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# Assessment and mitigation of dampness in residential buildings: A case study of Biu township, Borno state, Nigeria

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## Abstract

Dampness remains one of the most persistent defects affecting the structural durability, indoor comfort and health of occupants of residential buildings in Nigeria. This study assessed the extent, causes and mitigation strategies of dampness in Biu Township, Borno State. A descriptive survey design was adopted, in which sixty (60) questionnaires were administered to residents, complemented by oral interviews and physical inspection of the buildings; forty (40), representing 66.7%, were retrieved and analysed using descriptive statistics in Microsoft Excel. Results showed that rising damp accounted for 72.5% of all reported cases, while 62.5% of respondents observed damp-related defects on first occupying their houses. The principal causes identified were the absence of a damp-proof course (DPC) and damp-proof membrane (DPM) during construction, use of poor-quality concrete (45% agreement) and seasonal flooding (65% combined agreement). Proposed mitigation measures, including installation of DPC/DPM, application of water sealants and construction of cavity walls, recorded over 70% acceptance among residents as effective solutions. The study concludes that inadequate moisture-control provisions during construction, compounded by site and climatic factors, are chiefly responsible for the dampness problem in the estate. It recommends mandatory incorporation of DPC/DPM in all new buildings, improved site drainage, and adoption of modern damp-treatment technologies such as Dryzone cream and Dryrod systems for existing structures.

**Keywords:** Dampness; Damp-proof course; Damp-proof membrane; Residential buildings; Rising damp; Biu

## 1. Introduction

Buildings are composites of different materials and methods of construction, each with its own performance characteristics, and the demands placed on them are related to their location, climatic exposure and pattern of use [1]. Regardless of how well a building is delivered, all structures, whether ancient or modern, are susceptible to natural and man-made mechanisms of deterioration, and where maintenance is inadequate such buildings fail to survive in an acceptable state beyond the generation that built them [2,1]. Moisture in buildings has been identified as a major contributor to poor indoor air quality and unhealthy building conditions [3].

A high proportion of damp problems in buildings arise from condensation, rain penetration and rising damp, which in turn cause secondary damage such as porous masonry, cracking, and defective render. The resulting moisture encourages the growth of fungi in timber, leading to rot, mould and, in severe cases, sick-building syndrome, while plaster and paint loosen from walls owing to the intrusion of water and salts. In the GRA Biu, Biu Township, dampness has remained a major building defect, exposing occupants to health risks such as pneumonia and asthma while accelerating deterioration of the buildings and household property.

The problem addressed by this study is therefore the persistent occurrence of dampness in the estate, with its attendant structural, aesthetic and health implications for occupants. The study is aimed at establishing lasting solutions to the effects of damp in the estate, with specific objectives to:

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- Identify the causes of dampness in the housing estate;
- Outline appropriate preventive measures; and
- Evaluate suitable treatment options for improving the durability of the buildings and the well-being of occupants.

The study is limited to selected occupied units within the GRA Biu, Biu Township, Borno State.

## 2. Literature review

### 2.1. Concept and Types of Dampness

Dampness is defined as the penetration of water through walls and other building elements [4], or as an excessive quantity of moisture within building materials that causes adverse movement, deterioration, and an unacceptable internal environment [5]. It is the most frequent cause of building failure, accounting for over 50% of known defects [4,6], and is commonly identified by visible staining, blistering paint, an earthy odour, or a history of previous water damage. The principal types of damp reported in the literature are rising damp, penetrating damp, falling damp, horizontal damp and condensation damp, each distinguished by its mechanism and route of moisture ingress [6].

