BLOOD PRESSURE
2023, VOL. 32, NO. 1, 2165901
https://doi.org/10.1080/08037051.2023.2165901

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RESEARCH ARTICLE

Current practice of blood pressure measurement in Germany: a nationwide questionnaire-based survey in medical practices

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ABSTRACT

Purpose: Discrepancies exist between guideline recommendations and real-world practice of blood pressure (BP) measurements. The aim of this study was to assess, with a nationwide, questionnaire-based survey, the current practice of BP measurement and associated BP values in German medical practices.

Material and methods: A nationwide survey in German medical practices was performed in the period from 10 May 2021 to 15 August 2021. The questionnaire was divided into five sections. The current office BP (OBP) values as well as the current drug therapy were recorded. In addition, the implementation of office BP (OBP) and home BP monitoring (HBPM) was queried. For analysis, questionnaires were scanned and automatically digitised.

Results: A total of 7049 questionnaires were analysed, the majority of which came from general practitioners (66%) and internal medicine practices (34%). The average OBP (SD) was 140.0 (18)/82.7 (11) mmHg. 40.8% of treated patients had OBP in the controlled range, with monotherapy (34.7%) or dual combination therapy (38.2%) prescribed in most cases. OBP was taken from a single measurement in 66.3% of cases, and in 21.8% from 23 measurements. OBP was mostly measured after a rest period (87.1%) and in a separate room (80.4%). HBPM was performed in 62.3% of patients; however, in 24.9% of the participants HBP measurements were recorded once a week or less.

Conclusion: In this nationwide survey in German medical practices, BP control remains at below 50%, while monotherapy is prescribed in around one third of patients. Moreover, office measurements and HBPM are often not performed according to current guideline recommendations.

ARTICLE HISTORY

Received 15 September 2022
Revised 3 January 2023
Accepted 4 January 2023

KEYWORDS

Hypertension; blood pressure; office blood pressure; home blood pressure monitoring; HBPM

PLAIN LANGUAGE SUMMARY

What is the context?

Elevated blood pressure (hypertension) is an important risk factor for diseases such as stroke or heart attack. However, sufficient drug therapy can significantly reduce the risk of complications such as a stroke. An adequate blood pressure measurement is the basis for diagnostics and successful therapy. In order to measure blood pressure as accurately as possible, recommendations for performing blood pressure measurements (at home as well as in the office) have been published by medical societies.

Research suggests that blood pressure is not always measured according to these recommendations. However, there are no current studies for Germany.

What is new?

In this study, we analysed the results of a survey in which medical practices and pharmacies throughout Germany were asked about blood pressure measurement and blood pressure therapy. The key results of our study suggest that:

- The blood pressure of many participants with known hypertension is not within the desired target range.
- Office blood pressure measurements are often not performed as suggested by guidelines. This mainly affects time-consuming work steps such as repeating the measurement several times.
- Home blood pressure is not recorded in a structured form, as suggested, but rather according to a random pattern by the patient.

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/08037051.2023.2165901.

What is important?
This study suggests that blood pressure control is not sufficient in the study participants. Furthermore, blood pressure measurement as an important tool for hypertension management is frequently not performed as proposed by guidelines.

Introduction

Hypertension is a main risk factor for cardiovascular morbidity and mortality, and adequate therapy significantly reduces cardiovascular risk [1,2]. Despite intensive international efforts, awareness and blood pressure (BP) control still need to be improved [3,4]. Appropriate BP-readings are a basic requirement for diagnosis and management of hypertension and thus for BP-control. In addition to measuring office BP (OBP), out-of-office methods are recommended, with home BP monitoring (HBPM) becoming increasingly important in recent years [5,6].

HBPM involves the regular measurement and documentation of home blood pressure (HBP) according to a fixed time schedule for several consecutive days [6,7]. Compared to OBP, HBPM can improve patient adherence and BP-control [8–10]. In addition, home-BP readings have a greater diagnostic prognostic relevance than OBP-values [7,11]. Nevertheless, OBP is required for diagnosis of masked- and white-coat-hypertension. Thus, both procedures complement each other and are of outstanding importance for the diagnosis and therapy of hypertension [6].

