inviting me to review the study protocol (Development and validation of the Global Adolescent And Child Physical Activity Questionnaire (GAC-PAQ) in 14 countries: Study protocol). This international study consists of eight stages; the first three stages were finished. Currently, the authors are conducting stage 4 (Stage 4. Cognitive interviews in 14 countries).

- The idea is good, and the significance of the study [research gap and research questions ] was mentioned at the end of the introduction.
- The methods of the current study protocol are perfect, and all essential elements of sound methodology were carefully addressed, including ethical considerations, selection of countries, sampling methods, Sample Size Justification, and validation.
- The language and manner of presentation are excellent.

Authors' response: We thank the reviewer for these comments.

I have some comments to enhance the study protocol further.

v Major issues:

ETHICS AND DISSEMINATION: On page 25, it was mentioned that [Ethical approval has been or will be obtained for all stages requiring human participants from institutional review boards of all institutions with researchers involved in data collection]. Currently, the authors are conducting stage 4, including cognitive interviews that need ethical approval. So, it is advisable to mention the ethics committee(s) that approved the conduction of this step and other ongoing steps (mention IRB, FWA, and protocol registration numbers).

Authors' response: We have added the names of IRBs and protocol numbers in a new table (Supplementary File 3). We believe that the acronym FWA stands for Federalwide Assurance in the United States. Because our project does not include the United States, this does not apply.

v Minor issues:

-Adding a PRISMA flow diagram of the conducted systematic reviews is better.

Authors' response: The systematic review has now been submitted for publication to *Sports Medicine* on February 7, 2024" and contains the full PRISMA chart, so we cannot reproduce it here.

-(Strengths and Limitations of this Study). This section seems to be paragraphs rather than bullet points; summarising it is better.

Authors' response: We have shortened the statements in this section. We are open to further suggestions from the Associate Editor about the preferred format for the journal.

-The introduction and aim within the structured abstract contain numbering [1), 2), 3) ]. These numbers are better to be removed and written as a continuous paragraph.

Authors' response: We removed the numbers in the introduction section of the abstract. We kept the numbers in the methods and analysis section because they are used for an exhaustive list of the study stages.

Reviewer: 2

Dr. Yohane Vincent Abero Phiri, University at Buffalo School of Public Health and Health Professions  
Comments to the Author:

The study protocol represents work that is vital to the field. There is currently no standard method for assessing physical activity in adolescents and children that is suitable for both developed and developing countries. Most instruments for assessing children's physical activity have been developed and tested in developed countries. I sincerely recommend the publication of this work. See document attached.

Authors' response: We thank the reviewer for these comments.

Abstract (lines 5–24) and introduction (page 7, lines 53–55, page 8, lines 1–15). The authors emphasize that the current Global PAQ is justified because most previously developed PAs were from high-income countries. Interestingly, the authors explain that the current study is designed to recruit participants from low- and middle-income countries to ensure that the Global PAQ captures socioeconomic and demographic characteristics of populations in developing countries, which may not have been the case in previous PAQs. LMICs have the least amount of access to ICT services. According to the 2019 Malawi National Household Survey on ICT, only 14.6 percent of the population had access to these services, including the internet and mobile phones. In urban areas, 40.7 percent of individuals had internet access, compared to only 9.3 percent in rural areas. Given this information, how do research teams in countries like Malawi plan to address any biases that may arise from participants using electronic devices while completing the questionnaire on the APP? Will schools be pre-enrolled in the main study? What criteria will be used to determine if a school is rural or urban in an LMIC country, considering that some peri-urban areas may share similarities with rural schools? Are regional differences within a country to be considered in the recruitment of the main study participants?

