BENHA MEDICAL JOURNAL bmj

**Print ISSN** 1110-208X.

**Online ISSN** 2357-0016

# Adherence in Egyptian Hypertensive Patients to Medication Beliefs and Assessment of MicroRNAs as a Novel Biomarker of Hypertension in Qaliubeya Governorate, Egypt

Ahmed E. Mansour [a] , Mohammed A. Ibrahim [a], Abeer E. Abd Elsamiee [b], Eman A. Ahmed [a], Heba A. Mokhtar [a]

[a] Internal Medicine Department, Faculty of Medicine Benha University, Egypt.

[b] Public Health Department, Faculty of Medicine Benha University, Egypt.

**Corresponding** to:
Dr. Eman A. Ahmed.
Internal Medicine Department, Faculty of Medicine Benha University, Egypt.

**Email:**
fathy.gaber2012@gmail.com

**Received:** 15 May 2025

**Accepted:** 8 September 2025

## Abstract:

**Background:** It is crucial to ensure that hypertensive patients adhere to their medication regimens to prevent complications that may result in mortality, as hypertension is an incurable condition. Consequently, our objective was to ascertain the proportion of patients who adhered to the use of antihypertensive drugs and certain factors associated with adherence, as well as to investigate the efficacy of the MIR-122 gene as a screening instrument for the identification of hypertensive patients with inadequate medication adherence. **Methods:** This prospective study included 381 patients, seventy females and 311 males, adherence to treatment was assessed by Morisky Medication Adherence Scale (MMAS-8). Serum microRNAs were measured for all studied patients at six months. **Results:** 149 cases (39.2%) were adherent to treatment, and 232 patients (60.8%) were not adherent to treatment. Patients with poor adherence to treatment had statistically higher Mir-122 expression compared to good adherent group. Mir-122 expression could predict poor adherence to treatment, at a cutoff value > 9.4, the sensitivity was 100% and specificity was 100%, P<0.001. Low educational level, longer duration of HTN treatment, obesity, diabetes mellitus, vascular disease, high blood lipid levels, and Mir-122 were significant predictors of poor adherence in the studied group. Conclusion: Low educational level, longer duration of HTN treatment, obesity, diabetes mellitus, vascular disease, high blood lipid levels, and Mir-122 were significant predictors of poor adherence in the studied group.

**Keywords:** Hypertension, adherence, microRNAs

## Introduction

The definitions of hypertension, or elevated blood pressure, are a systolic blood pressure increase of 130 mmHg or higher or a diastolic blood pressure increase of 80 mmHg or higher on two separate occasions following a five-minute interval and adequate rest/quiet periods. When not identified and treated promptly, persistently elevated blood pressure can result in kidney failure, coronary heart disease, and stroke [(1)].

Globally, there are 1billion people with hypertension, and this is expected to increase to 1.5 billion by 2025. Low- and middle-income countries have a higher prevalence of hypertension among adults than high-income countries: 31.5% and 28.5%, respectively [(2)].

Treatment, control, and awareness rates are low in Egypt, despite the significant prevalence of HTN. About 26.3% of Egyptian adults (aged 25 years or older) were diagnosed with hypertension. For 60% of patients, the prevalence of additional cardiovascular risk factors complicates HTN, resulting in elevated cardiovascular morbidity and mortality [(3)].

Physically devastating, hypertension is referred to as the "silent killer" due to the emergence of fatal complications when blood pressure is uncontrolled. The linear relationship between blood pressure and cardiovascular problems has been broadly demonstrated by epidemiological research. Globally, hypertension is accountable for over 50% of heart assaults and strokes. So, after a diagnosis of hypertension has been confirmed through an appropriate blood pressure measurement, it is necessary to manage the condition for the duration of one's life through both pharmacological and non-pharmacological methods . Because hypertension is a chronic condition that cannot be cured, it requires lifelong management. This involves pharmacological treatment, such as the regular use of antihypertensive medications to control blood pressure. In addition, non-pharmacological approaches are essential, including lifestyle modifications such as reducing salt intake, maintaining a healthy weight, engaging in regular physical activity, limiting alcohol consumption, and avoiding smoking. [(4)].

Although there are effective antihypertensive medication therapies available, less than 25% of hypertensive patients achieve optimal blood pressure, and half of them are unable to adhere to their prescribed regimens [(5)]

There are two primary avenues for enhancing hypertension control: the first is to increase awareness of the disease, and the second is to ensure that both pharmacological and non-pharmacological treatments are adhered to [(6)].

The modulation of the SIRT6-Elabela-ACE2, LGR4-β-catenin, TGFβ-CTGF, and PTEN-PI3K-Akt signaling pathways by MiR–122 overexpression further exacerbates the angiotensin II-mediated loss of autophagy. As an outcome, this results in an increase in inflammation, apoptosis, extracellular matrix deposition, cardiovascular fibrosis, and dysfunction. Furthermore, miR-122 inhibition exhibits antifibrotic, anti-inflammatory, antioxidant, proautophagic, and anti-apoptotic features [(7)].