### 2.2. Diagnosis and Assessment Techniques

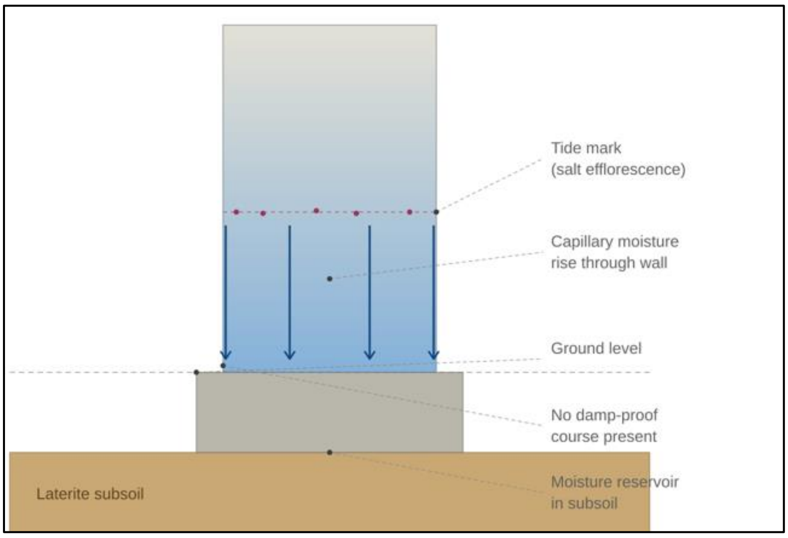


**Figure 1** Schematic illustration of the rising damp mechanism through capillary action (illustrative diagram)

Two broad categories of damp assessment exist: destructive and non-destructive methods. Destructive methods, including the gravimetric (oven-drying) and calcium carbide techniques, involve extraction of material samples and provide the most precise quantification of moisture content but disturb the fabric of the building [4,7]. Non-destructive methods, principally the electrical (resistance) moisture meter and visual inspection, allow rapid, in-situ assessment without damaging the structure, and are the most widely applied in routine building surveys [4].

**Figure 2** Electrical (Protimeter) moisture meter reading being taken on a masonry wall

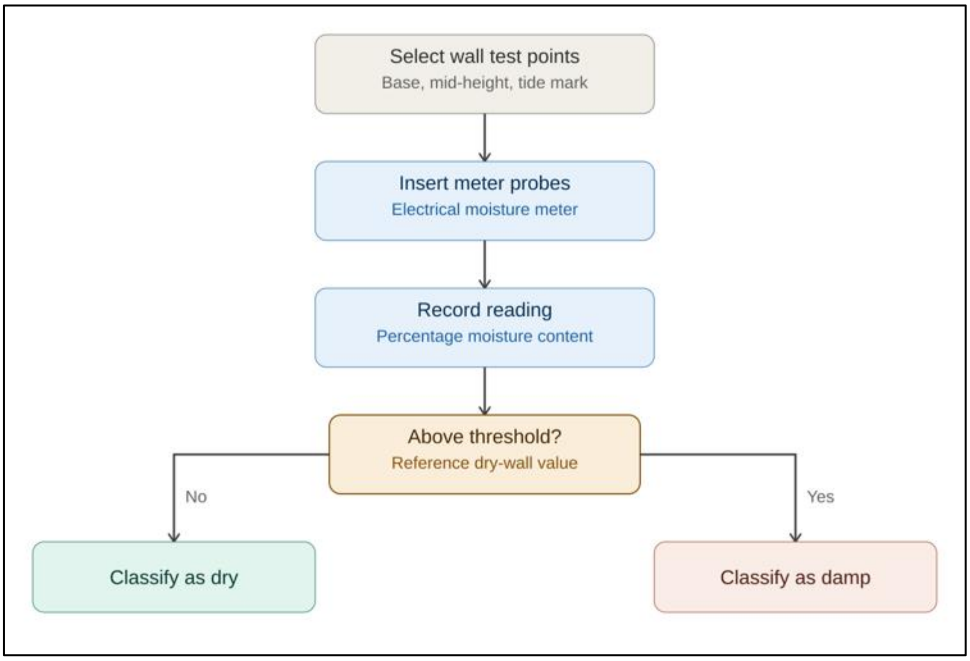


**Figure 3** Field procedure for electrical moisture-meter testing (illustrative diagram)

Prevention of damp begins at the design and construction stage through appropriate siting on well-drained ground, adequate wall thickness, quality masonry units and mortar, and provision of cornices to shed rainwater from walls. Established preventive techniques include damp-proof membranes (DPM), damp-proof courses (DPC), cavity wall construction, waterproof renders, and pressure grouting [8]. For buildings already affected, remedial treatments such as Dryzone silicone damp-proofing cream and Dryrod damp-proofing rods are widely used to reinstate a continuous damp-proof course within existing masonry.