Authors' response: Thank you for these observations. Access to ICT services is increasing rapidly in LMICs, so we believe that statistics from five years ago may no longer represent the reality. Nonetheless, here we outline our strategy to address the lack of access to mobile devices, which as you suggested, varies by country and urban/rural location. Country lead investigators will be invited to consider the best approach for collecting the data in their country. In all countries, children and adolescents will complete the questionnaire on tablets that we purchased for the study. In many high-income countries, parents will be asked to complete the questionnaire in the app using their own device, but in some low- and middle-income countries, investigators are planning to invite parents to the school (or other data collection sites) to complete the questionnaire on our tablets. The pilot-study will give us an opportunity to test the app procedures before the main study. The policies around the recruitment of schools vary both within and between countries, so a one-size-fits-all approach is impossible. Definitions of urban vs. rural areas vary between countries. As discussed in the manuscript, country investigators will use the method that is accepted in their country to distinguish urban and rural areas and will consult with experts (e.g., urban planners or geographers) in the case

that there is not a strict quantitative rule that can be used to differentiate them. Because peri-urban/suburban areas are near the centre of the continuum between rural and urban areas and more difficult to operationalize consistently between countries, we will recruit schools in urban and rural areas only. While funding is insufficient to recruit nationally representative samples, many countries will recruit participants in regions that differ in characteristics such as weather, topography, and language spoken as indicated in Table 1 and Table 3.

To address the reviewer's comment, we added the following sentences under Stage 7 (pages 15-16): "For Stages 7 and 8, children and adolescents will complete the questionnaire on tablets provided by the study team. Country investigators will be asked to consider the best way for the parents to complete the questionnaire (e.g., on their own time on their phone or tablet vs. in-person on tablets purchased for the study) based on considerations such as access to mobile devices.". Before this sentence, we also added: "Because peri-urban/suburban areas are near the centre of the continuum between rural and urban areas and more difficult to operationalize consistently between countries, we will recruit schools in urban and rural areas only".

2. Study design (Page 9, line 50): Stage 1 involved conducting a systematic review of the psychometric properties of physical activity questionnaires. This approach was commendable. It is of interest to know if the PAs employed in the LMIC were modified versions of those developed in developed countries. If so, were any metaanalysis results generated to evaluate the overall effect of the included studies, considering the socio-demographic characteristic and location of the study? Did the results suggest the need for PA based on region or SES? Are there any intentions to distribute these findings as proof for validating the main research? Additionally, students in LMICs must walk longer distances to reach schools. Was this variable investigated in the meta-analysis? How was it taken into account in the development of the new questionnaire?

Authors' responses: Many of the questionnaires whose psychometric properties were assessed in LMICs were developed in high-income countries. There was large heterogeneity in the methods and statistical analyses used in the included studies, so the review did not include a meta-analysis. The systematic review was conducted according to the COSMIN guidelines and the manuscript has been submitted for publication to *Sports Medicine*. In general, the results support the need for developing a new questionnaire that aims to address these gaps. Our new questionnaire includes questions on time spent engaging in active transportation to school, work (if applicable), and other places, whereas previous questionnaires typically assessed only transportation to school.

We added the following sentence under Stage 1 (page 8) to address the reviewer's comment: "Many of the included questionnaires whose psychometric properties were assessed in LMICs were developed in high-income countries, often with limited cultural adaptation, so results of the systematic review (submitted for publication) support the need for developing a new PA questionnaire."

1. Table 2. Stages of the Global Adolescent and Child Physical Activity Questionnaire (GAC-PAQ) (Page 13 Line 29/30). You mentioned that 63 out of a total of 137 experts (46%) responded to your invitation to assess the content validity of the Global PAQ. Was the invitation accompanied by a form to determine the reasons for their non-participation in the assessment? Since the response rate was below 50%, it is important to investigate why the contacted individuals chose not to participate.

Authors' response: As per our ethical requirements, we could not collect data on individuals who chose not to participate. We have acknowledged more clearly that the response rate was relatively low in Table 2. We say relatively low given the context that experts were contacted by email and were not invited to be co-authors of the manuscript that will report the content validation and cognitive interview results in more details (i.e., this was not a Delphi survey).

2. Supplementary File 2. Global Adolescent and Children Physical Activity Questionnaire (GAC-PAQ) draft used for cognitive interviews. Would it be possible to include pictures and diagrams in the GAC PAQ that accurately represent the reality in disadvantaged societies, particularly if the questionnaire is to be given to students in LMIC? The pictures and diagrams in supplementary file 2 currently show what you would typically observe in high-income schools. It may be beneficial to collaborate with local partners in order to accurately depict the intended activities of the targeted audience.