A novel therapeutic strategy for the progression of cardiovascular dysfunction involves targeting miR-122, which has been identified as an early-warning biomarker for cardiovascular fibrosis [(8)].

The objective of this study is to ascertain the proportion of patients who adhere to the use of antihypertensive drugs and certain factors associated with adherence, as well as to investigate the efficacy of the MIR-122 gene in identifying hypertensive patients who lack adherence to their medication regimen.

## Patients and methods

This prospective study was conducted during the period from December 2023 to the end of June 2024 to evaluate patient adherence to drug use at the following time points: one month, three months, and

six months after the start of the study and serum microRNAs was measured for all studied patients at six months to assess its difference between patients with good and bad adherence to medication. By conducting frequent meetings with patients to gain a better understanding of the patients with hypertension who are being examined and treated as outpatients in the internal medicine departments of three hospitals in three districts (Benha, Kalioub, and Shubraelkhima), a simple random sample was utilized to select participants from the eight districts of the Governorate.

The Target groups: Every patient was interviewed and their prescriptions were collected on four separate occasions: at the commencement of the study, at the first follow-up (one month later), at the second follow-up (three months later), and at the third follow-up (six months later).

The trial comprised all hypertensive patients aged 18 years or older who had been on antihypertensive medication for a minimum of one month and had provided their consent to participate. Patients with aberrant consciousness or abnormal mental status, as well as those who were pregnant or lactating, were excluded.

- ***Sample size***

The sample size was estimated according to previous study [9]**,** using the following equation;

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where n = sample size, Z = Z statistic for a level of confidence, P = expected prevalence from previous literature d = precision .If we suppose that Z for 95% confidence interval =1.96 P= 46***),*** d= 5% so the minimum sample size is ٣٨١.

**Data collection:** there are three phases of recording patient information regarding the patient's phone number or relatives and addresses in first meeting for follow up.

- 1st Phase at the beginning of the study: including complete history taking and medical examination.
- 2nd Phase at the time of the 1st (after one month), the 2nd (after 3 months), and the 3rd (after six months) follow-up, include assessment adherence to treatment according to the Morisky Medication Adherence Scale (MMAS-8) [10].
- Third phase; Assessment of serum MIR-122 gene: MIR 122 was measured for all studied patients at six months, using miRNeasy Micro Kit. Cat. No. / ID : 217084. Blood (2 ml) was obtained from the patient's serum, which was subsequently separated by centrifugation. The serum was subsequently collected and transferred to new containers, the supernatant was discarded, and the particle was stored at −80°C until it was required for RT-PCR for extraction and quantification. Small RNA was extracted from 2 mL of plasma using the miRcute miRNA Isolation Kit **(Tiangen, China)** in accordance with the manufacturer's protocol. Implementation of a multivolume spectrophotometer system (Epoch) was necessary to confirm the concentration and integrity of miRNA. The miRcute miRNA First-Strand cDNA Synthesis Kit (Tiangen) was employed to synthesize cDNA. Using the miRcute miRNA qPCR Detection reagent (SYBR Green), the relative quantification of miRNAs during real-time PCR was determined in the subsequent phase. As an internal control, U6 is implemented. At Sangon Biotechnology in Shanghai, the PCR primers were synthesized. Amplification reactions were performed using the 7500 FAST Real-Time PCR System (Applied Biosystems).To ascertain the relative miRNA expression level, the 2-ΔΔCt method was implemented [11].

**Statistical analysis**

The collected data was revised, coded, tabulated using Statistical package for Social Science (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.).

Data were presented and suitable analysis was done according to the type of data obtained for each parameter. Descriptive statistics: Mean, Standard deviation (± SD) for numerical data, frequency and percentage of non-numerical data. Student T Test was used to assess the statistical significance of the difference between two study group means. For the comparison of more than two groups' means, one way analysis of variance (ANOVA) was used. Chi-Square test was used to examine the relationship between two qualitative variables. The ROC Curve (receiver operating characteristic) provides a useful way to evaluate the sensitivity and specificity for quantitative diagnostic measures that categorize cases into one of two groups. The optimum cut off point was defined as that which maximized the AUC value. The area under the ROC curve (AUC) results were considered excellent for AUC values between 0.9-1, good for AUC values between 0.8-0.9, fair for AUC values between 0.7-0.8, poor for AUC values between 0.6-0.7 and failed for AUC values between 0.5-0.6. Regression analysis: Logistic and ordinal regression analyses were used for prediction of risk factors, using generalized linear models. An odds ratio (OR) is a measure of association between exposure and an outcome. The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. The 95 % confidence interval (CI) is used to estimate the precision of the OR. A large CI indicates a low level of precision of the OR, whereas a small CI indicates a higher precision of the OR.

