

## PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form (<http://bmjopen.bmj.com/site/about/resources/checklist.pdf>) and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below.

### ARTICLE DETAILS

<b>TITLE (PROVISIONAL)</b>	Effects of Smart Garments on the Wellbeing of Athletes: A Scoping Review Protocol
<b>AUTHORS</b>	Al Mahmud, Abdullah; Wickramarathne, Tharushi; Kuys, Blair

### VERSION 1 – REVIEW

<b>REVIEWER</b>	Dhruv Ramakrishna Seshadri Case Western Reserve University
<b>REVIEW RETURNED</b>	25-Jul-2020

<b>GENERAL COMMENTS</b>	<p><b><u>Effects of Smart Garments on the Wellbeing of Athletes: A Scoping Review Protocol</u></b></p> <p><b>Objective of study:</b> Compare the wide variety of technologies incorporated in smart garments for the health and wellbeing of athletes and to understand the knowledge gaps for future studies</p> <p><b>Type of paper:</b> protocol</p> <p><b>Comments to the Author:</b></p> <ol style="list-style-type: none"><li>1) Line 70: Definition: clothing items integrated with technology such as sensors and may connect with an app or wearables such as Fitbit or smartwatch. How are the authors differentiating between a smartwatch and Fitbit as the latter can tell time and provide biomechanical and physiological metrics relevant to the health and well-being of the athlete. Elucidating this differentiation and providing more specificity regarding the definition will help focus this protocol.</li><li>2) Line 72: What is a wearable computer and how is that different from a smartwatch? Consistency in terminology is necessary to elucidate this protocol</li><li>3) Line 77: a table detailing a list of biological and environmental details along with its corresponding details will help set the tone for the introduction</li></ol>
-------------------------	--

	<p>4) Line 77—can the authors please provide an example of a smart shirt for clarity purposes</p> <p>5) Line 82—The reviewer recommends removing content not related to sports performance and safety as it detracts from the scope of this protocol (also applies to lines 118-120)</p> <p>6) Line 104---reviewer recommends referring to the work from the Drummond lab (NPJ Digital Medicine 2019—Internal/External Workload and Physiological and Biochemical Performance of the athlete...etc), Rogers Lab (Science Translational Medicine), and Gatorade Sports Science Institute (works by Baker et al.)</p> <p>7) Line 111—Given that the inclusion study for this protocol is that the study must be within 10 years, the reviewer recommends the authors quantify the number of “outdated” manuscripts to once again help set the novelty for this protocol</p> <p>8) Line 115—flexible lithium-ion batteries have not evolved to a translational readiness level for widespread utility in wearable devices. This is one of the reasons why the form factor for these devices is either a rigid system or a rigid-flex integration (from a hardware standpoint). The review recommends deleting this line but appreciates the discussion of this technology. Revising this statement to discuss the need to further this technology would be well-received by the audience thereby highlighting future R&amp;D efforts of wearable bioelectronics, specifically in the context of sports performance.</p> <p>9) Line 192—should be changed to: Is the article a peer-reviewed primary study?</p> <p>10) Line 193—Is the article published within the last ten years...</p> <p>11) Line 195—needs a “?” at the end</p> <p>12) The reviewer recommends that the authors include information regarding the clinical application of the smart garments if they have been used in clinical trials or by teams today. Furthermore, a comparison of commercial products versus those developed in the academic setting would be interesting to provide gaps and opportunities for future research and development.</p> <p>13) Can the authors please elucidate why this is a randomized controlled trial (as noted on page 25)?</p> <p>14) Specifying what sports will be studied is needed and lacking.</p> <p>The reviewer thanks the authors for their efforts and looks forward to the revised protocol.</p>
--	--

<b>REVIEWER</b>	Lia Rigamonti Potsdam University, Potsdam, Germany
-----------------	---

<b>REVIEW RETURNED</b>	30-Jul-2020
------------------------	-------------

<b>GENERAL COMMENTS</b>	<p>With the increase of smart garments in everyday life, especially in sports, an overview of the scientific data about what exists and what is sufficiently used can be regarded as highly interesting.</p> <p>This paper describes a review protocol for a planned data analysis about the effects of smart garments on the wellbeing of athletes.</p> <p>The planned methodology can be regarded as standard and already well established.</p> <p>The focused steps are simple and clear but some points should be more written in more detail.</p> <p>1. What kind of review do the authors want to do? The paper names first a narrative review, then a systematic review, then meta analyses. All of these data analyses follow different protocols. It should be clearly stated, which of these will be in the focus of the planned analysis and scientific publication.</p> <p>2. Which are the athletes the authors want to concentrate on exactly? Every kind of athletes? Once in the paper, a specific type of athletes is named( Stage 1- „ Also, this review will generate input requirements for the research, which will carry out to develop a smart garment for endurance athletes“. But in the methods/review just general athletes are named. I recommend to be a little more specific in the description of the types of athletes that should be focused on (all athletes, recreational athletes, professional athletes, endurance athletes...).</p> <p>Concluding a relevant work, which should be specified in some aspects.</p>
-------------------------	---

