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Expert article

Physiotherapy-assisted prone or modified prone positioning in ward-based patients with COVID-19: a retrospective cohort study

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Abstract

Objectives To evaluate short-term change in oxygenation and feasibility of physiotherapy-assisted prone or modified prone positioning in awake, ward-based patients with COVID-19.
Design Retrospective observational cohort study.
Setting General wards, single-centre tertiary hospital in Australia.
Participants Patients were included if ≥18 years, had COVID-19, required $FiO_2 \geq 0.28$ or oxygen flow rate ≥4 l/minute and consented to positioning. Main outcome measures: Feasibility measures included barriers to therapy, assistance required, and comfort. Short-term change in oxygenation (SpO_2) and oxygen requirements before and 15 minutes after positioning.
Results Thirteen patients, mean age 75 (SD 14) years; median Clinical Frailty Scale score 6 (IQR 4 to 7) participated in 32 sessions of prone or modified prone positioning from a total of 125 ward-based patients admitted with COVID-19 who received physiotherapy intervention. Nine of thirteen patients (69%) required physiotherapy assistance and modified positions were utilised in 8/13 (62%). SpO2 increased in 27/32 sessions, with a mean increase from 90% (SD 5) pre-positioning to 94% (SD 4) (mean difference 4%; 95%CI 3 to 5%) after 15 minutes. Oxygen requirement decreased in 14/32 sessions, with a mean pre-positioning requirement of 8 l/minute (SD 4) to 7 l/minute (SD 4) (mean difference 2 l/minute; 95%CI 1 to 3 l/minute) after 15 minutes. In three sessions oxygen desaturation and discomfort occurred but resolved immediately by returning supine.
Conclusion Physiotherapy-assisted prone or modified prone positioning may be a feasible option leading to short-term improvements in oxygenation in awake, ward-based patients with hypoxemia due to COVID-19. Further research exploring longerterm health outcomes and safety is required.

Keywords: COVID-19; Physical therapy modalities; Prone positioning; Acute respiratory failure

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Contribution of the Paper

- Prone positioning may offer a therapeutic option for awake, ward-based patients with hypoxemic respiratory failure due to COVID-19
- Physiotherapy assistance and use of modified prone positions may enable patients with high clinical frailty scale scores and full prone limitations, such as obesity, to engage in prone positioning
- Prone or modified prone positioning leads to short-term improvements in oxygen saturation and reduced oxygen requirements, although further studies are required to determine longer term effects and safety in ward-based settings

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Introduction

Severe acute respiratory syndrome coronavirus (SARS-CoV-2) emerged in early 2019 and is a multifactorial lung process, with early viral pneumonitis, potentially evolving to overt acute respiratory distress syndrome (ARDS) [1]. There is also mounting evidence that patients experience a concurrent microvascular angiopathy and are at high risk of larger vessel pulmonary thrombosis [2]. The resulting combination of pulmonary parenchymal and vascular impairment results in significant ventilation/perfusion mismatch and disproportionate hypoxaemia [3]. Prone positioning is a valuable strategy to counteract this physiologic impairment by achieving a more homogeneous distribution of ventilation, reducing shunt fraction and optimising ventilation perfusion matching [4]. Side-lying positions may be also associated with beneficial effects on gas exchange in awake patients with COVID-19 [5].

Despite there being limited and low-quality evidence, there is growing interest in the use of prone positioning in patients with COVID-19 outside intensive care settings [6]. Guidelines have been developed for the use of prone positioning in awake, non-intubated patients [7,8] based on the success of prone positioning in mechanically ventilated patients with COVID-19 and those with non-COVID-19 related acute respiratory distress syndrome (ARDS) [9]. Prone positioning is associated with improvements in oxygenation in ward based settings, however, only a minority of studies have been conducted on patients with low respiratory support requirements [10]. Exploring the use of prone positioning in patients with low respiratory support requirements may offer further treatment options for individuals managed in ward-based settings where intensive care admission or high levels of respiratory support, such as non-invasive ventilation (NIV) or continuous positive airway pressure (CPAP) are not appropriate due to limits of care.

