



ORIGINAL ARTICLE

The Prevalence, Diagnosis, and Management of Primary Hyperaldosteronism in the Kingdom of Bahrain- Single Center Approach

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Received date: January 15, 2026; **Accepted date:** March 30, 2026; **Published date:** March 31, 2026

Abstract

Background: Primary hyperaldosteronism is a significant but often overlooked cause of secondary hypertension. It is characterized by excessive aldosterone production by the adrenal glands. A considerable gap exists in the prevalence of primary hyperaldosteronism, its diagnosis, and management, particularly in regions like the Middle East.

Methods: A Retrospective observational study of 158 patients who were screened for primary hyperaldosteronism between 2022 and 2023 was conducted. Access to their E-Files was granted by King Hamad University Hospital.

Results: All the patients underwent laboratory & clinical investigations to rule out secondary causes of hypertension. Elevated renin: aldosterone ratio was observed in 41 (26.8%), with 17 (11%) confirmed cases of primary hyperaldosteronism. Nine were males, eight were females, and all were Bahraini except one. Imaging showed hyperplasia in five cases, eight adenomas, and two patients did not have documented imaging done. Two of the patients had morphologically normal adrenals on imaging. Out of the eight cases with adenoma, six had bilateral disease, and two had unilateral. Of the seventeen patients, fourteen were treated with mineralocorticoid receptor antagonists, resulting in an increase in potassium levels (from 1.7-3.9 to 3.1-5.4 mmol/L) and a decrease in blood pressure (128/78-180/100 to 116/79-150/78 mmHg) post-treatment.

Conclusion: The incidence and prevalence of primary hyperaldosteronism in the Kingdom of Bahrain remain an area of active research. The available data highlights the potential underdiagnosis of primary hyperaldosteronism in this region, necessitating further comprehensive studies.

Keywords: Primary hyperaldosteronism, Renin, Aldosterone, Hypertension, Potassium

Introduction

Hypertension is one of the most prevalent chronic diseases across the world, mostly in low- and middle-income countries. According to the World Health Organization (WHO), an estimated 1.28 billion people are affected by it. In Bahrain, the prevalence of hypertension in 2019 was approximately 39% among patients aged 30 to 79 years.¹ Hypertension is divided into primary and secondary causes, with primary hyperaldosteronism (PHA), accounting for about 10% of secondary causes and 20% of resistant hypertension.²⁻⁴

Primary hyperaldosteronism is a frequently overlooked cause of secondary hypertension and is characterized by the excessive production of aldosterone from the adrenal glands with a suppressed renin. The excess aldosterone leads to a triad of hypertension, sodium retention, and a low level of potassium.⁵ In comparison with primary hypertension, patients with PHA have an increased cardiovascular morbidity and mortality risk; therefore, the underdiagnosis of PHA is of particular concern.⁶ Screening for it is usually done by performing the renin aldosterone ratio (RAR), keeping in mind that several drugs such as beta-blockers, α -methyldopa, clonidine, combined oral contraceptive Pills (COCPs), and non-steroidal anti-inflammatory drugs (NSAIDs) can affect the ratio.⁷⁻⁸ These drugs can suppress renin, raising the ratio and potentially leading to false positive results.⁴ After a positive screening, the diagnosis can be confirmed by conducting several more complex investigations, which, in some centres, are not always performed.

Establishing autonomous aldosterone secretion can be done through oral sodium loading or the saline infusion test.³ The gold standard test for differentiating unilateral adenoma from bilateral hyperplasia is adrenal vein sampling (AVS). It is also performed to ascertain the side of the lesion and, in cases of bilateral adenomas, to determine the lateralization of aldosterone hypersecretion.⁹⁻¹¹ A 2023 study investigated the use of [¹¹C]Metomidate PET-CT as a non-invasive alternative for diagnosing unilateral PHA.¹² While not routinely performed, other methods, such as the postural

stimulation test, can help in distinguishing adenoma from hyperplasia. In cases of bilateral idiopathic hyperplasia, this test will reveal a characteristic rise in serum aldosterone upon transition from supine to standing.¹³ In addition, imaging of the adrenal glands through magnetic resonance imaging (MRI) and computed tomography (CT) scans helps in the differentiation between adenomas and hyperplasias, and defines unilateral versus bilateral disease. Furthermore, management usually involves an adrenalectomy in cases of unilateral disease and a mineralocorticoid receptor antagonist for bilateral disease.⁵

Primary hyperaldosteronism was previously considered uncommon, with a low prevalence. In the 1990s, it was found that low potassium levels are not mandatory for the diagnosis of PHA, and that a normal-potassium variant of PHA exists.⁵

In the Middle East, where the prevalence of hypertension is on the rise, the prevalence of PHA remains largely unexplored. Limited studies and prevalence data in the region hinder our understanding of the true burden of PHA in Middle Eastern populations.