**Approval code:** The study protocol was approved by the Ethical Committee of Faculty of Medicine, Benha University (Approval code: Ms 39-11-2023)

## Results

This study included 381 patients, 70 females and 311 males, 8.5% of patients were 25-40 years, 18.2% were 41-50 years, 41.3% were 51-60 years and 32% were > 60 years old. The adherence to treatment during follows up visits at 1 month, third months and sixth months. 149 cases (39.2%) were adherent to treatment, and 232 patients (60.8%) were not adherent to treatment. Table 1

Patients with good adherence had statistically higher frequency of younger age, high educational level, high and moderate income, and statistically lower frequency of family history of HTN. While there was no statistical difference between patient good and poor adherent as regarding age, gender, residence, occupation, or marital status. Table 2. Adherence significantly decreases with increase hypertension duration and duration of treatment. Table 3

Patients with poor adherence to treatment had statistically higher BMI and higher frequency of DM compared to good adherent groups. While there was no statistical difference between patient good and poor adherent as regards heart disease, asthma, chronic kidney disease, vascular disease, high blood lipid levels. Table 4. There was no statistical difference between patient good and poor adherent as regards receiving treatment. Table 5

Patients with poor adherence to treatment had statistically higher Mir-122 expression compared to good adherent group. Figure 1.

Mir-122 expression could predict poor adherence to treatment, at a cutoff value > 9.4, the sensitivity was 100% and specificity was 100%, P<0.001., Table 6 & Figure 2.

In univariate analysis, Age, low educational level, low Income, longer duration of HTN, longer duration of HTN treatment, obesity, diabetes mellitus, chronic kidney disease, vascular disease, high blood lipid levels, and Mir-122 were associated with poor adherence in the studied group. While in multivariate analysis; low educational level, longer duration of HTN treatment, obesity, diabetes mellitus, vascular disease, high

blood lipid levels, and Mir-122 were significant predictors of poor adherence in the studied group. Table 7.

**Table 1:** Evaluation of adherence to treatment during follow up visits.

| | | N=381 | % |
|---|---|---|---|
| **1 month** | | | |
| **Sometimes I forget to take medicine** | **Yes** | 6 | 1.6% |
| | **No** | 375 | 98.4% |
| **In the past 2 weeks, there was a day that medicine was not taken** | **Yes** | 170 | 44.7% |
| | **No** | 211 | 55.3% |
| **Used to reduce, stop taking medicine when feeling worse** | **Yes** | 148 | 38.9% |
| | **No** | 233 | 61.1% |
| **When leaving home, traveling forget to bring medicine** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **I took medicine yesterday** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **Sometimes I stop taking medicine when feel my blood pressure is under control** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **Having trouble with taking medicine every day** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **Finding it difficult to remember a medication schedule** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **3 months** | | | |
| **Sometimes I forget to take medicine** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **In the past 2 weeks, there was a day that medicine was not taken** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **Used to reduce, stop taking medicine when feeling worse** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **When leaving home, traveling forget to bring medicine** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **I took medicine yesterday** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **Sometimes I stop taking medicine when feel my blood pressure is under control** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **Having trouble with taking medicine every day** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **Finding it difficult to remember a medication schedule** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **6 months** | | | |
| **Sometimes I forget to take medicine** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **In the past 2 weeks, there was a day that medicine was not taken** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **Used to reduce, stop taking medicine when feeling worse** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **When leaving home, traveling forget to bring medicine** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **I took medicine yesterday** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **Sometimes I stop taking medicine when feel my blood pressure is under control** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **Having trouble with taking medicine every day** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **Finding it difficult to remember a medication schedule** | **Yes** | 149 | 39.2% |
| | **No** | 232 | 60.8% |
| **Adherence** | **Good** | 149 | 39.2% |
| | **Poor** | 232 | 60.8% |

**Table 2:** Adherence to treatment as regards sociodemographic data

| | | Adherence | | | | Test | P value |
|---|---|---|---|---|---|---|---|
| | | Good | | Poor | | | |
| | | N=149 | % | N=232 | % | | |
| **Age** | **25-40 years** | 20 | 13.5 % | 12 | 5.2% | $X^2$=42.8 | <0.001* |
| | **41-50 years** | 46 | 31.1% | 23 | 10.0% | | |
| | **51-60** | 65 | 43.2% | 93 | 40.0% | | |
| | **>60 years** | 18 | 12.2% | 104 | 44.8% | | |
| **Sex** | **Females** | 29 | 19.6% | 41 | 17.4% | $X^2$=0.29 | 0.58 |
| | **Male** | 120 | 80.4% | 191 | 82.6% | | |
| **Place of** | **Benha** | 46 | 31.1% | 75 | 32.2% | $X^2$=0.89 | 0.64 |
| **Residence** | **Qaliub** | 66 | 43.9% | 108 | 47.0% | | |
| | **Shubra** | 37 | 25.0% | 49 | 20.9% | | |
| **Occupation** | **Not working** | 42 | 28.4% | 64 | 27.4% | $X^2$=0.44 | 0.81 |
| | **Working** | 107 | 71.6% | 168 | 72.6% | | |
| **Education** | **Low** | 29 | 19.6% | 123 | 53.0% | $X^2$=7.4 | <0.001* |
| **Level** | **High** | 120 | 80.4% | 109 | 47.0% | | |
| **Income** | **Low** | 21 | 14.2% | 95 | 40.9% | $X^2$=9.2 | <0.001* |
| | **Moderate** | 125 | 83.8% | 137 | 59.1% | | |
| | **High** | 3 | 2.0% | 0 | 0.0% | | |
| **Marital Status** | **Married** | 138 | 92.6% | 203 | 87.4% | $X^2$=2.5 | 0.11 |
| | **No** | 11 | 7.4% | 29 | 12.6% | | |
| **Family** | **Yes** | 103 | 68.9% | 200 | 86.5% | $X^2$=5.3 | <0.001* |
| **History** | **No** | 46 | 31.1% | 32 | 13.5% | | |