Correct blood pressure measurement is a prerequisite for adequate diagnostic accuracy of both methods. Therefore, detailed recommendations for the implementation of OBP and HBPM have been published in guidelines – including advice on measurement conditions as well as practical and technical requirements for adequate measurement [5,6]. However, in the past, there were concerns about the extent to which these recommendations are implemented in everyday clinical practice [12,13].

The aim of this study was to describe how OBP and HBPM are currently practiced in Germany. As HBPM requires structured documentation of blood pressure values [5,6], it was of interest to what extent patients measure home BP-values according to a specific protocol or schedule. This survey was conducted as part of the German campaign for World Hypertension Day 2021, which was explicitly dedicated to *accurate* blood pressure measurement.

Methods

The study is based on an evaluation of questionnaires from all over Germany. In the period from 10 May 2021 to 15 August 2021 a nationwide survey was carried out in German practices (general practice, general internal medicine, specialists) and pharmacies. The survey was under the patronage of the German Hypertension Society (DHL) and was part of the German campaign for World Hypertension Day 2021.

A total of 1093 information folders (measurement kits), each with 10 single data collection sheets and accompanying information on blood pressure measurement and therapy, were distributed in practices. The participating medical practices were personally recruited by employees of the company involved in the project. In addition, 122 measurement kits were sent by fax to pharmacies and 100 measurement kits were distributed by fax to hypertension specialists (doctors with special knowledge in diagnosis and treatment of hypertension who are registered with the German Hypertension Society (DHL)). All individuals (with and without known hypertension) older than 18 years who were treated in the practice or consulted in the pharmacy could be included in the study.

Data collection was anonymised on a one-page data collection form. The requested information should be entered in digits in the boxes provided. Alternatively, yes or no had to be ticked. The OBP measured at the current appointment should be recorded on the sheet. Participating practices were asked to measure OBP as usual, no instructions were given on how to perform the blood pressure measurement. In addition, the current practice of OBP and HBPM measurement was assessed with a questionnaire. The questionnaire was divided into 5 sections and included the following aspects: (1) Specification of the participating practice or pharmacy; the first 3 numbers of the postcode (2) Demographic variables of the patient (age, gender) and the current OBP (3) Measurement conditions of the recorded OBP (In a separate room/compartment?; With an automatic measuring device?; From how many measurements does the value result?; Was there a period of rest beforehand?) (4) Supplementary questions on the protocol and schedule of HBPM, if applicable to the

patient. (Was blood pressure measured at home?; If yes: Was a blood pressure diary brought along? Was BP documented *via* an app? How many times a day was BP measured? How many days a month was blood pressure measured? once a week or less/more than once a week/every day of the month; When was BP measured? at different times of the day/at the same time point(s) of the day) (5) Supplementary questions on medical therapy of known hypertension, if applicable to the patient. (Is hypertension known? If yes: Is hypertension treated with medication? If treated with medication: With how many blood pressure tablets? Are combination drugs used?). The complete questionnaire is provided in the supplement.

After completion of the study, the questionnaires were collected and sent by post for evaluation and analysis to uzbonn - Gesellschaft für empirische Sozialforschung und Evaluation, Bonn, Germany. In total 7049 questionnaires were returned, 6970 contained systolic as well as diastolic BP-values. The origin of the questionnaires by practice profile is shown in Table 1.

Data analysis

All questionnaires were scanned and automatically digitised after the end of the collection period (EYES and HANDS for Forms, Kofax Limited, Irvine, US). The statistical evaluation of the raw data was carried out by uzbonn - Gesellschaft für empirische Sozialforschung und Evaluation, Bonn, Germany and the Klinik für Nieren- und Hochdruckerkrankungen, Hannover Medical School, Germany. Data are reported as number and percent for categorical variables or as mean and standard deviation (SD) for continuous variables. Means were compared using an unpaired *t*-test. A three-way-ANOVA was conducted to compare the main effects of gender, age categories and location (separate/non-separate room) as well as their interaction effects on the dependent variable systolic office blood pressure. The Levene's test showed that the variances of the groups were homogeneous. The analysis was performed using the statistics program GraphPad Prism 7, IBM SPSS and Microsoft Excel 2013.

Table 1. Origin of questionnaires ($n = 7049$).

