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# BMJ Open

## Reducing the carbon footprint of research: experience from the NightLife study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2022-070200.R1
Article Type:	Communication
Date Submitted by the Author:	20-Dec-2022
Complete List of Authors:	<p>Quann, Niamh; University of Leicester College of Life Sciences, Leicester Clinical Trials Unit  Burns, Steph; University Hospitals of Leicester NHS Trust  Hull, Katherine; University Hospitals of Leicester NHS Trust, John Walls Renal Unit; University of Leicester, Department of Cardiovascular Sciences  Cluley, Victoria; University of Leicester Department of Cardiovascular Sciences  Richardson, Carla; University of Leicester College of Life Sciences, Leicester Clinical Trials Unit  MacConaill, Kateryna; University Hospitals of Leicester NHS Trust, John Walls Renal Unit, Leicester General Hospital  Conefrey, Carmel; University of Bristol Medical School  Rooshenas, Leila; University of Bristol, School of Social and Community Medicine  Eborall, Helen; University of Edinburgh , Usher Institute  Burton, James; University of Leicester Department of Cardiovascular Sciences; University Hospitals of Leicester NHS Trust, John Walls Renal Unit, Leicester General Hospital</p>
<b>Primary Subject Heading</b>:	Renal medicine
Secondary Subject Heading:	Research methods
Keywords:	Nephrology < INTERNAL MEDICINE, NEPHROLOGY, Dialysis < NEPHROLOGY, End stage renal failure < NEPHROLOGY, Quality of Life

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## Reducing the carbon footprint of research: experience from the NightLife study

**Total number of words:** 1850 with abstract, 1725 without abstract

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**Key words:** Carbon footprint, CO<sub>2</sub> emissions, climate change, environmental sustainability, carbon reduction, carbon impact, clinical trials, trial conduct, randomised controlled trial

**Abstract**

The National Health Service (NHS) has made a commitment to meet targets set by the UK Climate Change Act (2008). Research forms a core part of the NHS. Tackling environmental sustainability challenges is fundamental to reducing the carbon footprint of clinical trials. The National Institute for Health and Care Research (NIHR) provide guidelines and recommendations in their 'Carbon Reduction Strategy' (2019). While climate change and CO<sub>2</sub> emissions are significant issues, research sustainability and support from funding organisations is lacking. Policies and requirements from funding organisations do not mirror the global emphasis on carbon reduction. This communication reports the reduction in the carbon footprint of the NightLife study (ISRCTN87042063), an ongoing multi-centre randomised controlled trial assessing the impact of in-centre nocturnal haemodialysis on quality of life.

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3 Following the declaration of the COVID-19 pandemic outbreak by the World Health Organization  
4 (WHO)(1) in March 2020, the UK Government implemented a series of restrictions limiting face-to-  
5 face contact and enforcing social distancing. This had a significant impact on the delivery and  
6 conduct of health research. Adaptation required resourceful approaches to ensure patient safety  
7 and data integrity. Driven by the pandemic, trial management teams, working closely with Principal  
8 Investigators (PI) and Trial Management Groups (TMG), played a key role in rapidly adjusting the way  
9 clinical trials were designed and undertaken (2). While reductions in the carbon footprint of research  
10 activities were not the driving force for the changes required during the pandemic, it was  
11 nevertheless a significant and positive outcome. It is important that, where possible, clinical trials  
12 use these approaches to ensure carbon reductions and demonstrate an ongoing, responsible  
13 commitment to sustainability.  
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### 30 **Overview of the NightLife study**

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32 The NightLife study is an ongoing randomised controlled trial (RCT) using mixed methods to assess  
33 the effectiveness and cost effectiveness of thrice weekly, extended hours, in-centre nocturnal  
34 haemodialysis in comparison to standard care. The study is funded by the NIHR (funder reference  
35 NIHR127440; REC reference 20/WM/0275), sponsored by the University of Leicester and co-  
36 ordinated by the Leicester Clinical Trials Unit (LCTU). It includes three main workstreams: a RCT and  
37 internal pilot (workstream 1), an ongoing process evaluation (workstream 2) and a QuinteT  
38 Recruitment Intervention (QRI, workstream 3) (3).  
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### 50 **Adjustments to the NightLife study delivery in response to the COVID-19 pandemic**

51 All TMG, oversight committee and Patient Participation, Involvement and Engagement (PPIE)  
52 meetings were reconfigured and held online. Following UK Government instruction, staff worked  
53 from home wherever possible. Recruitment, feasibility assessments, site selection and initiation  
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3 visits were completed remotely. Queries and outstanding actions resolved via email  
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5 correspondence.

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7 Qualitative data collection through ethnographic methods and interviews with the research team,  
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9 dialysis unit staff and individuals with kidney disease were paused and additional data collection  
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11 techniques were considered to reduce face-to-face contact. This included virtual interviews using  
12  
13 common conference software programmes and 'photovoice'; a participatory research method that  
14  
15 utilises participant-led photography of the phenomena being researched (in this case, the lived  
16  
17 experience of haemodialysis) and allows remote access to experiences and phenomena outside of  
18  
19 the immediate field of study (4, 5).  
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### 25 **Calculation of carbon footprint**

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27 Using a web-based carbon footprint calculator (6, 7), the CO<sub>2</sub> emissions saved by converting to  
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29 virtual approaches, home working and alternative qualitative data collection techniques were  
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31 estimated. The calculator took into account: travel modality (including specific features such as  
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33 vehicle and fuel type), number of people travelling and distance in miles. For air travel, airport codes  
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35 and flight class were considered. Carbon savings were calculated over the first 18 months of the  
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37 NightLife study.  
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### 43 **What have we learnt?**

#### 44 ***Carbon reduction***

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46 To date, innovative changes to the management of the NightLife study have resulted in a net CO<sub>2</sub>  
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48 reduction of 136 tonnes. The CO<sub>2</sub> reduction of each workstream is outlined below, with real-life  
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50 equivalent values detailed in table 1 (6, 7).  
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**Table 1:** Table summarising the net CO<sub>2</sub> emission reduction for each workstream and equivalent values (6, 7)

Workstream	Net CO <sub>2</sub> emission reduction	Equivalent value
<b>Workstream 1</b>	12 tonnes	12 trees planted
		6,000 CO <sub>2</sub> fire extinguishers
<b>Workstream 2</b>	20 tonnes	20 trees planted
		20 x 500m <sup>3</sup> hot air balloons
<b>Workstream 3</b>	0.32 tonnes	Approximately half a tree planted
		38,926 smartphones charged
<b>Other benefits</b>	104 tonnes	104 trees planted
		Driving 624,000km in a diesel car
<b>Total</b>	136 tonnes	136 trees planted
		586 return flights from London to Rome

### **Workstream 1**

The net saving for workstream 1 was 12 tonnes (emissions reduced 12 tonnes; emissions used 0).

Key savings were related to travel due to online reconfiguration of study meetings, UK-wide site selection visits and SIVs.