External to intensive care settings, clinician input is critical to ensure prone positioning is safe and successful [11]. Physiotherapists have the skills and knowledge to explore assisted and modified prone positioning, based on physiological principles and patients' functional ability, whilst also managing risks [12]. Physiotherapy-assisted prone and modified prone positioning is evolving in clinical practice [8] and although it has not been specifically evaluated in ward-based patients with COVID-19 it may provide a further treatment option for patients with functional limitations. Furthermore, previous studies exploring awake prone positioning have generally not considered a modified prone position for patients unable to achieve a full prone position.

The objective of this study is to evaluate the short-term change in oxygenation and feasibility of physiotherapy-assisted prone or modified prone positioning in awake patients with COVID-19, managed in a ward-based setting of a tertiary teaching hospital in Melbourne, Australia.

Methods

Study design and setting

A retrospective cohort study was conducted at St Vincent's Hospital Melbourne (SVHM) and included patients diagnosed with COVID-19 between July and September 2020. This time period included the surge of COVID-19 patient admissions in this Melbourne-based hospital. During the time of the study, admissions included many people from residential aged care facilities (RACF) who had tested positive to COVID-19 and were transferred to hospital related to government directives regardless of their requirement for medical intervention or respiratory support. The study was approved by the institutional ethics review committee, including a waiver of consent for data collection and use. The study was reported according to the STROBE guidelines [13].

Patients included were in a general ward setting and were agreeable to physiotherapy-assisted prone or modified prone positioning. Patients in this study were managed on the SVHM general wards due to having low respiratory support requirements or because they were deemed inappropriate for intensive care as per their Acute Resuscitation Plan. The maximum oxygen requirement able to be delivered in this setting was high-flow oxygen therapy up to 40 l/minute, with a FiO_2 of 0.50. The treating medical team documented oxygen saturation targets for each patient.

Suitability and decision making around which patients were appropriate and would potentially benefit from prone positioning was based on established algorithms (Appendix A and B). Awake prone positioning was offered as a treatment option if patients were hypoxic, requiring a $FiO_2 \geq 0.28$

or oxygen flow rates of ≥4 l/minute to achieve target oxygen saturations [7]; had capacity to consent to therapy, accepting prone positioning as part of their treatment; and were not deemed for end of life care as per the medical team. Patients were excluded if they had an altered mental state impeding their ability to understand and participate in the treatment.

A standardised approach was undertaken when prone positioning was attempted. There was no pre-oxygenation provided prior to positioning. The treating physiotherapist/s took a SpO_2 measurement before assisting the patient into a prone or modified prone position (Appendix C).

Prone – patients lay on their front with their head turned to one side and both arms tucked under the chest/shoulders or positioned above their head.

Three quarter (3/4) prone – patients lay towards their front with pillow support beneath their body and head turned to one side.

Side lie – patients lay on their side with a pillow in front / beneath their trunk and another between their knees for support.

All vital signs were monitored throughout the duration of the physiotherapy positioning treatment and prone positioning was ceased if any measurements reached clinical review criteria on the adult observation and response chart (heart rate >100; SpO_2 <the documented target oxygen saturations, systolic blood pressure >180 or <90, respiratory rate >25). Appropriate placement of padding and pillows to pressure points, such as the shoulders, pelvis, knees and ankles, was used throughout to increase comfort and reduce the risk of pressure injuries. After obtaining a suitable position, the treating physiotherapist asked the patient if they were comfortable and amenable to remain in the position. For safety purposes all patients were monitored by the physiotherapist for a minimum of 15 minutes following position change. After being in the position for 15-minutes, a SpO_2 measurement was taken. If deemed stable and the patient was comfortable and agreeable, patients stayed in the position and were monitored by nursing staff. Nursing staff had a 1:4 nurse to patient ratio and could notify the physiotherapist if they desaturated or required assistance to return the patient to their usual supine position. Nursing staff did not participate in data collection, meaning reliable data on the duration of the intervention was unavailable. Routine nursing care included regular repositioning for pressure care however this differs from therapeutic positioning to optimise respiratory function. The treating physiotherapists entered their notes into the patient's electronic medical record as per usual clinical practice.