Authors' response: The images used in the draft for the cognitive interviews were just placeholder images to give participants an idea of what things could look like in the app. Indeed, some participants in the cognitive interview studies suggested that we include contextually relevant pictures/images. For the pilot-study and the main study, the images will be country-specific and will represent diversity in characteristics such as child age, sex, body size, ethnicity, and (dis)ability as indicated under "Stage 6". The images will also represent activities that are common in each country. We believe that this manuscript should show the images that were employed in the cognitive interviews for transparency.

Reviewer: 3

Dr. Fiona Ling, Northumbria University

Comments to the Author:

This manuscript describes the protocol for the development and validation of GAC-PAQ. I highly commend the rigor of the proposed project, from sampling considerations (eg. cultural appropriateness/sensitivity, inclusion of LMIC) to app design (eg. app accessibility, PPI) to variable considerations, and not least the clarity of the manuscript. The project will contribute significantly to global comparisons of PA, as well as potential influential factors of PA that might, or might not be, cultural-specific. Below are some points for improvement –

Authors' response: We thank the reviewer for these comments.

1. Whilst there is a plan in place for the administration of the questionnaires in the validation phase, it is not clear if the final version of the GAC-PAQ is designed to be self-administered, or an administrator will be required to facilitate its completion. If it is designed to be self-administered (which could be more likely outside of school setting), how can the researchers ensure that the youngest children can comprehend the instructions, questions and responses without support from adults? And if GAC-PAQ is not designed to be self-administered, there needs to be specific instructions that the completion of GAC-PAQ must be facilitated by an 'administrator', at least for the youngest age group.

Author's response: The GAC-PAQ is designed to be self-administered using the app which will include narration of the questionnaire in different languages and country-specific images representing the different types of physical activity. As stated in the manuscript, Tremblay and colleagues (reference #38 of the manuscript) have previously found that Canadian children as young as  $7.7 \pm 0.5$  years could recall their previous day physical activity reasonably accurately when facilitative video cues were provided. Our large sample size for the main study will allow us to examine the psychometric properties of the GAC-PAQ by age and determine if there's an age below which answers do not achieve sufficient reliability and/or validity. Our plans to examine how reliability and validity vary by age were already indicated near the end of the "Objective 1" paragraph under "Statistical analyses". The cognitive interviews have also helped us to simplify the terms used in the questionnaire.

We added the following sentence in the manuscript under Stage 5 (page 14): "Inclusion of narration and images also aims to facilitate use of the GAC-PAQ as a self-administered survey in future research."

2. How will GAC-PAQ be scored?

Authors' response: As part of the main study (stage 8), we plan to test different ways to score and calibrate the GAC-PAQ against ActiGraph accelerometer data to determine the best approach. We believe that scoring of the GAC-PAQ is beyond the scope of this protocol manuscript and warrants a separate, much more detailed paper.

3. Figure 2 shows that convergent validity will be ascertained by examining the children and parent responses. Please indicate this in the manuscript, as this justifies the sample size calculation for the child-parent dyad.

Authors' response: We added the following sentence in the statistical analyses section (page 22): "We will also assess convergent validity of the GAC-PAQ by comparing scores from children/adolescents and parents/guardians)."

4. Under 'Stage 3 Assessment of content validity' (p15), should the socio-demographic information include sex, and not gender? As the project is very specific about the difference between the 2 terminologies, it makes me wonder which is more appropriate for the purpose of this assessment.

Authors' response: We asked participants in the content validation survey to report their gender, but not their sex. So, the description of stage 3 is in line with what was done.

**VERSION 2 – REVIEW**

<b>REVIEWER</b>	Sobh, Zahraa Alexandria University, forensic medicine and clinical toxicology
<b>REVIEW RETURNED</b>	14-Apr-2024
<b>GENERAL COMMENTS</b>	All comments were carefully considered and required modifications were conducted. I recommended publication.
<b>REVIEWER</b>	Phiri, Yohane Vincent Abero University at Buffalo School of Public Health and Health Professions, Epidemiology and Environmental Health
<b>REVIEW RETURNED</b>	10-Apr-2024
<b>GENERAL COMMENTS</b>	Thank you for your detailed responses. All my previously raised concerns have been adequately addressed.
<b>REVIEWER</b>	Ling, Fiona Northumbria University
<b>REVIEW RETURNED</b>	23-Apr-2024
<b>GENERAL COMMENTS</b>	Thanks to the authors' responses to my queries for the previous version of the manuscript. However, there are a couple of responses I would like further clarifications.  1. Scoring of GAC-PAQ The authors mentioned that in stage 8 (as presented in Fig 2), the scoring of the questionnaire will be tested. However, what has been presented in Stage 8 is testing of the psychometric