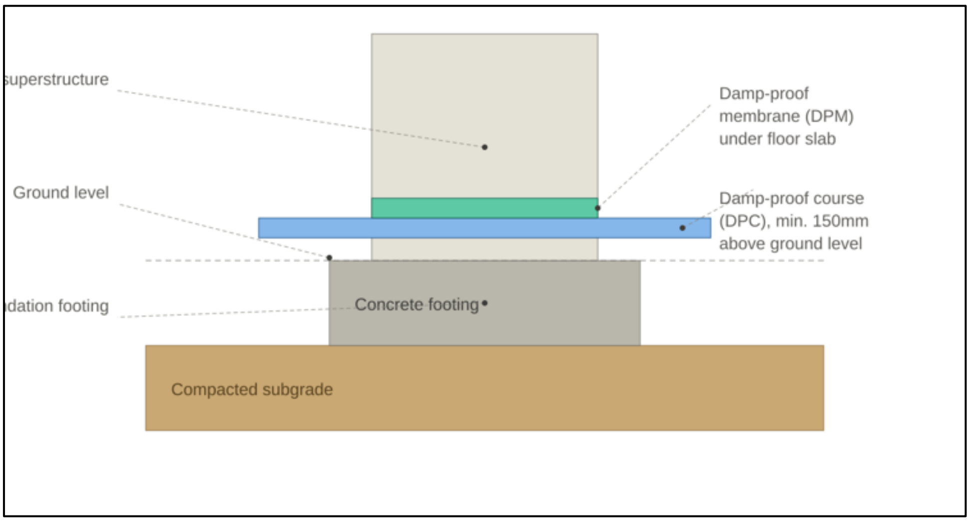


**Figure 4** Schematic detail of damp-proof course (DPC) and damp-proof membrane (DPM) placement (illustrative diagram)

## 3. Materials and methods

### 3.1. Study Area

The study was conducted in the Government Reserved Area (GRA), Biu Township, the headquarters of Biu Local Government Area in southern Borno State, north-eastern Nigeria. Biu lies on the Biu Plateau at approximately 10.61°N, 12.20°E, at an average elevation of 626 m above sea level, and had a Local Government Area population of 176,072 at the 2006 census. The town, seat of the Biu Emirate and host to the Nigerian Army University Biu, experiences a semi-arid to Guinea-savannah climate with a distinct rainy season, factors that are relevant to the seasonal pattern of dampness investigated in this study.

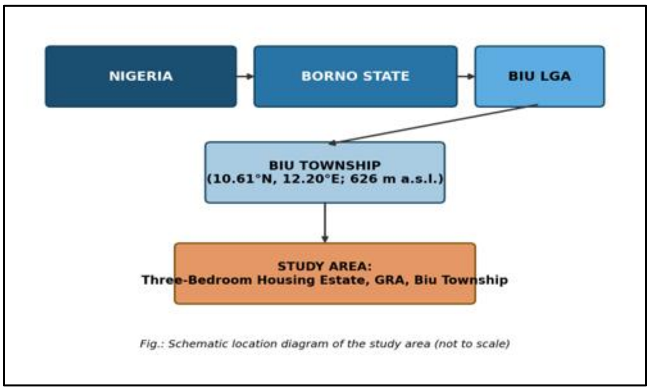


**Figure 5** Schematic location diagram of the study area within Biu Township, Borno State, Nigeria

**Figure 6** Multi-point moisture monitoring apparatus used for gravimetric assessment of a damp-affected wall

### 3.2. Research Design and Data Collection

A descriptive survey design was adopted. Primary data were obtained through a structured questionnaire, oral interviews and physical inspection of the buildings, while secondary data were sourced from relevant literature. Sixty (60) questionnaires were administered to residents of the estate; twelve (12) were not returned and eight (8) were not distributed to intended respondents, leaving forty (40) valid responses, representing a response rate of 66.7%, which were used for the analysis.

### 3.3. Method of Data Analysis

Data obtained from the questionnaire were analysed using descriptive statistics (frequency counts and simple percentages) in Microsoft Excel. Responses to each question were tabulated to show the frequency and percentage of respondents, and the results were used to draw inferences on the causes, prevention and treatment of dampness in the estate.