Patient selection

The medical records of all COVID-19 ward admissions were screened between 19th July–23rd September 2020. Patients were included in the study if they were of adult age (≥18 years), had a confirmed diagnosis of COVID-19 by nasopharyngeal RT-PCR; and required a FiO_2 ≥ 0.28 or oxygen flow rate of ≥4 l/minute to achieve documented target oxygen saturation levels. Those patients included in the study consented to assisted prone or modified prone positioning as part of their physiotherapy treatment (Fig. 1).

Data collection and management

Investigators (CT, SH) retrospectively screened the electronic medical records of all patients admitted to the medical wards at SVHM with COVID-19 and independently extracted relevant data on all individuals who received physiotherapy-assisted prone or modified prone positioning. The relevant data was extracted in a de-identified form into an excel spreadsheet. All data was stored in password protected electronic documents on secure organisational drives with access only by study personnel.

Patient demographic data and baseline clinical characteristics included age, gender, Charlson Comorbidity Index (CCI) score [14], Clinical Frailty Scale score [15], smoking history, usual place of residence, premorbid independence with activities of daily living (ADLs) and premorbid mobility (PMM) status. Clinical data consisted of length of hospital stay, acute ward and ICU stay, treatment limitation orders, resuscitation orders, and medical treatment. Survival and discharge disposition were also recorded.

Outcomes

Outcomes of interest relating to feasibility and short-term change in oxygenation were based on similar studies in awake patients using prone positioning [16–18]. Feasibility measures such as the success rate in achieving prone or modified prone positions, physiotherapy staffing requirements, and recognition of barriers to therapy and patient comfort from subjective reporting, were identified. Short-term change in oxygenation was measured by changes in oxygen saturations (SpO_2 measured using pulse oximetry) and changes in oxygen requirements (litres of oxygen (l/minute)) before and 15 minutes after prone or modified prone positioning. Any transient oxygen desaturation, oxygen or intravenous tubing displacement during the physiotherapy session were also recorded.

Statistical analysis

Descriptive and categorical data was summarised in frequency tables, presenting the subject counts and percentages. Continuous data was summarised using mean (standard deviation (SD)) or median (interquartile range (IQR)) figures, depending on the underlying distribution of data. Univariate analyses were performed, using chi-square or Fisher's exact test for categorical variables and Mann–Whitney '*U*' test or independent samples *t*-test as appropriate for continuous variables. Comparison of the mean (IQR) oxygen saturations (SpO_2) and oxygen requirements (l/minute)