Origin of questionnaires	*n* (%)
General medicine/family medicine	4643 (65.9)
Internal medicine	2406 (34.1)
Hypertension specialists (DHL)	434 (6.2)
Pharmacies	67 (0.95)
No information available	108 (1.5)

DHL: Deutsche Hochdruckliga/German Hypertension Society. Multiple choices were possible with regard to the specialties of the participating practices.

Results

Baseline characteristics

The mean age (SD) was 64.4 (15) years, with 64.7% of the participants being 60 years or older. 49.9% of the participants were female. The average OBP (SD) was 140.0 (18)/82.7 (11) mmHg, which is in the (borderline) uncontrolled range for systolic blood pressure (sBP) (Table 2). The BP of the female participants was slightly lower than the BP of the male patients (female: 139.3(18)/82.5 (11) mmHg; male: 140.8 (18)/83.0 (11) mmHg). With rising age, pulse pressure increased (Figure S1). 81.6% of participants had a known diagnosis of hypertension (Table 2). On average, patients with known hypertension were significantly older (67.1 ± 13) and had significantly higher OBP (SD) of 141 (18)/82.9 (11) mmHg, which indicates insufficient hypertension control on the population level (Table 3). Patients without known hypertension had a normal mean BP of 136.1 (20)/82 (11) mmHg. 40.8% of treated patients had OBP in the controlled range (Table 3), with 1 (34.7%) or 2 (38.2%) antihypertensive agents prescribed in most cases (Table 2).

Office blood pressure measurement

OBP is considered the most common blood pressure measurement method [5]. Since guidelines recommend certain measurement rules to achieve accurate measurements [5,6], we analysed OBP-procedures and settings. The measurement of OBP was carried out in

Table 2. Baseline characteristics.

Characteristics	*n* (%)	*n* of questionnaires (base)
Female	3458 (49.6)	6970
Age, years (SD)	64.4 ± 15	6970
Age groups		6970
<50	1074 (15.4)	
50–59	1344 (19.3)	
60–69	1725 (24.7)	
70–79	1598 (22.9)	
>80	1189 (17.1)	
Systolic OBP, mmHg	140 ± 18	6981[a]
Systolic OBP-females, mmHg	139.3 ± 18	3485[a]
Diastolic OBP, mmHg	82.7 ± 11	6971[b]
Diastolic OBP-females, mmHg	82.5 ± 11	3478[b]
Previous diagnosis of HT	5689 (81.6)	6970
Medical treatment	5588 (98)	5689
1 Tablet	1937 (34.7)	5588[c]
2 Tablets, 2 distinct drugs	2136 (38.2)	5588
3 Tablets, 3 distinct drugs	1031 (18.5)	5588
>3 Tablets, > 3 distinct drugs	401 (7.2)	5588

Baseline characteristics of participants with reported systolic and diastolic BP-values. Hypertensive OBP: systolic BP $\geq$ 140 mm Hg and/or diastolic BP $\geq$ 90 mm Hg. HT: Hypertension, OBP: office blood pressure. [a]Participants with reported systolic BP. [b]Participants with reported diastolic BP. [c]Participants with treated hypertension.

Table 3. Clinical characteristics according to hypertension status.

Characteristics	Previous HT base		No previous HT base		*p* Value
Age, years (SD)	67.1 ± 13	5648	53.5 ± 16	1347	<0.0001
Systolic OBP, mmHg (SD)	141 ± 18	5624	136.1 ± 20	1357	<00001
Diastolic OBP, mmHg (SD)	82.9 ± 11	5616	82 ± 11	1355	0.0069
Controlled HT (%)	2275 (40.8)	5615	–	–	N/A
Hypertensive range (%)[a]	–	–	653 (48.2)	1355	N/A

Hypertensive OBP: systolic BP ≥ 140 mm Hg and/or diastolic BP ≥ 90 mm Hg. [a]Fraction of participants without previous diagnosis of HT and OBP in the hypertensive range.

Table 4. Office blood pressure (OBP, $n = 7049$).