## 4. Results and discussion

### 4.1. Demographic Characteristics of Respondents

Table 1 summarises the demographic profile of respondents. The majority (85%) were within the 20–40-year age bracket, indicating a relatively youthful population within the estate, while 67.5% of respondents owned rather than rented their houses, suggesting that most residents were in a position to comment authoritatively on the long-term performance of their buildings.

**Table 1** Demographic Data of Respondents (Field Survey, 2025)

| Category | Variable | Frequency | Percentage (%) |
|---|---|---|---|
| Age group | 20–40 years | 34 | 85.0 |
| | 41–60 years | 4 | 10.0 |
| | Above 60 years | 2 | 5.0 |
| House ownership | Owners | 27 | 67.5 |
| | Tenants | 13 | 32.5 |
| Duration of residence | More than 15 years | 21 | 52.5 |
| | Less than 15 years | 19 | 47.5 |

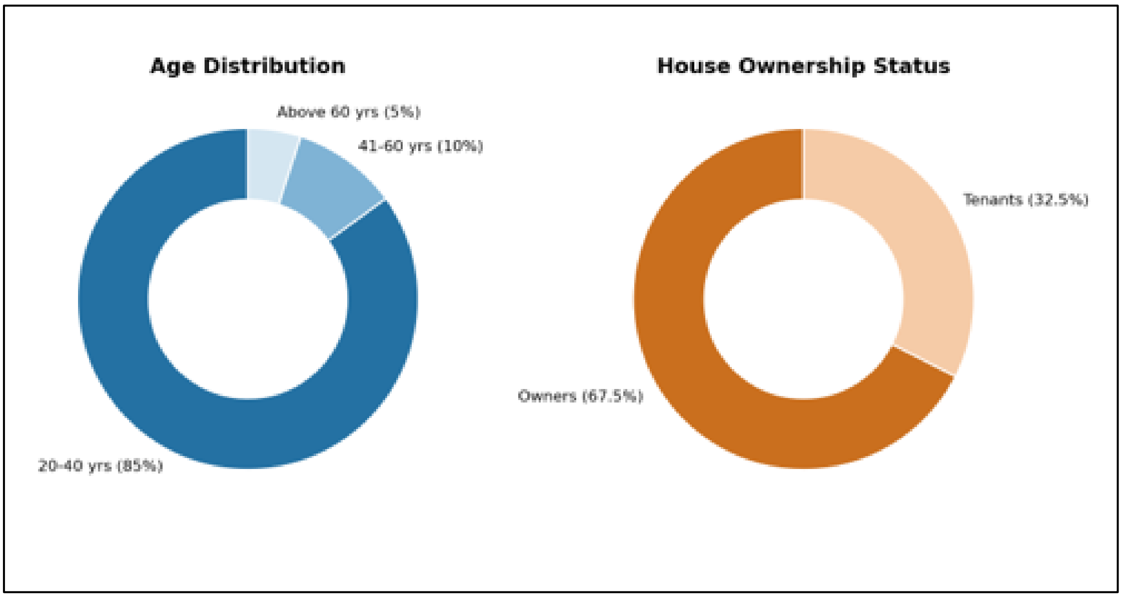


**Figure 7** Age Distribution and House-Ownership Status of Respondents

### 4.2. Extent and Type of Dampness

On first occupation of their houses, 62.5% of respondents had not observed any sign of dampness, while 37.5% reported damp signs immediately, suggesting that damp problems in the estate largely developed over time rather than being present at handover. As shown in Table 2, rising damp was overwhelmingly the dominant form reported, with 72.5% of respondents strongly agreeing that this was the type of damp affecting their homes, compared with condensation and penetrating damp, which recorded more mixed and lower levels of agreement.