$X^2$: Chi-square test, *: Significant

**Table 3:** Adherence to treatment regarding duration and treatment of hypertension

| | | Adherence | | | | Test | P value |
|---|---|---|---|---|---|---|---|
| | | Good | | Poor | | | |
| | | N=149 | % | N=232 | % | | |
| **Duration Of** | **1-5 years** | 65 | 43.9% | 29 | 12.6% | $X^2$=22.1 | 0.002* |
| **Hypertension** | **6-10 years** | 43 | 28.8% | 113 | 48.7% | | |
| | **11-20 years** | 33 | 22.3% | 76 | 32.6% | | |
| | **>20 years** | 8 | 5.4% | 14 | 6.1% | | |
| **Duration of** | **1-5 years** | 64 | 42.6% | 54 | 23.4% | $X^2$=22.6 | 0.043* |
| **Hypertension** | **6-10 years** | 42 | 28.4% | 116 | 50.0% | | |
| **Treatment** | **11-20 years** | 41 | 27.7% | 60 | 25.7% | | |
| | **>20 years** | 2 | 4.7% | 2 | 0.9% | | |

$X^2$: Chi-square test

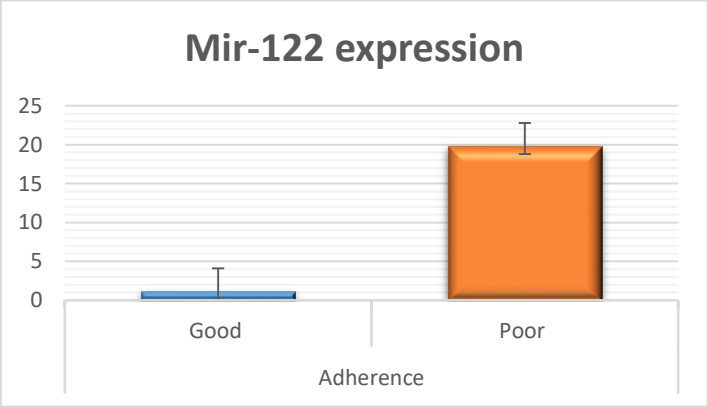


**Figure 1:** Mir-122 expression regarding adherence to treatment.

**Table 4:** Adherence to treatment as regards comorbidities.

| | | Adherence | | | | Test | P value |
|---|---|---|---|---|---|---|---|
| | | Good | | Poor | | | |
| | | N=149 | % | N=232 | % | | |
| **BMI** | **Mean ±SD** | 27.4±1.9 | | 30.9±2.2 | | t=2.8 | 0.021* |
| | **Range** | 21.5-34.3 | | 21.7-36.6 | | | |
| **Obesity** | **Normal (<25)** | 44 | 29.7% | 54 | 23.0% | $X^2$=1.92 | 0.09 |
| | **Overweight (25-30)** | 75 | 50.2% | 125 | 53.8% | | |
| | **Obese (>30)** | 30 | 20.1% | 53 | 22.8 | | |
| **Type 2 DM** | **Yes** | 94 | 62.8% | 184 | 79.6% | $X^2$=12.7 | <0.001* |
| | **No** | 55 | 37.2% | 48 | 20.4% | | |
| **Ischemic heart disease** | **Yes** | 29 | 19.6% | 33 | 14.3% | $X^2$=1.8 | 0.19 |
| | **No** | 120 | 80.4% | 199 | 85.7% | | |
| **Asthma** | **Yes** | 2 | 1.4% | 4 | 1.7% | $X^2$=0.09 | 0.72 |
| | **No** | 147 | 98.6% | 228 | 98.3% | | |
| **Chronic kidney disease** | **Yes** | 6 | 4.1% | 3 | 1.3% | $X^2$=2.9 | 0.08 |
| | **No** | 143 | 95.9% | 229 | 98.7% | | |
| **Peripheral vascular disease** | **Yes** | 6 | 4.1% | 6 | 2.6% | $X^2$=0.61 | 0.49 |
| | **No** | 143 | 95.9% | 226 | 97.4% | | |
| **High cholesterol levels** | **Yes** | 147 | 98.6% | 230 | 99.1% | $X^2$=0.2 | 0.65 |
| | **No** | 2 | 1.4% | 2 | 0.9% | | |
| **High triglyceride levels** | **Yes** | 147 | 98.6% | 230 | 99.1% | $X^2$=0.2 | 0.65 |
| | **No** | 2 | 1.4% | 2 | 0.9% | | |