### **Workstream 2**

The net saving for workstream 2 was 20 tonnes (total emissions reduced 20 tonnes; emissions used 0.74 tonnes). 50% of participants opted for virtual interviews/'photovoice' in place of traditional ethnographic methods such as face-to-face semi-structured interviews. Subsequently, researcher travel to base hospitals and satellite haemodialysis units was also reduced by 50%. The purchase of a smartphone and two electronic tablets incurred a CO<sub>2</sub> emission of 0.74 tonnes.



### **Workstream 3**

The net saving for workstream 3 was 0.32 tonnes (total emissions saved 0.32; emissions used 0).

Researcher travel was reduced by 100% as semi-structured interviews, attendance and observations of, TMG meetings, investigator meetings and SIVs, and provision of feedback regarding recruitment to participating units were completed remotely.

### **Cost savings**

All adaptations to the study organisation, management and design were made within the original study budget and resulted in significant cost savings. This included costs for travel, consumables and researcher time. The underspend was repurposed for researcher training, participant benefit and further opportunities for scientific communication (conference attendance and publication open access dissemination costs) following funder approval.

### **Other benefits**

Additional carbon savings were incurred through virtual attendance at national and international conferences and reduced travel due to home-working, saving 71 tonnes and 33 tonnes respectively across all workstreams. Virtual PPIE activities resulted in geographical and ethnic diversity of group members as individuals joined from various locations across the UK (see figure 1).

### **The value of this experience**

To date, adaptations to the management of the NightLife study have resulted in a net reduction of 136 tonnes of CO<sub>2</sub>. Key savings were related to travel due to reconfiguration of study meetings, UK-wide site selection visits and SIVs. Extrapolating these data forward will lead to further increases in savings over the five year study period based on a hybrid approach now that restrictions have been lifted.

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5 The benefits of the NightLife study adaptations go beyond the positive environmental impact.

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7 Interestingly, 50% of participants opted for virtual interviews and/or 'photovoice' in place of face-to-  
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9 face semi-structured interviews, which revealed a holistic insight into the lived experience of  
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11 haemodialysis. Photovoice allowed the researcher to approach the observational element  
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13 differently, allowing participants to lead data collection and extend it into their home life; the  
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15 experience of haemodialysis is a constant life disruption, not limited to the time spent in the clinical  
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17 environment. This added richness in findings that may not have been achieved with traditional  
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19 ethnographic methods alone.  
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26  
27 study budget and resulted in significant cost savings which were repurposed following funder  
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29 approval. Additional carbon savings were incurred through virtual attendance at national and  
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31 international conferences and reduced travel due to home-working.  
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35 Teleconferencing, video-conferencing and web-based training materials were proven to be effective,  
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37 with positive working relationships built and maintained. The inaugural investigator meeting was  
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39 held entirely remotely with more than 40 attendees from the research and nephrology community  
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41 across the UK. The virtual nature of TMG, Data Safety Monitoring Committee (DSMC) and Trial  
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43 Steering Committee (TSC) meetings allowed more flexibility for meeting attendance, particularly for  
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45 committee members based abroad. Indeed, the frequency of these meetings was increased to  
46  
47 support the ongoing oversight of the study at no additional cost. However, there is room and need  
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49 for hybrid approaches to some clinical trial activities, with an acceptance of some CO<sub>2</sub> emissions.  
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55 Debates are ongoing about how to incorporate a diverse range of patient voices in the design and  
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57 delivery of research, highlighting a lack of diversity and inclusion (8). The use of alternative meeting  
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3 techniques as part of the NightLife study resulted in both geographical and ethnic diversity of the  
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5 PPIE group, enriching the feedback of the lived experience of kidney disease and haemodialysis.  
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10 The findings of our work are supported by a retrospective analysis of 12 pragmatic randomised  
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12 control trials (9); CO<sub>2</sub> emissions are often generated in areas where steps could be taken to reduce  
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14 them, such as travel and trial conduct. Resistance to such changes, however, is common. Trial-  
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16 related travel is often comprised of heavy carbon emissions (particularly where multi-centre studies  
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18 are concerned). Traditionally this has included travel to SIVs across the UK (by rail and road), as well  
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20 as investigator meetings which often include international travel (by air), oversight committee  
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22 meetings, training, onsite monitoring and closedown visits, as well as conference attendance  
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24 throughout the study's duration. These are travel related activities that most Clinical Trials Units  
25  
26 (CTUs) cost for when considering the generation of a trial grant. This is generally done by aligning  
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28 activities and associated costs with the risk of study. For example, clinical trials of investigational  
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30 medicinal products (CTIMPs) are deemed higher risk, therefore onsite monitoring of participating  
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32 sites and pharmacies and resulting travel is a necessity. However, where trials are not bound by such  
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34 strict legislation, COVID-19 has presented an opportunity to change these practices in a way that  
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36 reduces the trial's carbon footprint, as reflected by our changes in the NightLife study.  
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44 Typically, most CTUs continue to utilise paper Investigator Site Files (ISFs). However, this approach to  
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46 trial organisation and data management is being challenged and there is widespread recognition  
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48 from the research community for significant improvements in environmental sustainability within  
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50 clinical trials (10) . There are many ways to reduce waste with increasing scope to switch from paper  
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52 to electronic trial management systems (e.g. ISFs) in order to (i) minimise paper usage and storage  
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54 requirements; (ii) increase document accessibility; (iii) streamline management, monitoring and  
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56 archiving of multi-centre clinical trials and; (iv) reduce monetary costs. Adshead *et al* suggest that  
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58 clinical trials with a lower carbon footprint should be prioritised by funders, and just as researchers  
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3 have to justify to funders the budget for a trial, they should also have to justify the carbon footprint  
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5 to their stakeholders and demonstrate that it as low as possible (10).  
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### 10 **An aid for future trial design and further work**

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12 To the authors' knowledge, this is one of few articles to consider and evaluate the environmental  
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14 improvements that can be made by remote working and virtual adaptations to study designs when  
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16 establishing a multi-centre RCT in patients with end-stage kidney disease. This work has the  
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18 potential to act as a guide for other clinical trials to reduce cost and their environmental impact. It  
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20 also demonstrates how to enhance geographical diversity of research teams (including PPIE  
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22 members) without excessive cost.  
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### 28 **Take home messages**

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30 The COVID-19 pandemic presented a need to adapt clinical trials to protect patients, carers, clinical  
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32 teams and researchers, and accelerated a pre-existing drive to reduce the carbon footprint of  
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34 research. Study processes needed to evolve rapidly to ensure they were robust and financially lean  
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36 in the COVID-19 era. The legacy of such changes has been wide ranging but of note, the impact on  
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38 CO<sub>2</sub> emission reduction experienced in the NightLife study is a benefit that should inspire and drive  
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40 the reduction of the carbon impact of all clinical trials from now and into the future. We have  
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42 highlighted opportunities for investigators and trial management teams to implement alternative  
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44 approaches to designing and conducting clinical trials in order to make them less carbon intensive,  
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46 more environmentally sustainable and better value for money.  
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**Contributors**

The paper was conceived by NQ and JB. SB performed the carbon footprint calculations. NQ, JB, KH, VC, CR, KM, CC, LR and HE reviewed and approved the final draft submitted.

**Funding**

The NightLife study is funded by the National Institute for Health and Care Research (NIHR) Health Technology Assessment (HTA) programme (funder reference: NIHR127440). The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care.