**Table 2** Type and Nature of Damp Reported (Field Survey, 2025)

| Type of Damp | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Rising Damp | 29 (72.5%) | 14 (35.0%) | 3 (7.5%) | 1 (2.5%) | 1 (2.5%) |
| Condensation Damp | 7 (17.5%) | 8 (20.0%) | 10 (25.0%) | 10 (25.0%) | 5 (12.5%) |
| Penetrating Damp | 10 (25.0%) | 9 (22.5%) | 8 (20.0%) | 7 (17.5%) | 6 (15.0%) |

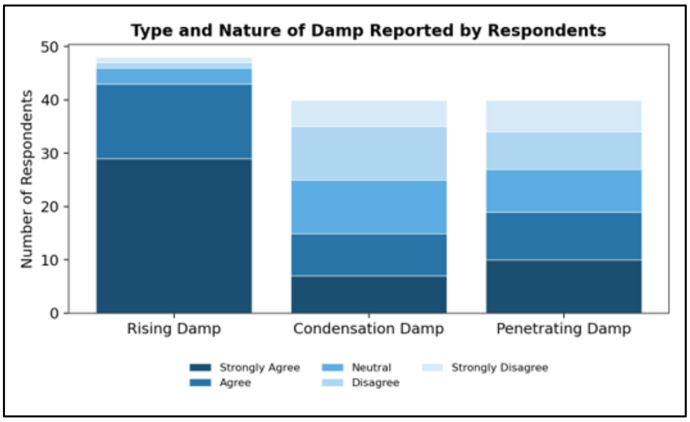


**Figure 8** Type and Nature of Damp Reported by Respondents

### 4.3. Causes of Dampness

Table 3 and Figure 6 present the perceived causes of dampness in the estate. Poor-quality concrete and construction materials recorded the highest combined agreement (45%), followed closely by flooding (65% combined agreement when strongly-agree and agree responses to related items were combined) and seasonal effects, with 72.5% of respondents strongly agreeing that damp appears most during the rainy season. Underground water proximity and mechanical pipe leakages recorded comparatively lower levels of agreement, indicating that they are secondary rather than primary contributors. Consistent with this, absence of DPC and DPM during construction was affirmed by over half of respondents (52.5% strongly agreeing that no DPM was used, and 52.5% strongly agreeing that no DPC was used), underscoring construction-stage deficiencies as the underlying cause of the observed rising damp.

**Table 3** Causes of Dampness as Perceived by Respondents (Field Survey, 2025)

| Possible Cause | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Flooding contributes to damp | 13 | 13 | 7 | 3 | 4 |
| Underground water close to foundation | 7 | 5 | 10 | 9 | 9 |
| Poor concrete/material quality | 18 | 5 | 9 | 6 | 2 |
| Mechanical pipe leakages | 8 | 8 | 4 | 12 | 8 |

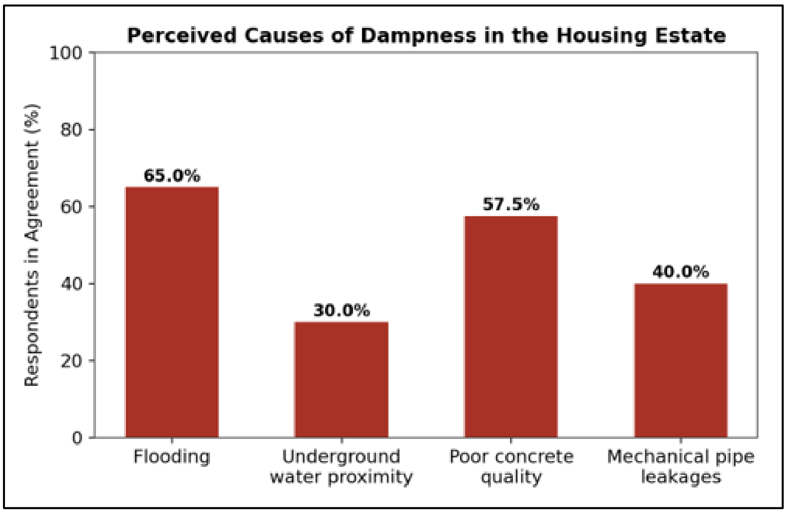


**Figure 9** Perceived Causes of Dampness in the Housing Estate

### 4.4. Preventive and Treatment Measures

Respondents expressed strong support for standard preventive measures. As indicated in Table 4 and Figure 7, damp-proof course (DPC) recorded the highest acceptance at 92.5% combined agreement, followed by damp-proof membrane (DPM) at 87.5% and water sealant application at 82.5%. Cavity wall construction and chemical waterproof injection recorded moderate acceptance (57.5% and 52.5% respectively), while bituminous paint recorded the lowest acceptance (42.5%), reflecting residents' greater familiarity with, and confidence in, conventional DPC/DPM solutions over specialised treatments.