$X^2$: Chi-square test, *: significant

**Table 5:** Adherence to treatment as regards medications

| | | Adherence | | | | Test | P value |
|---|---|---|---|---|---|---|---|
| | | Good | | Poor | | | |
| | | N=149 | % | N=232 | % | | |
| **Diuretics** | **Yes** | 50 | 33.8% | 64 | 27.4% | $X^2$=1.7 | 0.18 |
| | **No** | 99 | 66.2% | 168 | 72.6% | | |
| **Calcium Channel Blockers** | **Yes** | 19 | 12.8% | 45 | 19.6% | $X^2$=2.9 | 0.08 |
| | **No** | 130 | 87.2% | 187 | 80.4% | | |
| **Angiotensin-converting enzyme inhibitors** | **Yes** | 25 | 16.9% | 30 | 13.0% | $X^2$=1.1 | 0.30 |
| | **No** | 124 | 83.1% | 202 | 87.0% | | |
| **Angiotensin II receptor blockers** | **Yes** | 56 | 37.8% | 96 | 41.3% | $X^2$=0.45 | 0.51 |
| | **No** | 93 | 62.2% | 136 | 58.7% | | |
| **Beta-Blockers** | **Yes** | 76 | 50.7% | 103 | 44.3% | $X^2$=1.4 | 0.23 |
| | **No** | 73 | 49.3% | 129 | 55.7% | | |
| **Centrally acting alpha-2 adrenergic agonist** | **Yes** | 1 | 0.7% | 1 | 0.4% | $X^2$=0.10 | 0.75 |
| | **No** | 148 | 99.3% | 231 | 99.6% | | |
| **Drugs** | **Single** | 133 | 89.2% | 197 | 84.9% | $X^2$=3.23 | 0.09 |
| | **Two drugs** | 12 | 8.1% | 25 | 10.9% | | |
| | **More than two drugs** | 4 | 2.9% | 10 | 4.2% | | |

$X^2$: Chi-square test

**Table 6:** Performance of Mir-122 expression to detect cases of poor adherence to treatment.

| | AUC | 95% CI | | Cutoff value | Sensitivity | Specificity | P value |
|---|---|---|---|---|---|---|---|
| | | Lower | Upper | | | | |
| **Mir-122 expression** | 1.000 | 1.000 | 1.000 | >9.4 | 100% | 100% | <0.001* |

**Table 7:** Univariate and multivariate logistic regression analysis of risk factors of poor adherence in the studied group

| | Univariate analysis | | Multivariate analysis | |
|---|---|---|---|---|
| | OR (CI) | P value | OR (CI) | P value |
| **Age** | 1.500 (0.655-4.236) | **0.031*** | 1.132 (0.675-2.132) | 0.213 |
| **Low educational level** | 3.998 (1.133-20.43) | **<0.001*** | 3.832 (2.657-18.554) | **<0.001*** |
| **Low Income** | 1.732 (0.871-3.232) | **0.012*** | 1.273 (0.945-4.387) | 0.091 |
| **Positive family history** | 1.161 (0.629-1.415) | 0.113 | | |
| **Longer duration of HTN** | 1.523 (0.932-3.572) | **0.033*** | 1.765 (0.976-4.212) | 0.081 |
| **Longer duration of HTN treatment** | 2.388 (0.875-3.545) | **0.006*** | 1.876 (0.767-2.987) | **0.009*** |
| **Obesity** | 2.111 (0.839-4.215) | **0.003*** | 2.365 (0.912-4.254) | **0.021*** |
| **Diabetes mellitus** | 2.067(0.787-3.815) | **0.013*** | 1.868 (0.803-2.989) | **0.008*** |
| **Chronic kidney disease** | 1.872 (0.871-2.977) | **0.044*** | 1.335 (0.785-3.143) | 0.069 |
| **Vascular disease** | 2.329 (0.821-3.875) | **0.006*** | 2.622 (0.980-5.912) | **0.001*** |
| **High blood lipid levels** | 2.229 (0.843-4.911) | **0.003*** | 2.565 (0.954-5.871) | **0.003*** |
| **Mir-122** | 6.121 (1.526-23.54) | **<0.001*** | 7.989 (3.544-19.877) | **<0.001*** |