**Competing interests**

None declared.

**Patient consent**

Not required.

**Provenance and peer review**

Not commissioned; externally peer reviewed.

**Data sharing statement**

All data relevant to the study are included in the article.

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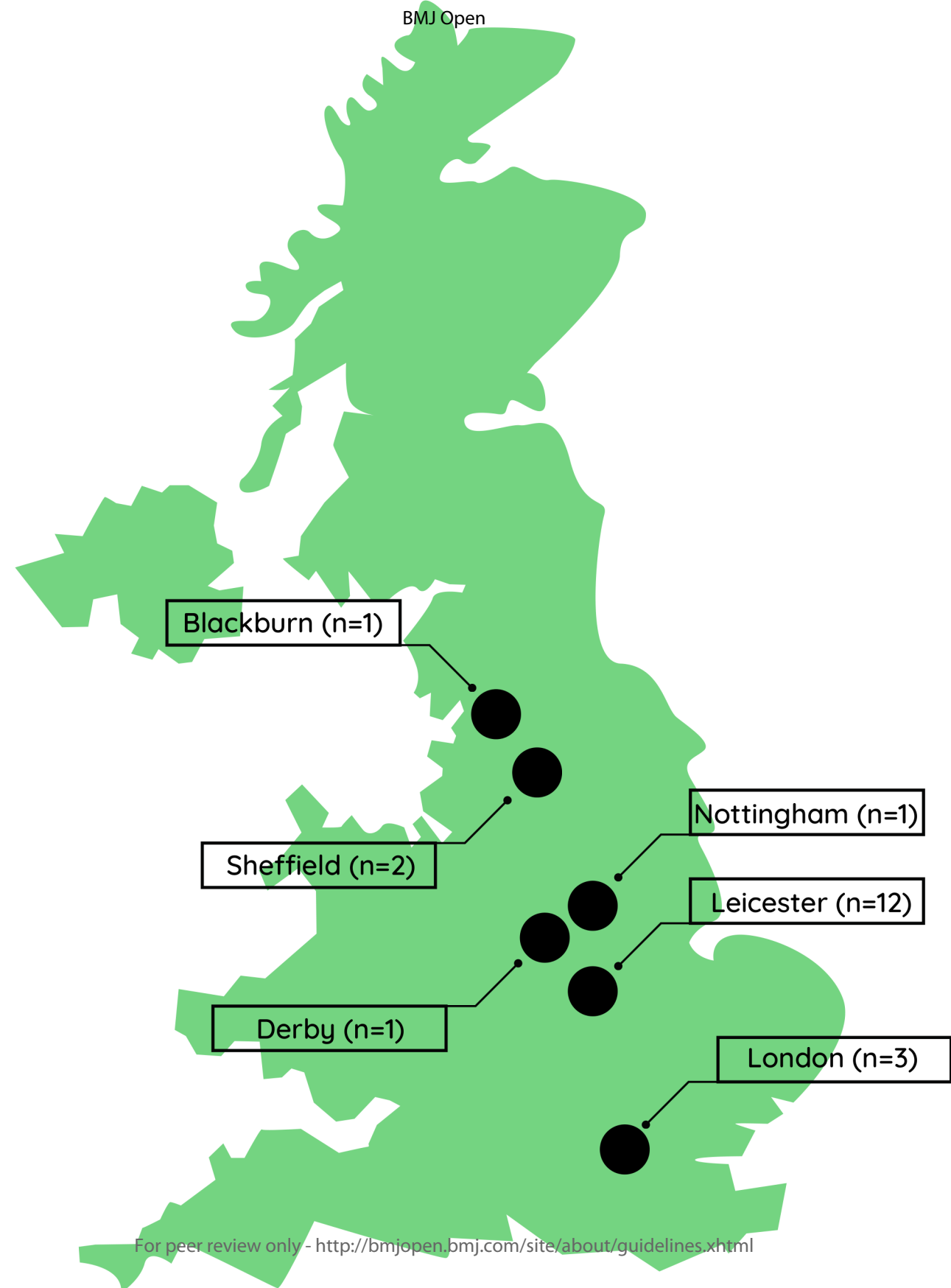
**Figures**

Figure 1: Map of UK showing geographical locations of PPIE group members

**Tables**

Table 1: Table summarising the net CO<sub>2</sub> emission reduction for each workstream and equivalent values

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Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2022-070200.R2
Article Type:	Communication
Date Submitted by the Author:	16-Feb-2023
Complete List of Authors:	Quann, Niamh; University of Leicester College of Life Sciences, Leicester Clinical Trials Unit Burns, Steph; University Hospitals of Leicester NHS Trust Hull, Katherine; University Hospitals of Leicester NHS Trust, John Walls Renal Unit; University of Leicester, Department of Cardiovascular Sciences Cluley, Victoria; University of Leicester Department of Cardiovascular Sciences Richardson, Carla; University of Leicester College of Life Sciences, Leicester Clinical Trials Unit MacConaill, Kateryna; University Hospitals of Leicester NHS Trust, John Walls Renal Unit, Leicester General Hospital Conefrey, Carmel; University of Bristol Medical School Rooshenas, Leila; University of Bristol, School of Social and Community Medicine Eborall, Helen; University of Edinburgh , Usher Institute Burton, James; University of Leicester Department of Cardiovascular Sciences; University Hospitals of Leicester NHS Trust, John Walls Renal Unit, Leicester General Hospital
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43 21 **Key words:** Carbon footprint, CO<sub>2</sub> emissions, climate change, environmental sustainability, carbon

44  
45 22 reduction, carbon impact, clinical trials, trial conduct, randomised controlled trial

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47 23

1  
2  
3 24 **Abstract**  
4

5 25 As set out in the Climate Change Act (2008), the UK National Health Service (NHS) has made a  
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7 26 commitment to halve greenhouse gas emissions by 2025 and reach net-zero by 2050. Research  
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10 27 forms a core part of NHS research activity; reducing the carbon footprint of clinical trials is a core  
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12 28 element of the National Institute for Health and Care Research (NIHR) 'Carbon Reduction Strategy'  
13  
14 29 (2019). However, support from funding organisations on how to achieve these targets is lacking.  
15  
16 30 This brief communication reports the reduction in the carbon footprint of the NightLife study; an  
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18 31 ongoing multi-centre randomised controlled trial assessing the impact of in-centre nocturnal  
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20 32 haemodialysis on quality of life. By using remote conferencing software and innovative data  
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22 33 collection methods, we demonstrated a total saving of 136 tonnes of carbon dioxide equivalent  
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24 34 (CO<sub>2</sub>e) over three workstreams during the first 18 months of the study, following grant activation on  
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26 35 1<sup>st</sup> January 2020. In addition to the environmental impact, there were additional benefits seen to  
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28 36 cost as well as increased participant diversity and inclusion. This highlights ways to make trials less  
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30 37 carbon intensive, more environmentally sustainable and better value for money.  
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## 38 **Introduction**

39 The social distancing restrictions implemented during the COVID-19 pandemic (1) had a significant  
40 impact on the delivery and conduct of health research in the UK. Trial management teams played a  
41 key role in rapidly adjusting the way clinical trials were designed and undertaken (1). Although  
42 reductions in the carbon footprint of research activities were not the driving force for the changes  
43 required during the pandemic, it was nevertheless a significant and positive outcome. It is important  
44 that, where possible, clinical trials use these approaches to ensure CO<sub>2</sub>e savings and demonstrate an  
45 ongoing, responsible commitment to sustainability.