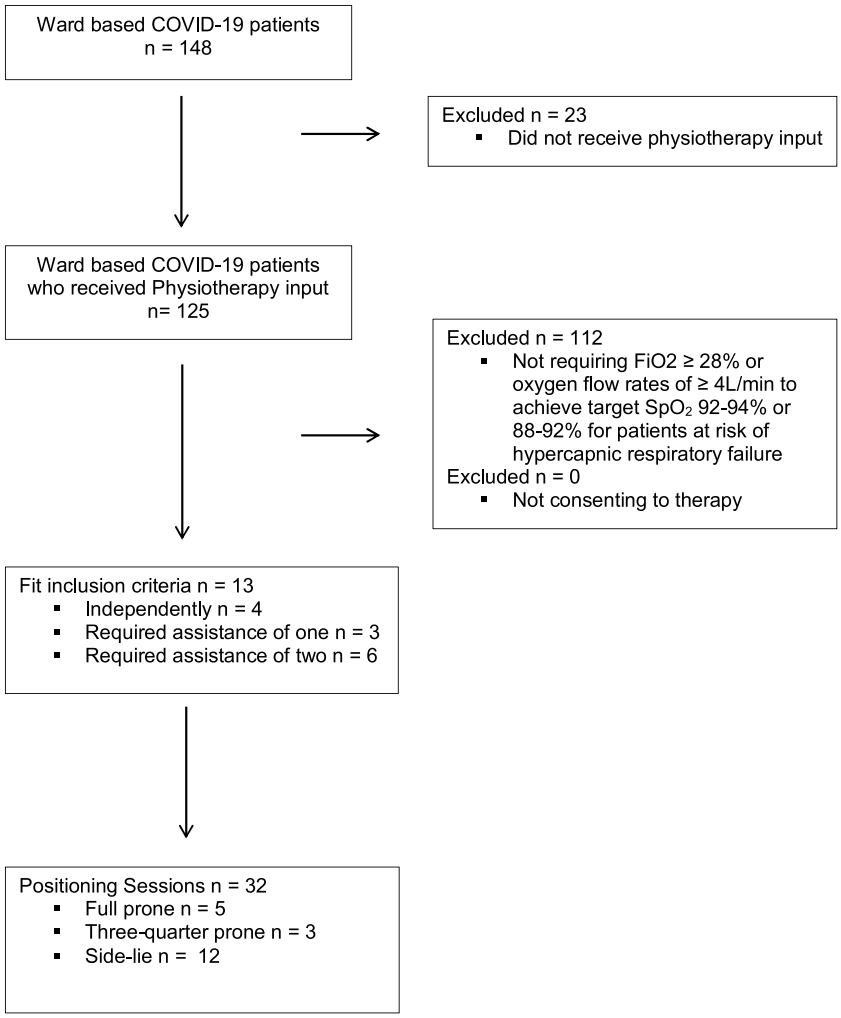

Fig. 1. Selection of patients appropriate for physiotherapy assisted, prone or modified prone positioning.

immediately before and 15 minute after prone positioning was completed using the paired samples t-test. Analyses were conducted using SPSS version 24 (IBM SPSS Inc, Armonk, NY).

Results

During the study period, 148 patients with COVID-19 were admitted to general wards, 125 of these patients received physiotherapy intervention and 13 patients fulfilled the inclusion criteria and consented to prone or modified prone positioning as part of this intervention (Fig. 1). Demographic data and clinical characteristics are summarised in Table 1. Mean age of the patient cohort was 75 (SD 14) years, median Charlson Comorbidity Index was 6 (IQR 3 to 8), median Clinical Frailty Scale score was 6 (IQR 4 to 7) and 5/13 (39%) patients lived in supported accommodation or a RACF. The median hospital length of stay (LOS) on the acute ward was 14 (IQR 10 to 17.5) days and 10/13 (77%) patients had treatment limitation orders in place.

Feasibility

During the study period, a total of 32 physiotherapy-assisted, prone or modified prone positioning sessions were completed on 13 patients, with a median of 1.5 (IQR 1 to 4) sessions per patient. Four of the 13 (31%) patients were able to independently obtain a prone position, 3/13 (23%) patients required the assistance of one physiotherapist and 6/13 (46%) patients required the assistance of two physiotherapists. A full prone position was tolerated in all sessions for 5/13 (39%) patients and in three out of four sessions for one patient (8%). A modified prone position was used with 8/13 (62%) patients in 15/32 (47%) sessions. Of the sessions when a modified position was required, three-quarter prone was used in 3/15 (20%) sessions and side-lie in 12/15 (80%) sessions. Obesity was the most common reason (in 4/8 (50%) patients) why a decision was made to use a modified prone position to improve patient comfort. The only other reason for use of a modified position instead of full prone was due to the post-operative orders for a patient who had recently had neck surgery. Four (31%) patients reported musculoskeletal

Table 1
Demographic and clinical details of the cohort.