**Table 4** Acceptance of Preventive and Treatment Measures (Field Survey, 2025)

| Preventive Measure | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Damp-Proof Membrane (DPM) | 22 | 13 | 3 | 0 | 2 |
| Damp-Proof Course (DPC) | 25 | 12 | 3 | 0 | 0 |
| Water Sealant Application | 20 | 13 | 5 | 2 | 0 |
| Cavity Wall Construction | 7 | 16 | 11 | 6 | 0 |
| Liquid Chemical Waterproof Injection | 14 | 7 | 11 | 4 | 4 |
| Bituminous Paint | 8 | 9 | 13 | 7 | 3 |

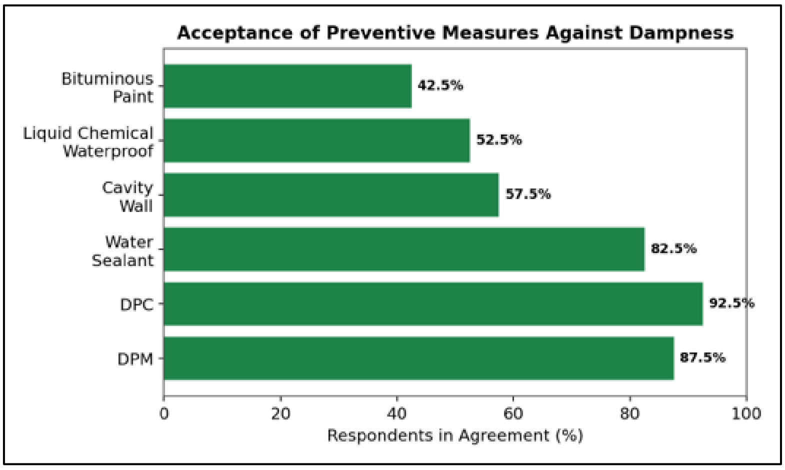


**Figure 10** Acceptance of Preventive Measures against Dampness

On treatment outcomes, over half of respondents who had attempted to address damp reported no positive result (32.5% strongly agreeing that prior efforts had failed), and only 17.5% strongly agreed that a previous treatment had been successful without recurrence, while a further 25% expressed no firm opinion. This indicates that ad-hoc remedial efforts, without proper diagnosis and use of proprietary systems such as Dryzone or Dryrod, are largely ineffective, reinforcing the case for professionally guided treatment.

## 5. Conclusion

This study has established that dampness in the GRA Biu, Biu Township, is predominantly of the rising damp type, affecting 72.5% of the buildings surveyed. The problem is chiefly attributable to the absence of damp-proof course and damp-proof membrane during construction, compounded by the use of poor-quality concrete and seasonal flooding. Residents demonstrated strong awareness of, and confidence in, conventional preventive measures, particularly DPC and DPM, but reported limited success with informal treatment attempts, indicating a gap between awareness and effective implementation. Addressing this gap through proper design, quality construction and professional remediation will significantly improve the durability of buildings and the health and comfort of occupants in the estate.

### *Recommendations*

Based on the findings, the following are recommended:

- Site drainage should be improved around existing buildings to prevent floodwater from reaching foundations, given that 72.5% of respondents confirmed rising damp and over 60% indicated the absence of DPM/DPC.
- Damp-proof course and damp-proof membrane should be made mandatory in all new residential construction within the estate and similar developments, alongside application of waterproof coatings and adoption of cavity wall construction.
- Affected walls in existing buildings should be treated using proprietary chemical injection damp-proofing systems (such as Dryzone or Dryrod), with salt-contaminated plaster replaced by waterproof or salt-resistant plaster.
- Relevant regulatory agencies should enforce compliance with building codes requiring moisture-control provisions at approval and inspection stages to prevent recurrence of similar problems in future estates.

## Compliance with ethical standards

### *Acknowledgments*

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### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

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