## 47 **Overview of the NightLife study**

48 The NightLife study is an ongoing randomised controlled trial (RCT) using mixed methods to assess  
49 the clinical and cost effectiveness of thrice weekly, extended hours, in-centre nocturnal  
50 haemodialysis in comparison to standard care (ISRCTN87042063(2); see study website(3)). The study  
51 includes three main workstreams: an RCT and internal pilot (workstream 1), an ongoing process  
52 evaluation (workstream 2) and a QuinteT Recruitment Intervention (QRI, workstream 3) (4).

## 54 **Adjustments to the NightLife study delivery in response to the COVID-19 pandemic**

55 Prior to the COVID-19 pandemic, it was planned to conduct all meetings and qualitative study  
56 elements in a face-to-face manner by ≥20 collaborators across the UK. This included in-person study  
57 launch and oversight committee meetings. Following UK Government instruction, staff worked from  
58 home wherever possible. All meetings, including trial management, oversight committee, patient  
59 experience and site feasibility were reconfigured and held online. Queries and outstanding actions  
60 were resolved via email correspondence. While study processes were conducted remotely, the  
61 patient population (adults receiving thrice weekly in-centre haemodialysis) enabled in-person  
62 recruitment for workstream 2, however all qualitative data was collected remotely. Workstream 1

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3 63 and workstream 3 (which were due to run in parallel) were paused for nine months due to the  
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5 64 impact of COVID-19 on research delivery.  
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10 66 Qualitative data collection through ethnographic methods (in-person observations and real-time  
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12 67 field notes) and interviews with the research team, dialysis unit staff and individuals with kidney  
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14 68 disease were paused and additional data collection techniques were considered to reduce face-to-  
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16 69 face contact. This included virtual interviews using common conference software programmes and  
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18 70 'photovoice'; a participatory research method that utilises participant-led photography of the  
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20 71 phenomena being researched (in this case, the lived experience of haemodialysis) and allows remote  
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22 72 access to experiences and phenomena outside of the immediate field of study (5, 6).  
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#### 27 28 74 **Calculation of carbon footprint**

29  
30 75 The original grant application outlined the total number of planned face-to-face meetings and  
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32 76 related costings for the duration of the study. This was used to map the study activities which were  
33  
34 77 reconfigured to virtual methods. Using a web-based carbon footprint calculator (7), the CO<sub>2</sub>e saved  
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36 78 by converting to virtual approaches, home working and alternative qualitative data collection  
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38 79 techniques were estimated. The calculator took into account: travel modality (rail, car, bicycle, air  
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41 80 travel), specific features such as vehicle and fuel type, number of people travelling and distance in  
42  
43 81 miles. For air travel, airport codes and flight class were considered. Estimated CO<sub>2</sub>e savings were  
44  
45 82 calculated over the first 18 months of the NightLife study.  
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#### 49 50 84 **What have we learnt?**

##### 51 52 85 ***Carbon reduction***

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54 86 To date, innovative changes to the management of the NightLife study have resulted in an estimated  
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56 87 net CO<sub>2</sub>e saving of 136 tonnes. The saving of each workstream is outlined below, with real-life  
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58 88 equivalent values detailed in table 1 (7).  
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89

90 **Table 1:** Table summarising the net CO<sub>2</sub>e saving for each workstream and real-life equivalent values

91 (7)

Workstream	Net CO <sub>2</sub> e saving	Original method as per grant application	Adaptations implemented	Real-life equivalent value
<b>Workstream 1</b>	12 tonnes	Face-to-face trial management, oversight committee, patient experience, site feasibility and study launch meetings.	Virtual trial management, oversight committee, patient experience, site feasibility and study launch meetings. Queries and actions resolved via email.	Driving 37,015 km in a car
<b>Workstream 2</b>	20 tonnes	In-person observations; real-time field notes; face-to-face interviews; regular researcher travel to base hospitals and satellite haemodialysis units.	'Photovoice'; virtual interviews; reduced researcher travel to base hospitals and satellite haemodialysis units.	Driving 61,692 km in a car
<b>Workstream 3</b>	0.32 tonnes	Face-to-face interviews; in-person attendance at, and observations of, trial management, investigator and site initiation meetings; face-to-face provision of	Virtual interviews; remote attendance at, and observations of, trial management, investigator and site initiation meetings; virtual provision of feedback to	Driving 987 km in a car

		feedback to 'recruiters' at participating units.	'recruiters' at participating units.	
<b>Other benefits</b>	104 tonnes	In-person conference attendance; onsite working.	Virtual conference attendance; home- working.	Driving 624,000 km in a car
<b>Total</b>	136 tonnes	-	-	Driving 419,503 km in a car

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### 93 **Workstream 1**

94 The net saving for workstream 1 was 12 tonnes of CO<sub>2</sub>e (emissions saved 12 tonnes; emissions used  
95 0). Key savings were related to travel due to online reconfiguration of study meetings, UK-wide site  
96 visits.

97

### 98 **Workstream 2**

99 The net saving for workstream 2 was 20 tonnes of CO<sub>2</sub>e (total emissions saved 20 tonnes; emissions  
100 used 0.74 tonnes). 50% of participants opted for virtual interviews/'photovoice' in place of  
101 traditional ethnographic methods such as face-to-face semi-structured interviews. Subsequently,  
102 researcher travel to base hospitals and satellite haemodialysis units was also reduced by 50%. The  
103 purchase of a smartphone and two electronic tablets incurred 0.74 tonnes of CO<sub>2</sub>e.

104

### 105 **Workstream 3**

106 The net saving for workstream 3 was 0.32 tonnes of CO<sub>2</sub>e (total emissions saved 0.32; emissions  
107 used 0). Researcher travel was reduced by 100% as semi-structured interviews, attendance and  
108 observations of, trial management meetings, investigator meetings and site visits, and provision of  
109 feedback regarding recruitment to participating units were completed remotely.

110

60



### 111 **Cost savings**

112 All adaptations to the study organisation, management and design were made within the original  
113 study budget and resulted in significant cost savings. This included costs for travel, consumables and  
114 researcher time. In the first 18 months, the estimated total travel saving was £9,659 across all  
115 workstreams, meaning 93% of the travel budget (£10,391) and 24% of the entire non-staff costs  
116 (£40,603) were saved. The underspend was repurposed for researcher training, participant benefit  
117 and further opportunities for scientific communication (conference attendance and publication open  
118 access dissemination costs) following funder approval.

### 120 **Other benefits**

121 Additional CO<sub>2</sub>e savings were incurred through virtual attendance at national and international  
122 conferences and reduced travel due to home-working, saving 71 tonnes and 33 tonnes of CO<sub>2</sub>e  
123 respectively across all workstreams. Virtual patient experience activities resulted in geographical and  
124 ethnic diversity of group members as individuals joined from various locations across the UK (see  
125 figure 1).