Our retrospective study aims to provide insight into the prevalence of primary hyperaldosteronism at a single center in the Kingdom of Bahrain and its clinical significance within the local population. Investigating the prevalence of PHA becomes paramount for effective hypertension management and prevention of associated cardiovascular and cerebrovascular complications.

Materials and Methods:

Study design and population

The aim of our study was to assess the prevalence of primary hyperaldosteronism in the Kingdom of Bahrain and to identify the demographic characteristics, clinical features, and associated comorbidities of individuals diagnosed with primary hyperaldosteronism.

We retrospectively analysed a total of 158 patients who were screened for primary hyperaldosteronism by using the Renin/Aldosterone ratio (>20 ng/dL per ng/mL per hour) at a single tertiary hospital (King

Hamad University Hospital), during the years 2022 to 2023.

Ethical approval was obtained from the Royal Medical Services Research Committee, the Royal College of Surgeons of Ireland, and the University of Bahrain Research Committee. Informed consent was waived by both ethical committees as personal identification was removed, and strict confidentiality was maintained.

Male and female genders, ages fourteen and above, and undergoing laboratory screening for primary aldosteronism with a renin/aldosterone ratio were included in this study. Patients aged below 14 years and the presence of other causes of secondary hypertension were excluded from the study.

Data collection

Access to the electronic medical records from King Hamad University Hospital via HOPE EMR was granted. Data including demographic information (age, gender, ethnicity), duration of hypertension (when available), the use of confirmatory tests to diagnose PHA such as saline infusion test, and/or imaging studies including CT and MRI scans, the treatment modalities used (medications, dosage, surgical interventions), as well as blood pressure assessment (baseline, follow-up measurements) were collected and recorded in a Microsoft Excel. Laboratory investigations, including serum potassium, plasma aldosterone, metanephrines, normetanephrines, 24-hour urine cortisol, and adrenocorticotropic hormone (ACTH) were also included.

Statistical Analysis

Descriptive statistics were used to summarize patient characteristics and treatment modalities. Differences in mean renin, aldosterone, and the RAR across patients with and without confirmed hyperaldosteronism were estimated using linear regression. The models were adjusted for age and sex. The difference in means across those with confirmed hyperaldosteronism and those who screened negative was also obtained using the same method. Statistical significance will be set at $p < 0.05$.

Results

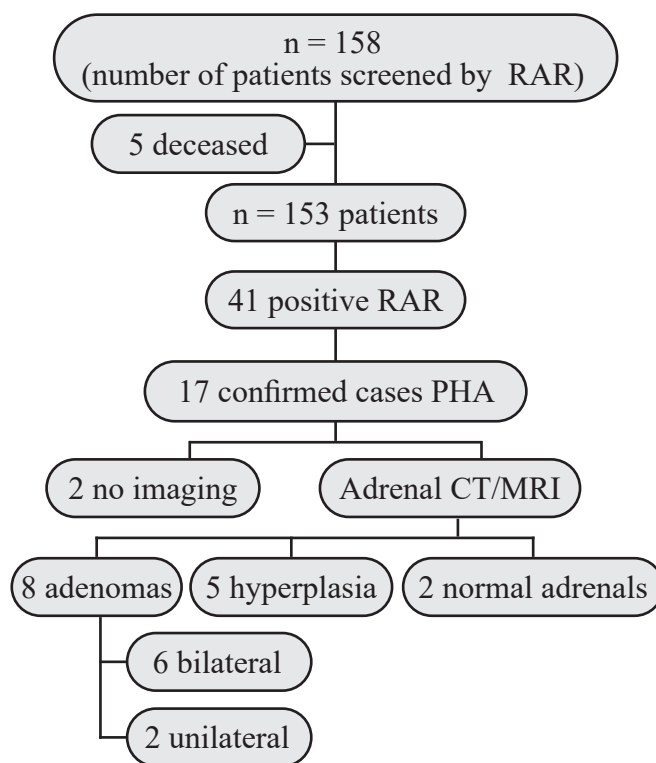


Figure 1: Study flow chart for confirmed cases of PHA and their subtype.