Variable (unit)	Cohort ($n = 13$)	Survivors ($n = 6$)	Non-survivors ($n = 7$)
Age (Years), mean (SD)	75 (14)	67 (16)	82 (7)
Male gender, n (%)	9 (69)	4 (67)	5 (71)
Preferred language, n (%)			
- English	9 (69)	5 (83)	4 (57)
-NESL	4 (31)	1 (17)	3 (43)
Charlson comorbidity index (CCI) score, median (IQR)	6 (3 to 8)	3 (1 to 6)	6 (6-8)
Clinical Frailty Score, median (IQR)	6 (3 to 7)	3 (2 to 5)	7 (6 to 7)
Smoking history, n (%)			
- Current	1 (8)	1 (17)	0 (0)
- Past	7 (54)	2 (33)	5 (71)
- Never	5 (39)	3 (50)	2 (29)
Usual place of residence, n (%)			
- Home	8 (62)	4 (67)	4 (57)
- Supported accommodation	3 (23)	1 (17)	2 (29)
- Nursing home	2 (15)	1 (17)	1 (14)
Activities of daily living (ADLs), n (%)			
- Independent	6 (46)	5 (83)	1 (14)
- Requires assistance	7 (54)	1 (17)	6 (86)
Premorbid mobility (PMM), n (%)			
- Independent	8 (62)	6 (100)	2 (29)
- Supervision	3 (23)	0 (0)	3 (43)
- 1x assist	2 (15)	0 (0)	2 (29)
Hospital LOS (days), median (IQR)	15 (11 to 18)	20 (12 to 26)	11 (11 to 16)
LOS on the acute ward (days), median (IQR)	14 (10 to 18)	20 (10 to 26)	11 (11 to 16)
LOS in ICU (days), median (IQR)	2 (1 to 2)	2 (1 to 2)	0 (0-0)
ICU admission, n (%)			
- Yes	2 (15)	2 (33)	0 (0)
- No	11 (85)	4 (67)	7 (100)
Treatment limitation orders, n (%)			
- Not for escalation beyond ward-based care	10 (77)	3 (50)	7 (100)
- No limitations to escalation beyond ward-based care	3 (23)	3 (50)	0 (0)
Resuscitation orders, n (%)			
- Not for resuscitation	10 (77)	3 (50)	7 (100)
- For resuscitation	3 (23)	3 (50)	0 (0)
Medical treatment, n (%)			
- Antibiotic and corticosteroid agents	7 (54)	1 (17)	6 (86)
- Antibiotic, corticosteroid and antiviral agents	6 (46)	5 (83)	1 (14)

n = number, IQR = interquartile range, NESL = non english speaking language, LOS = length of stay.

pain which limited their ability to remain in a prone or modified prone position. The mean age of patients' who reported musculoskeletal pain was 85 (SD 6) years.

Short-term change in oxygenation

Across 32 sessions, SpO_2 increased after 15-minutes in prone or modified prone in 27/32 (84%) sessions, 1–3% in 9/27 (33%) sessions and ≥4% in 18/27 (67%) sessions. SpO_2 was unchanged in 3/32 (9%) sessions and reduced in 2/32 (6%) sessions by 3% (Fig. 2 and supplementary material). The mean SpO_2 increased from 90% (SD 5) pre-positioning to 94% (SD 4) (mean difference 4%; 95% CI 3 to 5%) after 15 minutes of positioning. Across 32 sessions, oxygen requirement decreased in 14/32 (44%) sessions and was unchanged in 18/32 (56%) sessions. The mean oxygen usage prior to prone or modified prone positioning was 8 l/minute (SD 4) vs 7 l/minute (SD 4) (mean difference 2 l/minute; 95% CI 1 to 3 l/minute) after 15 minutes of positioning. Three patients during seven sessions were able to wean from a non-rebreather or Hudson mask to nasal prongs. Two patients, during one session each, were on high flow oxygen therapy via an AIRVO machine and experienced no change in oxygen requirement before or 15 minutes after initiating prone positioning.

There were 3/32 sessions in which physiotherapy care was modified due to a patient's negative response to positioning. For one patient, the only session they completed was limited to 15 minutes due to self-reported discomfort and observed increased work of breathing that resolved with supine repositioning. Another patient had 2/4 sessions limited to 90 minutes and 25 minutes due to drop in oxygen saturation of 3% during each session which resolved with supine repositioning.

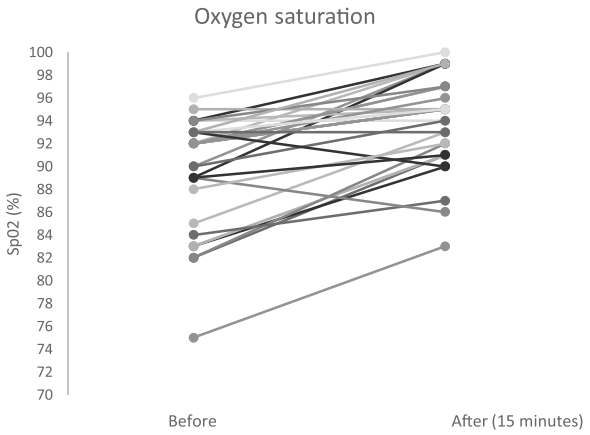

Fig. 2. Scatter plot for changes in oxygenation after 15-minutes in prone or modified prone positioning across all 32 physiotherapy sessions (for scatter plots for individual participant results please see the Supplementary material).