### 127 **The value of this experience**

128 To date, adaptations to the management of the NightLife study have resulted in a net saving of 136  
129 tonnes of CO<sub>2</sub>e. Key savings were related to travel due to reconfiguration of study meetings, UK-  
130 wide site visits. Extrapolating these data forward will lead to further increases in savings over the  
131 five year study period based on a hybrid approach now that restrictions have been lifted.

133 The benefits of the NightLife study adaptations go beyond the positive environmental impact.

134 Interestingly, 50% of participants opted for virtual interviews and/or 'photovoice' in place of face-to-  
135 face semi-structured interviews, which revealed a holistic insight into the lived experience of  
136 haemodialysis. Photovoice allowed the researcher to approach the observational element

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3 137 differently, allowing participants to lead data collection and extend it into their home life; the  
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5 138 experience of haemodialysis is a constant life disruption, not limited to the time spent in the clinical  
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7 139 environment. This added richness in findings that may not have been achieved with traditional  
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10 140 ethnographic methods alone.

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14 142 All adaptations to the study organisation, management and design were made within the original  
15  
16 143 study budget and resulted in significant cost savings which were repurposed following funder  
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18 144 approval. Additional CO<sub>2</sub>e savings were incurred through virtual attendance at national and  
19  
20 145 international conferences and reduced travel due to home-working.

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25 147 Teleconferencing, video-conferencing and web-based training materials were proven to be effective.  
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27 148 The inaugural investigator meeting was held entirely remotely with more than 40 attendees from  
28  
29 149 the research and nephrology community across the UK. The virtual nature of trial management and  
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31 150 oversight committee meetings allowed more flexibility for meeting attendance, particularly for  
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33 151 committee members based abroad. Indeed, the frequency of these meetings was increased to  
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35 152 support the ongoing oversight of the study at no additional cost. However, there is room and need  
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37 153 for hybrid approaches to some clinical trial activities, with an acceptance of some CO<sub>2</sub>e.

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43 155 Debates are ongoing about how to incorporate a diverse range of patient voices in the design and  
44  
45 156 delivery of research, highlighting a lack of diversity and inclusion (8). The use of alternative meeting  
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47 157 techniques as part of the NightLife study resulted in both geographical and ethnic diversity of the  
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49 158 patient experience group, enriching the feedback of the lived experience of kidney disease and  
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51 159 haemodialysis.

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57 161 The findings of our work are supported by a retrospective analysis of 12 pragmatic randomised  
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59 162 control trials (9); emissions are often generated in areas where steps could be taken to reduce them,  
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3 163 such as travel and trial conduct. Resistance to such changes, however, is common. Trial-related  
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5 164 travel is often comprised of heavy emissions (particularly where multi-centre studies are concerned).  
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7 165 Traditionally this has included travel to site visits across the UK (by rail and road), as well as  
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9 166 investigator meetings which often include international travel (by air), oversight committee  
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11 167 meetings, training, onsite monitoring and closedown visits, as well as conference attendance  
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13 168 throughout the study's duration. These are travel related activities that most Clinical Trials Units  
14  
15 169 (CTUs) cost for when considering the generation of a trial grant. This is generally done by aligning  
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17 170 activities and associated costs with the risk of study. For example, clinical trials of investigational  
18  
19 171 medicinal products (CTIMPs) are deemed higher risk, therefore onsite monitoring of participating  
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21 172 sites and pharmacies and resulting travel is a necessity. However, where trials are not bound by such  
22  
23 173 strict legislation, COVID-19 has presented an opportunity to change these practices in a way that  
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25 174 reduces the trial's carbon footprint, as reflected by our changes in the NightLife study.  
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32 176 Typically, most CTUs continue to utilise paper Investigator Site Files (ISFs). However, this approach to  
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34 177 trial organisation and data management is being challenged and there is widespread recognition  
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36 178 from the research community for significant improvements in environmental sustainability within  
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38 179 clinical trials (10) . There are many ways to reduce waste with increasing scope to switch from paper  
39  
40 180 to electronic trial management systems (e.g. ISFs) in order to (i) minimise paper usage and storage  
41  
42 181 requirements; (ii) increase document accessibility; (iii) streamline management, monitoring and  
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44 182 archiving of multi-centre clinical trials and; (iv) reduce monetary costs. Adshead *et al* suggest that  
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46 183 clinical trials with a lower carbon footprint should be prioritised by funders, and just as researchers  
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48 184 have to justify to funders the budget for a trial, they should also have to justify the carbon footprint  
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50 185 to their stakeholders and demonstrate that it as low as possible (10).  
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### 57 187 **An aid for future trial design and further work**

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3 188 To the authors' knowledge, this is one of few articles to consider and evaluate the environmental  
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5 189 improvements that can be made by remote working and virtual adaptations to study designs when  
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7 190 establishing multi-centre RCTs. This work has the potential to act as a guide for other clinical trials to  
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9 191 reduce cost and their environmental impact. It also demonstrates how to enhance geographical  
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11 192 diversity of research teams without excessive cost.  
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16 194 **Take home messages**

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18 195 The COVID-19 pandemic presented a need to adapt clinical trials to protect patients, carers, clinical  
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20 196 teams and researchers, and accelerated a pre-existing drive to reduce the carbon footprint of  
21  
22 197 research. Study processes needed to evolve rapidly to ensure they were robust and financially lean  
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24 198 in the COVID-19 era. The legacy of such changes has been wide ranging but of note, the impact on  
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26 199 CO<sub>2e</sub> saving experienced in the NightLife study is a benefit that should inspire and drive the  
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28 200 reduction of the carbon impact of all clinical trials from now and into the future. We have  
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30 201 highlighted opportunities for investigators and trial management teams to implement alternative  
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32 202 approaches to designing and conducting clinical trials in order to make them less carbon intensive,  
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34 203 more environmentally sustainable and better value for money.  
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4 206 **Contributors**

5 207 The paper was conceived by NQ and JB. SB performed the carbon footprint calculations. NQ, JB, KH,  
6  
7 208 VC, CR, KM, CC, LR and HE reviewed and approved the final draft submitted.  
9

10 209

11  
12 210 **Funding**

13  
14 211 The NightLife study is funded by the National Institute for Health and Care Research (NIHR) Health  
15  
16 212 Technology Assessment (HTA) programme (funder reference: NIHR127440). The views expressed are  
17  
18 213 those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social  
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20 214 Care.  
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25 216 **Competing interests**

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27  
28 217 None declared.  
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32 219 **Patient consent**

33  
34 220 Not required.  
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39 222 **Provenance and peer review**

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41 223 Not commissioned; externally peer reviewed.  
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46 225 **Data availability statement**

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48 226 No additional data available.  
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227 **References**