<b>REVIEWER</b>	Patricia McInerney University of the Witwatersrand South Africa
<b>REVIEW RETURNED</b>	03-Sep-2020

<b>GENERAL COMMENTS</b>	<p>Thank you for the opportunity to review this proposal - I found it very interesting. I have a few comments. The manuscript needs careful editing, especially lines 119-120 and 192. It is stated that the development of the protocol used Arksey and O'Malley's approach and that the authors further refined it using the Joanna Briggs Institute methodology. It is not evident where the JBI approach has been used. It is not appropriate to have a discussion in a proposal - this is for the completed review. The authors have used the PRISMA- ScR template - whilst this acceptable the template is for completed reviews.</p> <p>I wish you success in completing this review</p>
-------------------------	---

### VERSION 1 – AUTHOR RESPONSE

- 1) Line 70: Definition: clothing items integrated with technology such as sensors and may connect with an app or wearables such as Fitbit or smartwatch. How are the authors differentiating between a smartwatch and Fitbit as the latter can tell time and provide biomechanical and physiological metrics relevant to the health and wellbeing of the athlete. Elucidating this differentiation and providing more specificity regarding the definition will help focus this protocol.
  - Thank you for the comment. We have updated the Background section to provide more clarity. Basic monitoring devices include heart rate monitor, fitness monitors and smart wristwatches like Fitbit. The study focusses on smart garments that are evolved from basic monitoring devices that can be worn like regular clothing and can measure a broad spectrum of biomechanical and physiological metrics and/or provide advance functions like posture controlling elevating health and wellbeing of the athlete
  
- 2) Line 72: What is a wearable computer and how is that different from a smartwatch? Consistency in terminology is necessary to elucidate this protocol
  - We updated the Background section to provide more clarity. Wearable computers include basic monitoring devices like smartwatches and also evolved smart clothing.
  
- 3) Line 77: a table detailing a list of biological and environmental details along with its corresponding details will help set the tone for the introduction
  - Thank you for the suggestion. We have included a table to the Background section detailing smart monitoring and other smart functions offered by existing smart garments (See Table 1 in the manuscript).
  
- 4) Line 77—can the authors please provide an example of a smart shirt for clarity purposes
  - We have included a commercial smart shirt example to the Background section to improve clarity. Hexoskin smart shirt that can measure biological/physical parameters like cardiac, respiratory, sleep, and activity data. is an example of such a smart garment application
  
- 5) Line 82—The reviewer recommends removing content not related to sports performance and safety as it detracts from the scope of this protocol (also applies to lines 118-120)
  - We updated the Background section to remove content that are not related to sports performance and safety. We have also updated 118-120 lines to improve clarity.
  
- 6) Line 104---reviewer recommends referring to the work from the Drummond lab (NPJ Digital Medicine 2019—Internal/External Workload and Physiological and Biochemical Performance of the athlete...etc), Rogers Lab (Science Translational Medicine), and Gatorade Sports Science Institute (works by Baker et al.)
  - Thank you for suggesting the references to improve the quality of the manuscript. We have included below references to our paper (see Background and Rationale sections) • Wearable sensors for monitoring the internal and external workload of the athlete. NPJ digital medicine, 2019. 2(1): p. 1-18. • Skin-interfaced systems for sweat collection and analytics by Jungil Choi, Roozbeh Ghaffari, Lindsay B. Baker and A. Rogers Furthermore, we have added the following information to the Background section • A soft, wearable microfluidic device for the capture, storage, and colourimetric sensing of sweat. Science translational medicine

- 7) Line 111—Given that the inclusion study for this protocol is that the study must be within 10 years, the reviewer recommends the authors quantify the number of “outdated” manuscripts to once again help set the novelty for this protocol
  - We wanted to include the studies within the last 10 years considering the below aspects - A limited number of smart sports garment studies available that include a physical product/prototype. - To capture a wide spectrum of smart sports garment applications evolved over the last 10 years. - We are planning on reviewing these studies to understand the technologies used in existing smart sports garment applications and identifying the research gaps.
  
- 8) Line 115—flexible lithium-ion batteries have not evolved to a translational readiness level for widespread utility in wearable devices. This is one of the reasons why the form factor for these devices is either a rigid system or a rigid-flex integration (from a hardware standpoint). The review recommends deleting this line but appreciates the discussion of this technology. Revising this statement to discuss the need to further this technology would be well received by the audience thereby highlighting future R&D efforts of wearable bioelectronics, specifically in the context of sports performance.
  - Please note that the technology readiness level of textile batteries is very low. We changed this line in the Rationale section to emphasise the importance of these technologies in uplifting performance of future sports smart clothing.
  
- 9) Line 192—should be changed to: Is the article a peer-reviewed primary study?
- 10) Line 193—Is the article published within the last ten years...
- 11) Line 195—needs a “?” at the end
  - Thank you for pointing out the incorrect grammar and punctuations. We have corrected these errors.
  