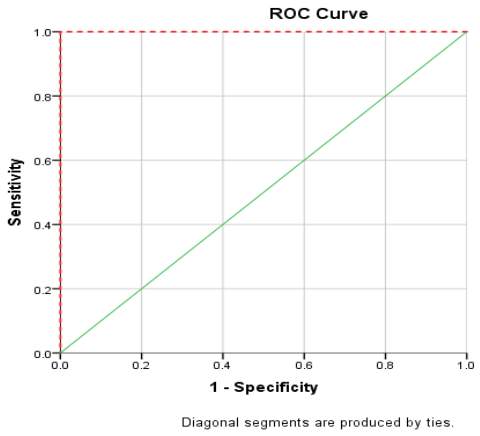


**Figure 2:** ROC curve of performance of Mir-122 expression to detect cases of poor adherence to treatment.

## Discussion

These results showed that 148 cases (38.9%) were adherent to treatment, and 230 patients (61.1%) were not adherent to treatment. A similar results were reported by Hassanein, [9], Their analysis revealed that 41.3% of patients achieved high adherence, 26.2% were medium adherent, and 32.6% were low adherent to the treatment.

Although these findings are somewhat distinct from those of Tilea et al. [12], As determined by a prescription record review instrument, 69.8% of patients exhibited high adherence, 20.3% exhibited medium adherence, and 9.9% exhibited low adherence in the Romanian study, which

reported improved adherence rates. Also in the study by Pham et al., [13], after three follow-up visits, they showed that the patient's drug adherence rate was 70% .

On the other side, Pal et al., [14], The adherence of hypertensive patients in India to antihypertensive medication has decreased by 15.8%, as per the researcher who investigated the prevalence of antihypertensive medication adherence and associated factors. Disparities in demographics, questionnaires, sample selection criteria, sample size, and samplers are among the causes of this discrepancy.

In the current study, patients with good adherence had a statistically higher frequency of younger age, higher educational level, and moderate to high income, as well as a statistically lower frequency of family history of hypertension. There was no statistically significant difference between adherent and non-adherent patients regarding gender, residence, occupation, or marital status.

Our findings are consistent with the study by Daniel & Veiga [15] in Brazil, which reported that individuals aged 40–59 and those over 80 demonstrated better adherence to therapy. In that study, 31.4% of the total participants, the most adherent group, were aged 61–70.

Our results were also in agreement with Hassanein, [9], The results suggested that educational attainment was significantly correlated with adherence rates. In total, 559 individuals (67.8%) completed university, 232 (28.1%) completed primary/secondary school, and 34 (4.1%) were illiterate ($p < 0.001$).In addition, this operates in keeping with Pham et al., [13], who observed that patients who reside in urban areas, work in jobs that require social interaction (such as traders and civil servants), have a family history of hypertension, and have an education level of 3 or higher have a significantly higher rate of medication adherence.

The primary factors that influence patients' adherence are (1) knowledge, (2) skill/level of social communication, (3) early awareness of the hazards of hypertension, and the importance of treatment. This is an attempt to elucidate the outcome.

However, our results weren't in the same line with Bandi et al. [16], According to a study conducted in New York City, the adherence to medication was more prevalent among senior patients (34.0%) than among youthful patients (24.5 percent, $p = 0.001$). This was attributed to the fact that youthful patients had a reduced level of education, more limited knowledge of hypertension control, and consumed excessive amounts of alcohol.

Our results did not align with the gender classification differential in terms of adherence with Hassanein, [9], whose findings indicated that males exhibited significantly higher levels of treatment adherence than females (56.4% versus 43.6%, $p < 0.001$).In contrast, Ambaw et al. [17] The study revealed that males were less adherent than women. In addition, they stated that males are overextended by outdoor activities, which cause them to become preoccupied and neglect their medications.

In the current study, there was a statistically significant difference between patients who were good adherents and those who were bad adherents in terms of the duration and duration of treatment of hypertension. The good adherence group had statistically higher frequencies of duration 1-5 and 6-10 years, compared to the poor adherence group, which had higher frequencies of duration 11-20 and > 20 years. Our results were matched with Pham et al., [13], who noted that adherence to therapy was significantly reduced by protracted disease duration (≥10 years) and prolonged treatment duration. In addition, Nguyen et al., [18] it was also reported that patients who had been under treatment for more than three years had a non-adherence rate that was 3.98 times higher. A

correlation was discovered between factors such as age, disease duration, and treatment duration in these studies. For instance, elderly patients experience a progressive decline in memory, are plagued by comorbidities, require long-term treatment, and consume numerous medications. Additionally, they harbour concerns regarding adverse effects, which results in a diminished rate of adherence [(19)].

In the current study, patients with poor adherence to treatment had statistically higher BMI and higher frequency of DM compared to good adherent groups. While there was no statistical difference between patient good and bad adherent as regarding heart disease, asthma, chronic kidney disease, vascular disease, high blood lipid levels.

In the study by Pal et al., [(14)], Nonadherence was significantly influenced by a variety of factors, including the complexity of the medication regimen, uncontrolled blood pressure, comorbidities such as Diabetes Mellitus and Ischemic Heart Disease, low education levels, and high age.