	<p>properties, and not so much about testing the scoring - the questionnaire results need to be scored first before the psychometric properties can be tested. Can the authors clarify the process pls?</p> <p>2. Regarding using the terminology 'gender' instead of 'sex' under Stage 3, I still wonder the purpose asking about gender, partly because children may treat it as 'sex' anyway, and I also wonder if most children are aware of their gender even if they can differentiate between the 2 terminologies? Maybe to help them to differentiate between the terminologies, 'sex' can be added too?</p>
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## VERSION 2 – AUTHOR RESPONSE

Reviewer: 1

Dr. Zahraa Sobh, Alexandria University

Comments to the Author:

All comments were carefully considered and required modifications were conducted. I recommended publication.

Authors' response: Thank you for reviewing our manuscript.

Reviewer: 2

Dr. Yohane Vincent Abero Phiri, University at Buffalo School of Public Health and Health Professions

Comments to the Author:

Thank you for your detailed responses. All my previously raised concerns have been adequately addressed.

Authors' response: Thank you for reviewing our manuscript.

Reviewer: 3

Dr. Fiona Ling, Northumbria University

Comments to the Author:

Thanks to the authors' responses to my queries for the previous version of the manuscript. However, there are a couple of responses I would like further clarifications.

Authors' response: Thank you for reviewing our manuscript.

### 1. Scoring of GAC-PAQ

The authors mentioned that in stage 8 (as presented in Fig 2), the scoring of the questionnaire will be tested. However, what has been presented in Stage 8 is testing of the psychometric properties, and not so much about testing the scoring - the questionnaire results need to be scored first before the psychometric properties can be tested. Can the authors clarify the process pls?

Authors' response: We agree that the questionnaire needs to be scored, but we think it is still premature to do so at this time, because the questions and response options may change based on the feedback received in the pilot study (stage 7). In the previous round of review, we indicated in our response to reviewers that "As part of the main study (stage 8), we plan to test different ways to score and calibrate the GAC-PAQ against ActiGraph accelerometer data to determine the best approach. We believe that scoring of the GAC-PAQ is beyond the scope of this protocol manuscript and warrants a separate, much more detailed paper."

Now we added some information in the manuscript about how we plan to generate estimates of physical activity for the main study. We added the following sentences in the analysis section: “In stage 8, we will derive estimates of PA from the GAC-PAQ. To do this, we plan to use mid-points for the response options that are provided as ranges. Next, we will give a weight to these midpoints to account for the fact that, for example, children are not engaging in MVPA for the entire duration of their physical education period [53,54]. Then, we will calibrate the GAC-PAQ against accelerometry data following a process similar to Saint-Maurice et al. [55] to improve our estimates of PA.”

2. Regarding using the terminology 'gender' instead of 'sex' under Stage 3, I still wonder the purpose asking about gender, partly because children may treat it as 'sex' anyway, and I also wonder if most children are aware of their gender even if they can differentiate between the 2 terminologies? Maybe to help them to differentiate between the terminologies, 'sex' can be added too?

Authors response: Stage 3 was the assessment of content validity with experts, so we assume that the reviewer meant Stage 4, which is already completed as indicated in Table 2.

In Stages 7 and 8 we will ask children to indicate their gender, but the question as implemented in the app uses age-appropriate words. It's “are you a...” followed, by the options ‘boy’, ‘girl’, etc. To prevent confusion about the concepts of sex and gender, we will ask parents to report their child's sex. Sex- and gender-based analysis is increasingly encouraged – if not required – by many journals, in line with the SAGER guidelines (e.g., see: <https://www.springer.com/fr/editorial-policies/sex-and-gender-in-research-sager-guidelines>) So, it is important for us to collect both sex and gender where possible.