OBP procedure	*n* (%)
OBP was measured in a separate room	5670 (80.4)
OBP was measured with an automatic device	2516 (35.7)
OBP was measured after a rest	6139 (87.1)
Number of repeated measurement(s)	
1 Measurement	4671 (66.3)
2–3 Measurements	1534 (21.8)
≥4 Measurements	182 (2.6)
N/A	662 (9.4)

OBP: Office blood pressure.

a separate room in 80.4% of all cases; mostly after a rest period (87.1%). In 35.7% of the participants, BP was measured with an automatic device. In addition, the documented OBP was based on a single measurement in 66.3% of the cases. Repeated measurements were carried out less frequently, e.g. in only 21.8% of the cases measurements were taken 2–3 times (Table 4).

We next analysed documented OBP levels according to setting (Table 5). When measured in a separate room, sBP was significantly lower than sBP values obtained in the comparison group (sBP 139.9 ± 18 vs 141.1 ± 18, $p = 0.033$). To further analyse and compare the effects of gender, age and location of BP measurement (separate room, no separate room) on sBP, a three-way ANOVA was performed. There was a significant main effect of gender ($F(1,6772) = 8.82$, $p = 0.003$), age ($F(1,6772) = 6.48$, $p = 0.011$) and the BP-measurement location ($F(1,6722) = 3.97$, $p = 0.046$). However, the overall effect size of the influencing factors was low (e.g. sex $d = 0.036$). Importantly, no significant interaction between location (separate room, no separate room) and gender ($F(1,6722) = 0.129$, $p = 0.720$) or location and age ($F(1,6722) = 0.625$, $p = 0.429$) could be shown (Table S5). Furthermore, systolic and diastolic BP values measured with an automatic device were significantly higher than values obtained by auscultation (sBP 142.8 ± 19 vs 138.5 ± 18, $p < 0.0001$; dBP 84.7 ± 12 vs 81.7 ± 10 $p < 0.0001$; Table 5).

Home blood pressure monitoring (HBPM)

HBPM is recommended for the diagnosis and treatment of HT, as these values have a higher prognostic relevance than OBP values [6,14,15]. Therefore, we examined the use and documentation of HBPM as well as the applied measurement protocols. In the subgroup of patients with known HT ($n = 5689$), 62.3% measured their blood pressure at home. The average OBP (SD) in this subgroup was 141.3(18)/82.8 (11) mmHg and thus did not differ significantly from the group of patients who did not perform HBPM (data not shown). 49.3% of the patients had brought a blood pressure diary with them; 3.1% used an app for this purpose (Table 6).

Various guidelines suggest performing HBPM according to a defined and structured protocol, e.g. obtain BP-readings in the morning and evening for at least three consecutive days (5, 6). In this survey, 24.9% of the participants stated that they measured HBP only once a week or even less, whereas 24.3% of the patients reported daily measurements. With regard to the number of measurements per day, most participants reported taking their blood pressure either once (40.8%) or 2–3 times (43.5%) a day. Furthermore, while 29.0% of participants measured their HBP regularly at the same time of day, 55.9% of participants measured at different timepoints throughout the day (Table 6).

Discussion

Arterial hypertension is an important modifiable risk factor and BP lowering is an effective means to lower cardiovascular disease burden [1,2]. Nevertheless, in this analysis the BP-control rate was only 41%. Moreover, in ambulatory healthcare facilities, both OBP and HBPM were not always performed according to guideline recommendations.

With regard to BP-control rate, our findings are in line with previous studies, which also documented an unsatisfactory level of hypertension control [16]. A population survey in Germany in 2012 documented that approximately 50% of the population had BP in the controlled range [17]. A recent evaluation of the May Measurement Month demonstrated that approximately 60% of treated hypertensive patients had a controlled BP [18].

Table 5. Office blood pressure according to setting.

Blood pressure	Separate room	No separate room	*p*
Systolic OBP, mmHg (SD)	139.9 ± 18 (*n* = 5621)	141.1 ± 18 (*n* = 1256)	0.0327
Diastolic OBP, mmHg (SD)	82.7 ± 11 (*n* = 5615)	83.2 ± 11 (*n* = 1254)	0.1453 (ns)
	Automatic device	No automatic device	
Systolic OBP, mmHg (SD)	142.8 ± 19 (*n* = 2490)	138.5 ± 18 (*n* = 4322)	<0.0001
Diastolic OBP, mmHg (SD)	84.7 ± 12 (*n* = 2484)	81.7 ± 10 (*n* = 4320)	<0.0001

OBP: Office blood pressure.