However, in the study by Tilea et al., [(12)], However, the statistical probability of low, medium, or high adherence was not significantly influenced by concurrent DM ($p = 0.07$). Conversely, an elevated level of adherence to antihypertensive therapy was associated with the presence of established cardiovascular disease ($p = 0.03$). Antihypertensive therapy is administered to individuals with CKD who have an eGFR of 60 mL/min/1.73 m2 or less ($p = 0.03$) and exhibit an elevated level of adherence.

In the present study, there was no statistical difference between patient good and bad adherent as regards receiving treatment.

However in the study by Hassanein, [(9)], A high adherence rate was associated with the once-daily (99.2%) fixed-dose combination (FDC), as opposed to twice-daily (0.8%), $p = 0.03$. This discovery is comparable to those of Mallat et al. [(20)], who discovered that there is a correlation between poor adherence and the increased number of antihypertensive medications prescribed in the presence of comorbid factors. Nevertheless, the current body of evidence is insufficient to establish that there are distinctions between free combination therapy and an FDC in the treatment of hypertension [(21)].

Adherence to the treatment plan is significantly influenced by the following factors: the presence of sufficient knowledge, awareness of the disease and its potential complications, the capacity to afford the medication's cost, the ability to renew prescriptions, the significance of effective doctor-patient communication, and the use of specialized drug dispensing containers (blister packs, bottles, and timed dosing batches) [(22)].

In the current study, patients with poor adherence to treatment had statistically higher Mir-122 expression ($19.8\pm1.3$) compared to good adherent group ($1.1\pm0.06$), $p<0.001$.

As far as is known, no prior research has evaluated Mir-122 expression in hypertensive patients based on their adherence. As evidenced by prior research, miRNAs are significant regulatory molecules that regulate a wide range of physiological and pathological processes in cells, such as cell proliferation, differentiation, apoptosis, survival, activation, and morphogenesis. Numerous investigations have implicated miRNAs in the regulation of hypertension's pathogenesis and progression. Venous endothelial cells and smooth muscle function can also be influenced by miRNAs, which can also affect renin [(23)].

The occurrence and development of hypertension and HF have been linked to MiR-122 [(8)]. Zhang et al.,[(24)] Patients with essential hypertension, particularly those who were younger, exhibited elevated plasma miR-122 levels. The overexpression of miR-122, which suppressed the expression of cationic

amino acid transporter one, incited endothelial dysfunction. This degradation of the endothelial structure resulted in an increase in the risk factors for cardiovascular dysfunction during hypertension. Furthermore, the levels of miR-122 were significantly increased in hypertensive patients, indicating that miR-122 functions as a predictive hazard factor in cardiovascular homeostasis and disorder.

The inquiry is subject to numerous constraints. At the outset, the investigation was restricted to a specific region, which suggests that the overall level of adherence to generic drug use has not been assessed. This was the second occasion on which the patient's blood pressure index was excluded from the research sample during each successive visit. The assessment of drug adherence is made more objective by the incorporation of a blood pressure index value. The trial did not include interviews to monitor the patient's diet and activities.

## Conclusion:

Patients adhered to antihypertensive medications at a rate of 38.9%. Factors that significantly influence the adherence of hypertensive patients to their medication regimen include Age, educational level, Income, r duration of HTN, duration of HTN treatment, obesity, diabetes mellitus, chronic kidney disease, vascular disease, high blood lipid levels. Mir-122 expression was significantly higher in patients with poor adherence. Low educational level, longer duration of HTN treatment, obesity, diabetes mellitus, vascular disease, high blood lipid levels, and Mir-122 were significant predictors of poor adherence in the studied group.

**Acknowledgements**

We would want to express our gratitude to the patients and the healthy volunteer who participated by providing the necessary information & samples with such good humor and dedication.