During the study period, a cohort of 158 patients underwent screening tests aimed at identifying secondary causes of hypertension, with the exclusion of five deceased individuals. The screening process involved determining renin, aldosterone, and RAR levels. The demographic and baseline characteristics of the cohort, including age, gender, ethnicity, and pertinent laboratory investigations, are presented in Table 1.

Within the cohort of 153 patients, 41 individuals (26.8%) exhibited an elevated RAR exceeding 20 ng/dL per ng/mL per hour, resulting in confirmation of 17 cases of PHA: 15 by imaging modalities and 2 by the saline infusion test. Two patients with normal adenomas on imaging had a saline infusion test done to confirm PHA. The gender distribution among the confirmed cases comprised nine males and eight females, all of whom were Bahraini nationals, except for one. 10 of our patients were between 50 and 75 years of age, with one outlier at 18 years of age. The mean potassium level at the time of diagnosis was 3.79 ± 0.4 . Notably, 11 (64.7%) patients presented with hypokalemia (serum potassium levels below 3.5 mmol/L) prior to the formal diagnosis.

Table 1. Patient characteristics (N=153)

	Screened negative	Screened positive	Total
Age [mean + SD]	42.2 + 19.4	52.4 + 14.5	44.9 + 18.7
Sex			
Females [n(%)]	44 (39%)	23 (56%)	67 (44%)
Males [n(%)]	68 (61%)	18 (44%)	(86) (56%)
Ethnicity			
GCC [n(%)]	109 (97%)	37 (90%)	146(95%)
Other [n(%)]	3 (3%)	4 (10%)	7(5%)
Renin [mean + SD]	46.2 + 72.3	5.0 + 4.3	35.2 + 64.5
Aldosterone [mean + SD]	15.7 + 17.8	28.5 + 17.8	19.2 + 18.7
R/A ratio [mean + SD]	6.4 + 4.9	106.2 + 118.3	33.5 + 75.7
K before [mean + SD]	4.1 + 0.5	3.53 + 0.5	3.9 + 0.5
K after [mean + SD]	-	4.2 + 0.5	4.2 + 0.5

Abbreviations: SD, standard deviation; GCC, Gulf Cooperation Council; R/A, renin aldosterone; K, potassium.

Diagnostic imaging studies, specifically adrenal CT and adrenal MRI, were performed for the confirmed patients, although two cases lacked corresponding imaging data. Results from these studies delineated eight cases of adrenal adenomas, five cases of hyperplasia, and the remaining cases demonstrating normal adrenal morphology (Figure 1). The majority (59%) of cases exhibited bilateral lesions upon imaging. It is important to note that AVS was conducted solely for one patient. [¹¹C] Metomidate scan was not done to any of the confirmed cases.

Of the seventeen confirmed patients, fourteen are currently receiving mineralocorticoid receptor antagonists, namely Spironolactone or Eplerenone. The daily dosage of mineralocorticoid receptor antagonists administered to these patients ranged between 12.5mg - 150mg. Regarding antihypertensive medications, 2 patients were on single therapy, 7 patients were on dual agents, and the remaining 8 were on 4 to 5 agents. No genetic testing was done to rule out familial hyperaldosteronism.

In terms of blood pressure readings, pre-diagnosis systolic blood pressure ranged from 132 to 175 mmHg, and diastolic blood pressure from 73 to 103 mmHg. Subsequent blood pressure assessments in the latest records showed systolic readings ranging from 116 to 160 mmHg and diastolic readings from

73 to 90 mmHg. Notably, none of the confirmed cases underwent any surgical intervention during the study.