Table 6. Home blood pressure monitoring (HBPM).

Home blood pressure monitoring	*n* (%)	*n* of questionnaires (base)
Participants with HT who measured HBP	3545 (62.3)	5689
systolic OBP, mmHg (SD)	141.3 ± 18	3504
diastolic OBP, mmHg (SD)	82.8 ± 11	3504
Documentation of HBP		
Blood pressure diary	1749 (49.3)	3545
App	109 (3.1)	3545
HBPM-protocol		
Measurement days within a month		3545
once a week or less	883 (24.9)	
more than once a week	1589 (44.8)	
every day of the month	862 (24.3)	
N/A	211 (6.0)	
Measurements per day		3545
<1 Measurement	18 (0.5)	
1 Measurement	1447 (40.8)	
2–3 Measurements	1541 (43.5)	
≥4 Measurements	151 (4.3)	
Timing of measurement		3545
At different times of the day	1980 (55.9)	
At the same time point(s) of the day	1027 (28.9)	
N/A	538 (15.2)	

HBP: Home blood pressure; HBPM: home blood pressure monitoring. Participants with previously known hypertension (*n* = 5689) who measured HBP (*n* = 3545) were considered.

One reason for lack of hypertension control may be inadequate drug therapy. In this survey, 34.7% of patients received antihypertensive monotherapy, although current ESH/ESC guidelines recommend an initial combination therapy for most patients [6]. This compares to a recent study from our group, in which we analysed prescription data from approximately 2 million German patients from 2011 to 2013. This analysis showed that in patients with a new diagnosis of hypertension, monotherapy was prescribed in 30% after one year and in 21.7% during long-term follow-up [19]. Although the 2018 ESH guidelines emphasise initial combination therapy for the majority of patients [6], prescribing patterns in Germany do not appear to have changed significantly in recent years.

Adequate blood pressure measurement forms the basis for appropriate diagnosis and therapy and thus for hypertension control [6]. Therefore, guidelines recommend specific procedures for OBP and HBPM, including measurement conditions as well as practical and technical requirements [5,20].

OBP is the most common method for documenting BP and diagnosing hypertension [5]. This study indicates that in most cases a rest period prior to BP measurement was implemented. For methodological reasons, this period cannot be specified or quantified more precisely. In this context, a recent randomised trial is of interest, which compared BP values obtained after no rest (0 min) or after a short rest (2 min) with the recommended rest of 5 min. Interestingly, differences between BP values at the different time points were minimal. For participants with an sBP < 140 mmHg, the first-time points were non inferior to the recommended 5-min rest [21]. Given this, even shorter pre-measurement resting periods could be sufficient for many individuals and the exact duration of rest may be of minor importance. However, especially for hypertensive patients, further studies are needed.

In this analysis, auscultatory BP-measurements were used in the majority of cases. Interestingly, the BP values obtained with automatic devices were on average higher than BP-readings obtained by auscultation. This finding is difficult to interpret and contradicts published data [22]. Methodological limitations of a self-reported survey could likely explain this finding. The survey explicitly aimed to investigate the prevalence of automatic blood pressure measurement in the office setting (AOBP). However, it cannot be excluded that some respondents, unaware of AOBP,

differentiated between manual methods (auscultatory) and electronic/automatic BP-monitors. Moreover, a study with 50 patients indicated that it was not the automatic device itself, but the fact that the measurement was unattended that led to lower blood pressure values [23]. This study was not designed to investigate distribution and use of AOBP in Germany. However, in this analysis the measurement in a separate room (which is not equal to unattended measurement) resulted in significantly lower BP-values. This suggests, that environmental factors can have a significant impact on blood pressure and measurements in a private environment are preferable.