**Funding**

no funding, no grants

## References

1. Wahyuni AS, Mukhtar Z, Pakpahan DJR, Guhtama MA, Diansyah R, Situmorang NZ, et al. Adherence to consuming medication for hypertension patients at primary health care in medan city. Open access Maced J Med Sci. 2019;7(20):3483.
2. Mills KT, Bundy JD, Kelly TN, Reed JE, Kearney PM, Reynolds K, et al. Global disparities of hypertension prevalence and control: a systematic analysis of population-based studies from 90 countries. Circulation. 2016;134(6):441–50.
3. Reda A, Ragy H, Saeed K, Alhussaini MA. A semi-systematic review on hypertension and dyslipidemia care in Egypt—highlighting evidence gaps and recommendations for better patient outcomes. J Egypt Public Health Assoc. 2021;96(1):1–14.
4. Mohammed ZO, Amein NM, Abou Zeid ON. Barriers facing medication adherence among patients with chronic hypertension at out patient medical clinics. Minia Sci Nurs J. 2022;12(1):134–41.
5. Hamrahian SM, Maarouf OH, Fülöp T. A critical review of medication adherence in hypertension: barriers and facilitators clinicians should consider. Patient Prefer Adherence. 2022;2749–57.
6. Parati G, Lombardi C, Pengo M, Bilo G, Ochoa JE. Current challenges for hypertension management: From better hypertension diagnosis to improved patients' adherence and blood pressure control. Int J Cardiol. 2021;331:262–9.
7. Liu Y, Song JW, Lin JY, Miao R, Zhong JC. Roles of microRNA-122 in cardiovascular fibrosis and related diseases. Cardiovasc Toxicol. 2020;20(5):463–73.
8. Song JJ, Yang M, Liu Y, Song JW, Wang J, Chi HJ, et al. MicroRNA-122 aggravates angiotensin II-mediated apoptosis and autophagy imbalance in rat aortic adventitial fibroblasts via the modulation of SIRT6-elabela-ACE2 signaling. Eur J Pharmacol. 2020;883:173374.
9. Hassanein M. Adherence to antihypertensive fixed-dose combination among Egyptian patients presenting with essential hypertension. Egypt Heart J. 2020;72:1–9. doi:10.1186/s43044-020-00044-6.
10. Laghousi D, Rezaie F, Alizadeh M, Jafarabadi MA. The eight-item Morisky Medication Adherence Scale: validation of its Persian version in diabetic adults. Casp J Intern Med. 2021;12(1):77.
11. Rizzacasa B, Morini E, Mango R, Vancheri C, Budassi S, Massaro G, et al. Comparative Ct method quantification (2-ΔCt method). 2019;
12. Tilea I, Petra D, Voidazan S, Ardeleanu E, Varga A. Treatment adherence among adult hypertensive patients: a cross-sectional

retrospective study in primary care in Romania. Patient Prefer Adherence. 2018;625–35.
13. Pham ST, Dang YTN, Vo T V, Tran HY, Nguyen T. Medication use and adherence in patients with hypertension: a prospective study in Vietnam. J Heal Sci Med Res. 2023;41(5):2023956.
14. Pal B, Dutta A, Chaudhary V, Kumari S, Meenakshi S, Murti K. Prevalence of antihypertensive medication adherence and associated factors in India: A systematic review and meta-analysis. Hipertens y Riesgo Vasc. 2024;
15. Daniel ACQG, Veiga EV. Factors that interfere the medication compliance in hypertensive patients. Einstein (Sao Paulo). 2013;11:331–7.
16. Bandi P, Goldmann E, Parikh NS, Farsi P, Boden-Albala B. Age-related differences in antihypertensive medication adherence in Hispanics: a cross-sectional community-based survey in New York City, 2011–2012. Prev Chronic Dis. 2017;14:E57.
17. Ambaw AD, Alemie GA, W/Yohannes SM, Mengesha ZB. Adherence to antihypertensive treatment and associated factors among patients on follow up at University of Gondar Hospital, Northwest Ethiopia. BMC Public Health. 2012;12:1–6.
18. Nguyen TH, Truong H Van, Vi MT, Taxis K, Nguyen T, Nguyen KT. Vietnamese version of the general medication adherence scale (GMAS): Translation, adaptation, and validation. In: Healthcare. MDPI; 2021. p. 1471.
19. Jin H, Kim Y, Rhie SJ. Factors affecting medication adherence in elderly people. Patient Prefer Adherence. 2016;2117–25.
20. Mallat SG, Tanios BY, Itani HS, Lotfi T, Akl EA. Free versus fixed combination antihypertensive therapy for essential arterial hypertension: a systematic review and meta-analysis. PLoS One. 2016;11(8):e0161285.
21. Lee HJ, Jang SI, Park EC. Effect of adherence to antihypertensive medication on stroke incidence in patients with hypertension: a population-based retrospective cohort study. BMJ Open. 2017;7(6):e014486.
22. Abbas H, Kurdi M, Watfa M, Karam R. Adherence to treatment and evaluation of disease and therapy knowledge in Lebanese hypertensive patients. Patient Prefer Adherence. 2017;1949–56.
23. Wang L, Chen H. Correlation between serum miR-122 and myocardial damage and ventricular function in patients with essential hypertension. J Thorac Dis. 2021;13(8):4999.
24. Zhang HG, Zhang QJ, Li BW, Li LH, Song XH, Xiong CM, et al. The circulating level of miR-122 is a potential risk factor for endothelial dysfunction in young patients with essential hypertension. Hypertens Res. 2020;43(6):511–7.

**To cite this article:** Ahmed E. Mansour, Mohammed A. Ibrahim, Abeer E. Abd Elsamiee, Eman A. Ahmed, Heba A. Mokhtar. Adherence in Egyptian Hypertensive Patients to Medication Beliefs and Assessment of MicroRNAs as a Novel Biomarker of Hypertension in Qaliubeya Governorate, Egypt. BMFJ 2025;42(11):154-165.