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3 251 **Figures**  
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5 252 Figure 1: Map of UK showing geographical locations of patient experience group members  
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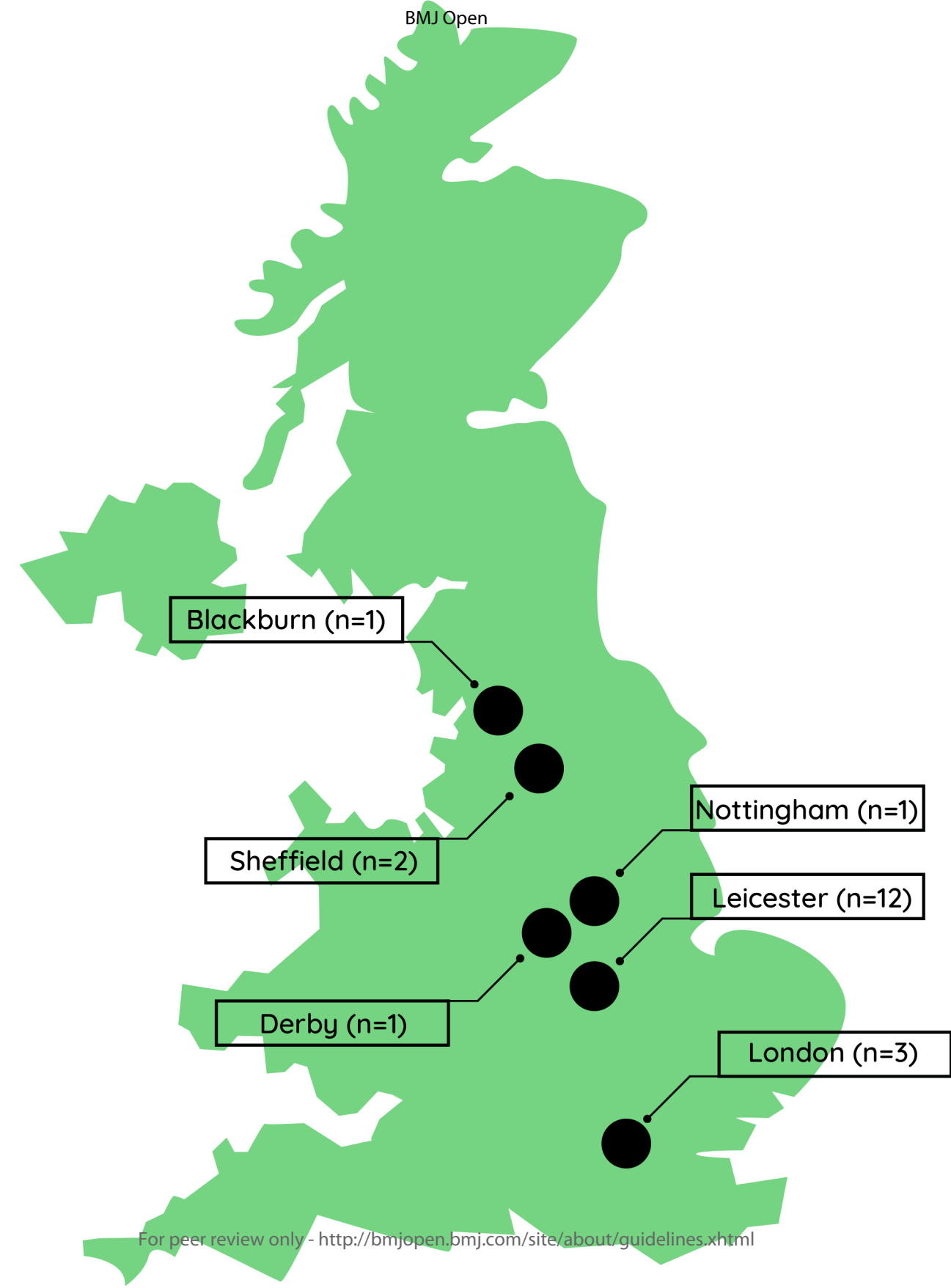
8 254 **Tables**

9 255

10 256 Table 1: Table summarising the net CO<sub>2</sub>e saving for each workstream and real-life equivalent values  
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For peer review only

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# BMJ Open

## Reducing the carbon footprint of research: experience from the NightLife study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2022-070200.R3
Article Type:	Communication
Date Submitted by the Author:	03-Mar-2023
Complete List of Authors:	<p>Quann, Niamh; University of Leicester, Leicester Clinical Trials Unit, College of Life Sciences  Burns, Steph; University Hospitals of Leicester NHS Trust  Hull, Katherine; University of Leicester, Department of Cardiovascular Sciences, College of Life Sciences; University Hospitals of Leicester NHS Trust, John Walls Renal Unit, Leicester General Hospital  Cluley, Victoria; University of Nottingham, School of Sociology and Social Policy  Richardson, Carla; University of Leicester, Leicester Clinical Trials Unit, College of Life Sciences  MacConaill, Kateryna; University Hospitals of Leicester NHS Trust, John Walls Renal Unit, Leicester General Hospital  Conefrey, Carmel; University of Bristol Medical School, Bristol Population Health Science Institute  Rooshenas, Leila; University of Bristol, Bristol Population Health Science Institute, Bristol Medical School  Eborall, Helen; University of Edinburgh , Usher Institute, College of Medicine and Veterinary Medicine  Burton, James; University of Leicester, Department of Cardiovascular Sciences, College of Life Sciences; University Hospitals of Leicester NHS Trust, John Walls Renal Unit, Leicester General Hospital</p>
<b>Primary Subject Heading</b>:	Renal medicine
Secondary Subject Heading:	Research methods
Keywords:	Nephrology < INTERNAL MEDICINE, NEPHROLOGY, Dialysis < NEPHROLOGY, End stage renal failure < NEPHROLOGY, Quality of Life

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3 **1 Reducing the carbon footprint of research: experience from the NightLife study**

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6  
7 3 MacConaill<sup>3,4</sup>, Carmel Conefrey<sup>5</sup>, Leila Rooshenas<sup>5</sup>, Helen Eborall<sup>6</sup>, James O Burton<sup>3,4,7</sup> on behalf of  
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9 4 the NightLife Study Team

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46  
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49  
50 22 **Keywords:** Carbon footprint, CO<sub>2</sub>e emissions, climate change, environmental sustainability, carbon  
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52 23 reduction, carbon impact, clinical trials, trial conduct, randomised controlled trial

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2  
3 25 **Abstract**  
4

5 26 As set out in the Climate Change Act (2008), the UK National Health Service (NHS) has made a  
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7 27 commitment to halve greenhouse gas emissions by 2025 and reach net-zero by 2050. Research  
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9 28 forms a core part of NHS activity and reducing the carbon footprint of clinical trials is a core element  
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11 29 of the National Institute for Health and Care Research (NIHR) Carbon Reduction Strategy (2019).  
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14 30 However, support from funding organisations on how to achieve these targets is lacking. This brief  
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16 31 Communication article reports the reduction in the carbon footprint of the NightLife study, an  
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18 32 ongoing multicentre randomised controlled trial assessing the impact of in-centre nocturnal  
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20 33 haemodialysis on quality of life. By using remote conferencing software and innovative data  
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22 34 collection methods, we demonstrated a total saving of 136 tonnes of carbon dioxide equivalent over  
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24 35 three workstreams during the first 18 months of the study, following grant activation on Jan 1<sup>st</sup>,  
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26 36 2020. In addition to the environmental impact, there were additional benefits seen to cost as well as  
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28 37 increased participant diversity and inclusion. This work highlights ways in which trials could be made  
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30 38 less carbon intensive, more environmentally sustainable and better value for money.  
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## 39 **Introduction**

40 The social distancing restrictions implemented during the COVID-19 pandemic had a significant  
41 impact on the delivery and conduct of health research in the UK. Trial management teams played a  
42 key role in rapidly adjusting the way clinical trials were designed and undertaken (1). Although  
43 reductions in the carbon footprint of research activities were not the driving force for the changes  
44 required during the pandemic, it was nevertheless a significant and positive outcome. It is important  
45 that, where possible, clinical trials use these approaches to ensure carbon dioxide equivalent (CO<sub>2</sub>e)  
46 savings and demonstrate an ongoing, responsible commitment to sustainability.