- 12) The reviewer recommends that the authors include information regarding the clinical application of the smart garments if they have been used in clinical trials or by teams today.
  - We have included Hexoskin, a clinically validated smart shirt (in the Background section) that can measure biological/physical parameters like cardiac, respiratory, sleep, and activity data. Furthermore, a comparison of commercial products versus those developed in the academic setting would be interesting to provide gaps and opportunities for future research and development.
  - We have updated the Background section highlighting the gap between commercial sportswear products and those developed in the academic setting. Most of the commercialised sport smart garments are common functions like smart monitoring, communication, compression and cushioning and consist of non-textile electrical/electronic devices/components to inbuild smart functions to the clothing inhibiting user experience. Researchers started exploring e-textiles to design smart technologies into textiles. Also, some studies examined creative, smart technology applications to improve user experience. The smart garments that react to the wearer mood are one such example. These experiments provide an opportunity for enhanced future smart sports garments that can enhance the health and wellbeing of athletes. A technology mapping and review of existing smart

garments that are designed for athletes will assist in understanding up to what extent these advancements in e-textiles, and smart garments are penetrated to sports garment applications to inform new product development and also to guide new research.

13) Can the authors please elucidate why this is a randomised controlled trial (as noted on page 25)?

- In the original draft, we included 'randomised controlled trials (RCT)' also as one filter in PubMed search to capture the smart sports garment studies that were conducted incorporating RCT. Considering the reviewer's comment, we updated the PubMed search strategy to improve the clarity by defining article/source type as below. All the studies except reviews We have verified the updated search strategy

14) Specifying what sports will be studied is needed and lacking.

- The manuscript has been updated to provide more clarity. Stage 1 section-We are considering only the smart studies that are conducted for professional athletes. Strength and Limitations section-To capture a wide spectrum of smart garment applications incorporated for professional sportswear applications; we will not narrow down the study considering sports category/type.

## Reviewer 02

1. What kind of review do the authors want to do? The paper names first a narrative review, then a systematic review, then meta analyses. All of these data analyses follow different protocols. It should be clearly stated, which of these will be in the focus of the planned analysis and scientific publication.

- This paper presents a protocol for a scoping review. We updated the Rationale and Stage 5 sections of the manuscript to provide more clarity. Also, we removed additional details related to a systematic review, and metaanalyses from the manuscript to improve clarity. Rationale section: This paper presents a protocol for conducting a scoping review that can provide a comprehensive evaluation and a technology mapping of the latest smart sports garment technologies that can guide future research projects. Stage 5 section -We will analyse the study data incorporating descriptive statistics. The extracted data will also undergo a thematic analysis to understand the emerging themes

Which are the athletes the authors want to concentrate on exactly? Every kind of athletes? Once in the paper, a specific type of athletes is named( Stage 1- „ Also, this review will generate input requirements for the research, which will carry out to develop a smart garment for endurance athletes“. But in the methods/review just general athletes are named. I recommend to be a little more specific in the description of the types of athletes that should be focused on (all athletes, recreational athletes, professional athletes, endurance athletes...). Concluding a relevant work, which should be specified in some aspects.

- The manuscript has been updated to provide more clarity. Stage 1 section-We are considering the smart garment studies that are conducted only focusing on professional athletes. Strength and Limitations section-To capture a wide spectrum of smart garment applications in professional sportswear; we will not narrow down the study considering sports category.

### Reviewer 3

The manuscript needs careful editing, especially lines 119-120 and 192. It is stated that the development of the protocol used Arksey and O'Malley's approach and that the authors further refined it using the Joanna Briggs Institute methodology. It is not evident where the JBI approach has been used.

- Thank you for pointing this out. We have corrected line 119-120 and 192. We also updated the manuscript Methods section to improve clarity

It is not appropriate to have a discussion in a proposal - this is for the completed review.

- We removed the discussion section and included Ethics and Dissimilation section to the main text.

The authors have used the PRISMA- ScR template - whilst this acceptable the template is for completed reviews.

- We removed the statement from the paper. We will be using PRISMA-ScR template during the proposed scoping review.

### VERSION 2 – REVIEW

<b>REVIEWER</b>	Dhruv Ramakrishna Seshadri Case Western Reserve University United States of America
<b>REVIEW RETURNED</b>	07-Oct-2020

<b>GENERAL COMMENTS</b>	The reviewer thanks the authors for the changes and recommends this manuscript for publication.
-------------------------	---

<b>REVIEWER</b>	Lia Rigamonti Universität Potsdam , Germany
<b>REVIEW RETURNED</b>	20-Oct-2020

<b>GENERAL COMMENTS</b>	The authors answered the question previously asked. Simply review method, that every master s student should have studied and done at least once.Could be easily repeated. I think could be helpful for more students and is ready to be published.
-------------------------	---

<b>REVIEWER</b>	Patricia McInerney University of the Witwatersrand Johannesburg South Africa
<b>REVIEW RETURNED</b>	29-Sep-2020

<b>GENERAL COMMENTS</b>	The authors appear to have considered reviewers' previous comments and addressed them.
-------------------------	--