Discussion

Earlier studies indicated a primary hyperaldosteronism prevalence of less than 1%, but recent research, such as one study conducted in Korea, revealed a prevalence of 10%.⁵ In our study, conducted from 2022 to 2023, we found a prevalence of 11% at a single center. PHA screening, involving renin, aldosterone, and their ratio, is typically conducted for individuals displaying hypertension, unexplained hypokalemia, and metabolic alkalosis. Upon retrospectively analysing our data, it was apparent that there was no clear screening protocol in place, as not all patients who had RAR done were hypertensive or exhibited characteristics of potential underlying PHA. Previously, it was suggested that hypokalemia was a prerequisite to diagnose PHA; however, more recent publications have shown that only 9-37% of these patients have documented hypokalemia.¹⁴⁻¹⁶ Similarly, in our study, 23.5% of patients diagnosed with PHA presented with hypokalemia at diagnosis (reference range: <3.5 mmol/L). The rationale for performing case detection testing was limited by the study's retrospective design and incomplete documentation in the EMS. The 24 cases with positive RAR but

unconfirmed PHA could be interpreted as false positives. This could be due to the fact that these cases were on specific antihypertensive medications, including calcium channel blockers, beta blockers, and angiotensin receptor blockers, which have been shown to affect the RAR. During data collection for our study, medication histories were not systematically reviewed for all patients. Therefore, potential medication-induced confounding could not be fully assessed for those with a positive RAR result. Although some studies suggest stopping antihypertensive medications for at least 2 weeks before performing the RAR, others state that if there are safety concerns about stopping antihypertensive medications, the RAR cutoff points should be adjusted accordingly.³

PHA has been associated with multiple target organ damage, including left ventricular hypertrophy (LVH) and albuminuria.^{17,18} Our patients had an echocardiography done, revealing that 6 patients had grades 1 or 2 diastolic dysfunction, and of them, in concordance, 4 patients exhibited LVH. Albuminuria was not measured in our study population, unlike in the Korean study.⁵ It has been shown that elevated levels of aldosterone and mineralocorticoid receptor activation are modifiable risk factors of cardiovascular disease.¹⁹⁻²¹ Although in our cohort of patients, coronary artery disease was only documented in 2 of our confirmed PHA cases, it is vital to look at the long-term implications of this.

In previous studies, it was suggested that only patients with high levels of aldosterone more than 10 ng/dL (277 pmol/L) and RAR greater than 30 ng/dL per ng/mL per hour (832 pmol/L per mg/L per hour) in the screening process undergo confirmatory testing for PHA, which includes saline infusion testing.²² In terms of the absolute aldosterone levels, our study showed that the mean aldosterone levels were significantly higher in those with confirmed hyperaldosteronism ($p=0.04$), after adjusting for age and sex (Figure 2). Similarly, the mean RAR was significantly higher in confirmed cases of hyperaldosteronism ($p=0.04$) after adjusting for age and sex (Figure 3). Although our study participants

had a high average of both aldosterone and RAR, only 3 of them underwent the saline infusion testing, because in comparison, they had relatively low levels of aldosterone and RAR, thus contradicting the advice of prior studies.²²

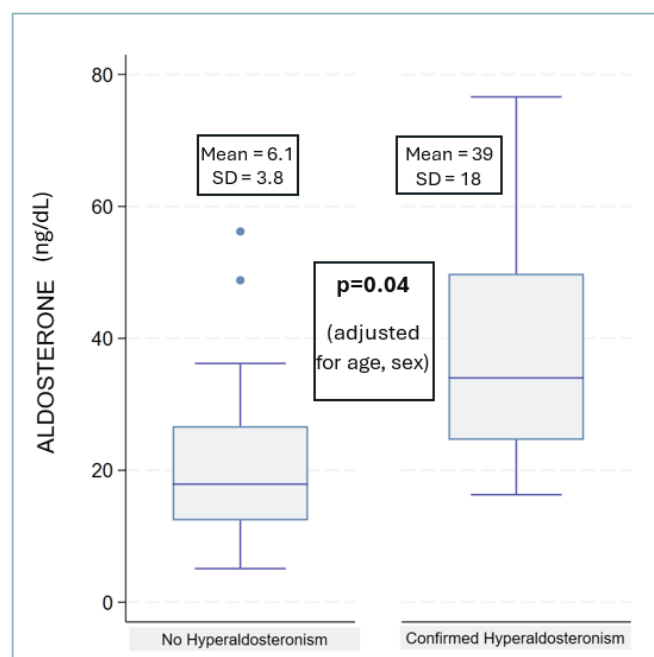


Figure 2: Aldosterone levels across participants with a positive RAR (N=41) comparing those confirmed hyperaldosteronism vs. those who do not