## 48 **Overview of the NightLife study**

49 The NightLife study is an ongoing randomised controlled trial (RCT) using mixed methods to assess  
50 the clinical and cost effectiveness of thrice weekly, extended hours, in-centre nocturnal  
51 haemodialysis in comparison to standard care (ISRCTN87042063(2); see study website(3)),. The  
52 study includes three main workstreams: an RCT and internal pilot (workstream 1), an ongoing  
53 process evaluation (workstream 2) and a QuinteT Recruitment Intervention (QRI, workstream 3) (4).

## 55 **Adjustments to the NightLife study delivery in response to the COVID-19 pandemic**

56 Prior to the COVID-19 pandemic, it was planned to conduct all meetings and qualitative study  
57 elements in a face-to-face manner by ≥20 collaborators across the UK. This included in-person study  
58 launch and oversight committee meetings. Following UK Government instruction, staff worked from  
59 home wherever possible. All meetings, including trial management, oversight committee, patient  
60 experience and site feasibility were reconfigured and held online. Queries and outstanding actions  
61 were resolved via email correspondence. While study processes were conducted remotely, the  
62 patient population (adults receiving thrice weekly in-centre haemodialysis) enabled in-person  
63 recruitment for workstream 2, however all qualitative data was collected remotely. Workstream 1

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3 64 and workstream 3 (which were due to run in parallel) were paused for nine months due to the  
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5 65 impact of COVID-19 on research delivery.  
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10 67 Qualitative data collection through ethnographic methods (in-person observations and real-time  
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12 68 field notes) and interviews with the research team, dialysis unit staff and individuals with kidney  
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14 69 disease were paused and additional data collection techniques were considered to reduce face-to-  
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16 70 face contact. This included virtual interviews using common conference software programmes and  
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19 71 'photovoice'; a participatory research method that utilises participant-led photography of the  
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21 72 phenomena being researched (in this case, the lived experience of haemodialysis) and allows remote  
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23 73 access to experiences and phenomena outside of the immediate field of study (5, 6).  
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#### 27 28 75 **Calculation of carbon footprint**

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30 76 The original grant application outlined the total number of planned face-to-face meetings and  
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32 77 related costings for the duration of the study. This was used to map the study activities which were  
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34 78 reconfigured to virtual methods. Using a web-based carbon footprint calculator (7), the CO<sub>2</sub>e saved  
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36 79 by converting to virtual approaches, home working and alternative qualitative data collection  
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39 80 techniques were estimated. The calculator took into account: travel modality (rail, car, bicycle, air  
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41 81 travel), specific features such as vehicle and fuel type, number of people travelling and distance in  
42  
43 82 miles. For air travel, airport codes and flight class were considered. Estimated CO<sub>2</sub>e savings were  
44  
45 83 calculated over the first 18 months of the NightLife study.  
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#### 49 50 85 **What have we learnt?**

##### 51 52 86 ***Carbon reduction***

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54 87 To date, innovative changes to the management of the NightLife study have resulted in an estimated  
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56 88 net CO<sub>2</sub>e saving of 136 tonnes. The saving of each workstream is outlined below, with real-life  
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59 89 equivalent values detailed in table 1 (7).  
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91 **Table 1.** Table summarising the net CO<sub>2</sub>e saving for each workstream and equivalent kilometres

92 driven in a car (7)

Workstream	Net CO <sub>2</sub> e saving	Original method as per grant application	Adaptations implemented	Equivalent kilometres driven in a standard (non-electric) car
<b>Workstream 1</b>	12 tonnes	Face-to-face trial management, oversight committee, patient experience, site feasibility and study launch meetings.	Virtual trial management, oversight committee, patient experience, site feasibility and study launch meetings. Queries and actions resolved via email.	37,015 km
<b>Workstream 2</b>	20 tonnes	In-person observations; real-time field notes; face-to-face interviews; regular researcher travel to base hospitals and satellite haemodialysis units.	'Photovoice'; virtual interviews; reduced researcher travel to base hospitals and satellite haemodialysis units.	61,692 km
<b>Workstream 3</b>	0.32 tonnes	Face-to-face interviews; in-person attendance at, and observations of, trial management, investigator and site initiation meetings; face-to-face	Virtual interviews; remote attendance at, and observations of, trial management, investigator and site initiation meetings; virtual provision of	987 km

		provision of feedback to 'recruiters' at participating units.	feedback to 'recruiters' at participating units.	
<b>Other benefits</b>	104 tonnes	In-person conference attendance; onsite working.	Virtual conference attendance; home- working.	624,000 km
<b>Total</b>	136 tonnes	-	-	419,503 km

93

#### 94 **Workstream 1**

95 The net saving for workstream 1 was 12 tonnes of CO<sub>2</sub>e (emissions saved 12 tonnes; emissions used  
96 0). Key savings were related to travel due to online reconfiguration of study meetings, UK-wide site  
97 visits.

98

#### 99 **Workstream 2**

100 The net saving for workstream 2 was 20 tonnes of CO<sub>2</sub>e (total emissions saved 20 tonnes; emissions  
101 used 0.74 tonnes). 50% of participants opted for virtual interviews/'photovoice' in place of  
102 traditional ethnographic methods such as face-to-face semi-structured interviews. Subsequently,  
103 researcher travel to base hospitals and satellite haemodialysis units was also reduced by 50%. The  
104 purchase of a smartphone and two electronic tablets incurred 0.74 tonnes of CO<sub>2</sub>e.

105

#### 106 **Workstream 3**

107 The net saving for workstream 3 was 0.32 tonnes of CO<sub>2</sub>e (total emissions saved 0.32; emissions  
108 used 0). Researcher travel was reduced by 100% as semi-structured interviews, attendance and  
109 observations of, trial management meetings, investigator meetings and site visits, and provision of  
110 feedback regarding recruitment to participating units were completed remotely.

111



### 112 **Cost savings**

113 All adaptations to the study organisation, management and design were made within the original  
114 study budget and resulted in significant cost savings. This included costs for travel, consumables and  
115 researcher time. In the first 18 months, the estimated total travel saving was £9,659 across all  
116 workstreams, meaning 93% of the travel budget (£10,391) and 24% of the entire non-staff costs  
117 (£40,603) were saved. The underspend was repurposed for researcher training, participant benefit  
118 and further opportunities for scientific communication (conference attendance and publication open  
119 access dissemination costs) following funder approval.