Discharge

Six out of 13 (46%) patients survived to hospital discharge with 3 (50%) being discharged to their usual residence and 3 (50%) being transferred to a subacute facility. Seven (54%) patients did not survive hospital admission, these patients were more likely to be frail and require assistance with premorbid ADLs and mobility.

Discussion

This retrospective observational study described the feasibility and short-term change in oxygenation of physiotherapy-assisted prone or modified prone positioning in awake, ward-based patients with COVID-19.

The cohort of patients had a high mortality rate, which was expected given their age, comorbidities, level of frailty and limits of care. A major concern throughout the study was that prone positioning in acutely unwell, frail patients could have resulted in discomfort or distress with little known benefit to the patients. Frail individuals with critical illness are likely to have poorer outcomes and a higher mortality rate [19] but may still have enough intrinsic capacity to endure the stressors of hospitalisation and make a good recovery [20]. Therefore clinicians are encouraged to empathetically focus on engaging with and supporting frail patients to ensure access to care in keeping with their values and goals [21]. The multidisciplinary team tried several approaches to help manage the deteriorating respiratory status of these patients in the ward-setting. This study evaluated an option for therapy that physiotherapists could consider for frail patients, if it were in keeping with their values and goals [21,22]. While the benefits of prone positioning remain unclear from this study, patients who are able to give consent could be offered prone positioning as a treatment option until future research can be undertaken to further inform the team and the patient of the risks or benefits.

Previous published studies have largely excluded patients who were unable to independently obtain a prone position, subsequently having younger, less frail and more functionally independent patient participants [10]. A strength of this study was that patients who were unable to self-prone were included. Furthermore, when a full prone position was not possible, most commonly due to obesity, modified positions were used. This finding is clinically relevant due to the prevalence of obesity and its role as a risk factor for those patients with COVID-19 in developing severe disease [23]. Full prone positioning was only used in five of the 32 physiotherapy sessions highlighting the need for ongoing evaluation in the clinical effect of modified positions. Positioning was achieved with only a minority of patients experiencing discomfort or oxygen desaturation, which resolved with return to a supine position.

Patients demonstrated an improvement in short-term oxygen saturations and a reduction in oxygen requirements when in the prone or modified prone position. The mean improvement in oxygen saturation is similar to findings of previous studies using awake prone positioning, including a meta-analysis of twenty-five studies that showed a mean difference in SpO2 of 4.75% (95% CI 3 to 6%) [10]. Although it may be unclear how clinically significant small changes in oxygenation are for individual patient outcomes, the reduction in oxygen requirements observed in this study holds additional clinical significance. Three patients during seven sessions were able to wean from an oxygen therapy mask to nasal prongs. As a result, patients may have experienced the additional benefits of enhanced communication and improved comfort [24].

This study has a number of limitations. It used a small cohort of participants, limiting the power and generalisability of the results. Only thirteen patients met our criteria for prone positioning as majority of patients were admitted to hospital from RACF due to inadequate resources to manage COVID-19, regardless of the severity of illness. This resulted in a large number of patients who did not require medical interventions or respiratory support for symptoms of COVID-19, but rather for isolation from other residents or for mobility input. The retrospective design limited the data available for interpretation, such as the length of time patients tolerated prone positions or body mass index measures, as well as the impact of confounding variables. It is also acknowledged that one of the authors was a treating physiotherapist in the study which may have introduced a source of observer bias.

Nonetheless, this is essentially a proof of concept study, aimed at describing the experience of using prone positioning in generally frail, awake, ward-based patients. It is acknowledged that in situations with increased clinical demand or workforce shortages, the feasibility of providing physiotherapy-assisted prone positioning will be impacted. Larger prospective studies are required to better elucidate the longer-term clinical benefits.

Conclusions

Prone or modified prone positioning may be a feasible therapeutic option for short-term improvements in oxygenation for patients with hypoxemic respiratory failure due to COVID-19 depending on available resources. This small retrospective observational study should be interpreted with caution and any changes in clinical practice requires evidence of safety and longer term improvements in health outcomes.

Ethical approval: St Vincent's Hospital Human Research Ethics Committee approved this study (LRR 218/20).

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Conflicts of interest: None declared.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.physio.2021.09.001.

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