In addition, it was striking that in 66% of the cases only a single blood pressure measurement was carried out. Guidelines recommend repeated OBP measurements with a low level of evidence (usually 3 or at least 2 measurements if blood pressure is normal [5,6]). In a Japanese cross-sectional study, 1.6% of all analysed long-term care facilities regularly implemented recommendations for repeated BP-measurements [12]. Moreover, an analysis of self-reported questionnaires from 321 primary care clinics in Utah revealed that OBP was based on the mean of 2 measurements in only 58.5% of the clinics [13]. Apparently, recommendations for repeated OBP-measurement are only implemented to a very limited extent internationally. However, various studies have already shown that insufficient recording of OBP can lead to falsely high blood pressure values [24]. In one study, BP-values measured according to a specific protocol (2 measurements) were significantly lower (127.3 mmHg) than comparative BP-values which were not systematically obtained (141.2 mmHg) [24]. Limited human and time capacities are most likely one of the major reasons for this general observation [24,25]. The diversity in the extent of non-adherence may be related to the methodological heterogeneity of different studies. Previous studies often collected data per facility [12,13], whereas in this analysis a questionnaire was completed for each individual patient during the clinical workflow. This patient-centred approach should give an appropriate impression of current clinical practice in Germany.

Current guidelines recommend HBPM for the diagnosis and management of patients with hypertension [6]. Moreover, studies indicate that HBPM may improve blood pressure control [8]. In this survey, 62.3% of all participants measured their blood pressure at home. In comparison, in a Canadian study published in 2009, 45.9% of hypertensive adults measured their blood pressure at home. However, given the clear recommendations of the most recent guidelines [5,6], the proportion of patients performing HBPM still seems to be expandable.

It is worth noting that HBPM implies a structured documentation of BP-readings according to a specific schedule, e.g. measurements for 3–7 days in the morning and evening [6,7]. However, in this study, 24.9% of the participants stated that they measured their BP only once a week or even less. In addition, a large proportion of the participants measured their BP only once a day (40.8%). In summary, 62.3% of patients documented individual HBP-values, but only a small minority of them followed a structured HBPM-protocol. Various studies have proven, that the reproducibility, but also the diagnostic accuracy of HBPM increase with the number of consecutive measurement days [7,26,27]. In a recently published study of 567 adults who performed a 7-day HBPM protocol, it was shown that 4.5 consecutive measurement days are needed for an accurate diagnosis [28]. Therefore, documentation of single (random) readings is not use- or helpful.

In line with our results, older studies demonstrated that only a minority of patients fulfilled HBPM requirements sufficiently [29,30]. In addition, this analysis shows that, despite the increasing recommendation of HBPM in recent years, the diagnostic value of this method in practice is often at least questionable.

This analysis has several limitations. Data is obtained from self-reported questionnaires, thus, statements are based on the (subjective, uncontrollable) self-assessment of the respondents. In order to generate unambiguous answers, either the selection options were already pre-defined or it was only possible to give numbers. Important aspects could not be specified more precisely with this method. In order to obtain a realistic assessment, the questionnaire should be completed parallel to the clinical workflow and per patient, not per facility. In order to keep the workload of this approach manageable, only a limited number of questions were possible, so that not all aspects of blood pressure measurement could be covered.

Conclusion and perspectives

Based on a nationwide survey, this analysis describes the implementation of OBP and HBPM as well as the therapy of hypertension in German medical practices. Blood pressure control rates remain at an insufficient level, with both inappropriate BP-measurements and inadequate drug therapy (e.g. monotherapy) likely contributing to this observation. The implementation

of BP-measurement recommendations in clinical practice is a challenge: it is estimated that appropriate OBP takes about 16 min [31]. Increased use of out-of-office methods could help to overcome time limitations in clinical practice. In fact, clinical studies have proven that structured HBPM can contribute to better blood pressure control [8]. However, this analysis indicates that in clinical real-life, criteria for adequate HBPM are mostly not met. In order to promote the implementation of guideline-based OBP and HBPM, the personnel, technical and time expenditures must be adequately reimbursed, which is currently not the case in Germany. In addition, modern technologies could help to overcome these well-known limitations. Apps and digital coaches (which have only been used by about 3% of all participants in this survey so far) could possibly support training and guidance. However, further studies are needed to evaluate this in detail.

Ethics statement

The research work follows the principles of the Declaration of Helsinki.

Disclosure statement

Beger C, Mayerböck A, Klein K, Karg T, Haller H, Schmidt-Ott KM and Limbourg FP report no conflict of interest. Randerath O is an employee of Pharma GmbH & Co. KG, Monheim, Germany.

Funding

This study was financed by Apontis Pharma GmbH & Co. KG, Monheim, Germany. No influence was exerted on the study design, data analysis and interpretation.

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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