120

### 121 **Other benefits**

122 Additional CO<sub>2</sub>e savings were incurred through virtual attendance at national and international  
123 conferences and reduced travel due to home-working, saving 71 tonnes and 33 tonnes of CO<sub>2</sub>e  
124 respectively across all workstreams. Virtual patient experience activities resulted in geographical and  
125 ethnic diversity of group members as individuals joined from various locations across the UK (see  
126 figure 1).

127

### 128 **The value of this experience**

129 To date, adaptations to the management of the NightLife study have resulted in a net saving of 136  
130 tonnes of CO<sub>2</sub>e. Key savings were related to travel due to reconfiguration of study meetings, UK-  
131 wide site visits. Extrapolating these data forward will lead to further increases in savings over the  
132 five-year study period based on a hybrid approach now that restrictions have been lifted.

133

134 The benefits of the NightLife study adaptations go beyond the positive environmental impact.

135 Interestingly, 50% of participants opted for virtual interviews and/or 'photovoice' in place of face-to-  
136 face semi-structured interviews, which revealed a holistic insight into the lived experience of  
137 haemodialysis. Photovoice allowed the researcher to approach the observational element

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3 138 differently, allowing participants to lead data collection and extend it into their home life; the  
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5 139 experience of haemodialysis is a constant life disruption, not limited to the time spent in the clinical  
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7 140 environment. This added richness in findings that may not have been achieved with traditional  
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9 141 ethnographic methods alone.  
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14 143 All adaptations to the study organisation, management and design were made within the original  
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16 144 study budget and resulted in significant cost savings which were repurposed following funder  
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18 145 approval. Additional CO<sub>2</sub>e savings were incurred through virtual attendance at national and  
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20 146 international conferences and reduced travel due to home-working.  
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25 148 Teleconferencing, video-conferencing and web-based training materials were found to be effective.  
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27 149 The inaugural investigator meeting was held entirely remotely with more than 40 attendees from  
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29 150 the research and nephrology community across the UK. The virtual nature of trial management and  
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31 151 oversight committee meetings allowed more flexibility for meeting attendance, particularly for  
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33 152 committee members based abroad. Indeed, the frequency of these meetings was increased to  
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35 153 support the ongoing oversight of the study at no additional cost. However, an objective assessment  
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37 154 of the impact of remote working and study activities is beyond the scope of this work. As we move  
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39 155 away from the COVID-19 lockdown era, there is room and need for hybrid approaches to various  
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41 156 clinical trial activities, with an acceptance of some CO<sub>2</sub>e emissions.  
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48 158 Debates are ongoing about how to incorporate a diverse range of patient voices in the design and  
49  
50 159 delivery of research, highlighting a lack of diversity and inclusion (8). The use of alternative meeting  
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52 160 techniques as part of the NightLife study resulted in both geographical and ethnic diversity of the  
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54 161 patient experience group, enriching the feedback of the lived experience of kidney disease and  
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56 162 haemodialysis.  
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3 164 The findings of our work are supported by a retrospective analysis of 12 pragmatic randomised  
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5 165 control trials (9); emissions are often generated in areas where steps could be taken to reduce them,  
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7 166 such as travel and trial conduct. Resistance to such changes, however, is common. Trial-related  
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10 167 travel is often comprised of heavy emissions (particularly where multicentre studies are concerned).  
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12 168 Traditionally this has included travel to site visits across the UK (by rail and road), as well as  
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14 169 investigator meetings which often include international travel (by air), oversight committee  
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16 170 meetings, training, onsite monitoring and closedown visits, as well as conference attendance  
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19 171 throughout the study's duration. These are travel related activities that most Clinical Trials Units  
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21 172 (CTUs) cost for when considering the generation of a trial grant. This is generally done by aligning  
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23 173 activities and associated costs with the risk of study. For example, clinical trials of investigational  
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25 174 medicinal products (CTIMPs) are deemed higher risk, therefore onsite monitoring of participating  
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28 175 sites and pharmacies and resulting travel is a necessity. However, where trials are not bound by such  
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30 176 strict legislation, COVID-19 has presented an opportunity to change these practices in a way that  
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32 177 reduces the trial's carbon footprint, as reflected by our changes in the NightLife study.  
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37 179 Typically, most CTUs continue to utilise paper Investigator Site Files (ISFs). However, this approach to  
38  
39 180 trial organisation and data management is being challenged and there is widespread recognition  
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41 181 from the research community for significant improvements in environmental sustainability within  
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43 182 clinical trials (10) . There are many ways to reduce waste with increasing scope to switch from paper  
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45 183 to electronic trial management systems (e.g. ISFs) in order to (i) minimise paper usage and storage  
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47 184 requirements; (ii) increase document accessibility; (iii) streamline management, monitoring and  
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50 185 archiving of multicentre clinical trials and; (iv) reduce monetary costs. Adshead *et al* suggest that  
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52 186 clinical trials with a lower carbon footprint should be prioritised by funders, and just as researchers  
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54 187 have to justify to funders the budget for a trial, they should also have to justify the carbon footprint  
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57 188 to their stakeholders and demonstrate that it as low as possible (10).  
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3 **190 An aid for future trial design and further work**  
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5 191 To the authors' knowledge, this is one of few articles to consider and evaluate the environmental  
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7 192 improvements that can be made by remote working and virtual adaptations to study designs when  
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9 193 establishing multicentre RCTs. This work has the potential to act as a guide for other clinical trials to  
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11 194 reduce cost and their environmental impact. It also demonstrates how to enhance geographical  
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13 195 diversity of research teams without excessive cost.  
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19 **197 Take-home messages**  
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21 198 The COVID-19 pandemic presented a need to adapt clinical trials to protect patients, carers, clinical  
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23 199 teams and researchers, and accelerated a pre-existing drive to reduce the carbon footprint of  
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25 200 research. Study processes needed to evolve rapidly to ensure they were robust and financially lean  
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27 201 in the COVID-19 era. The legacy of such changes has been wide ranging but of note, the impact on  
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29 202 CO<sub>2</sub>e saving experienced in the NightLife study is a benefit that should inspire and drive the  
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31 203 reduction of the carbon impact of all clinical trials from now and into the future. We have  
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33 204 highlighted opportunities for investigators and trial management teams to implement alternative  
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35 205 approaches to designing and conducting clinical trials in order to make them less carbon intensive,  
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37 206 more environmentally sustainable and better value for money.  
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3 209 **Contributors**

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5 210 The paper was conceived by NQ and JB. SB performed the carbon footprint calculations. NQ, JB, KH,  
6  
7 211 VC, CR, KM, CC, LR and HE reviewed and approved the final submitted manuscript.  
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11  
12 213 **Funding**

13  
14 214 The NightLife study is funded by the National Institute for Health and Care Research (NIHR) Health  
15  
16 215 Technology Assessment (HTA) programme (funder reference: NIHR127440). The views expressed are  
17  
18 216 those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social  
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20 217 Care.  
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25 219 **Competing interests**

26  
27 220 None declared.  
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32 222 **Patient consent**

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34 223 Not required.  
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39 225 **Provenance and peer review**

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41 226 Not commissioned; externally peer reviewed.  
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46 228 **Data availability statement**

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48 229 No additional data available.  
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3 254 **Figure title**  
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5 255 **Figure 1.** Map of the UK showing geographical locations of patient experience group members  
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