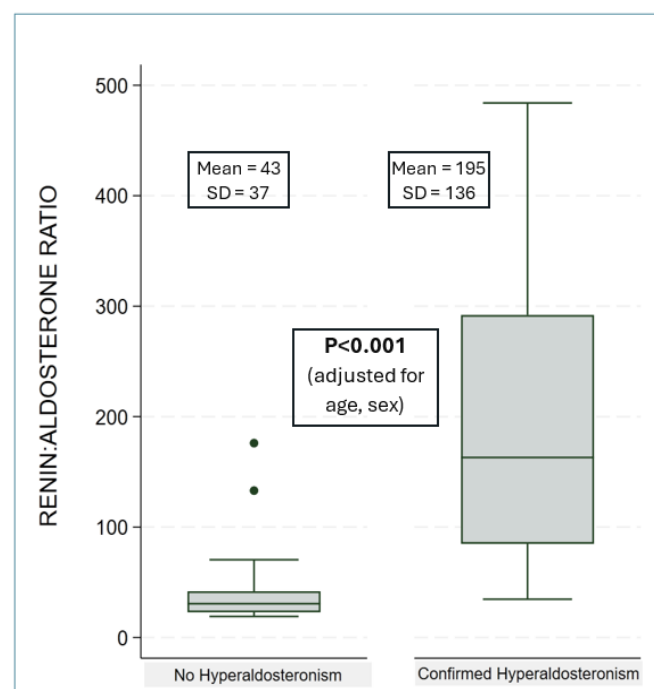


Figure 3: Renin to Aldosterone ratio across participants screened positive (N=41) comparing those confirmed hyperaldosteronism vs. those who do not

Regarding imaging, adrenal CT and MRI scans exhibit limited accuracy for localizing unilateral disease, prompting the recommendation of adrenal venous sampling in patients with PHA. This becomes pivotal in identifying candidates for unilateral adrenalectomy. Intriguingly, our study diverged from these recommendations, with only one patient undergoing AVS, and none subjected to surgical adrenalectomy. Such practice could lead to patients with potentially curable unilateral disease being maintained on lifelong medical therapy.

The study on PHA in Korea revealed that bilateral adrenal hyperplasia (66%) was more prevalent than adrenal adenoma (27%), consistent with many other studies.⁵ However, in our cohort, it was evident that 47% had adrenal adenomas, whilst 23% had bilateral adrenal hyperplasia.

In our study, patients demonstrated a significant reduction in blood pressure readings from pre- to post-treatment. The average pre-treatment blood pressure was 155/87 mmHg, and the average post-treatment blood pressure was 134/80 mmHg. Fifteen out of the seventeen confirmed PHA cases were treated with a mineralocorticoid receptor antagonist. Eight patients were being treated with 4 to 5 antihypertensive medications, while nine were either on single or dual therapy. Likewise, a statistically significant reduction in blood pressure after treatment was noted in a similar study done in Korea on PHA patients, where this was achieved mainly by adrenalectomy or mineralocorticoid antagonists.⁵ It's noteworthy to mention that a substantial portion of our confirmed PHA patients were already diagnosed with hypertension and were under pharmacological management. Despite the potential influence of antihypertensive medications on biochemical measurements, existing studies suggest that their continuation is warranted during initial testing.³

Limitations

This study has several limitations that should be noted. Firstly, it was conducted at a single center, which may limit its generalizability to a broader population. Additionally, there was no established

protocol for screening and managing patients with PHA, leading to a lack of standardized confirmatory tests for all patients. Furthermore, some patients were receiving medications that could affect RAR values, and these medications were not discontinued during the study. Lastly, adrenal vein sampling was not performed due to its unavailability, and no adrenalectomy was conducted.

Despite these limitations, this study is the first of its kind to investigate secondary hypertension in the Kingdom of Bahrain, providing valuable insights into this condition.

Conclusion

In conclusion, the incidence and prevalence of primary hyperaldosteronism in the Kingdom of Bahrain remain an area of active research. The available data highlight the potential underdiagnosis of PHA in this region, underscoring the need for comprehensive studies to inform clinical practice and healthcare policies. Further research is warranted to refine screening strategies and improve the recognition of this potentially treatable form of hypertension. It might also be essential to enhance awareness, improve diagnosis rates, develop protocols, and advocate for targeted treatment interventions for patients with PHA.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Funding

No public or commercial funding was needed to conduct the study.

Acknowledgements

The authors would like to thank the contribution of the Laboratory and Pathology Department of King Hamad University Hospital for their cooperation and assistance in this study.

Data availability

The data set generated/analysed during the current study is available from the corresponding author upon reasonable request.

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