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Duration-to-Attain Target Blood Pressure Level and Its Predictors among Newly Diagnosed Hypertensive Adults Treated in a Comprehensive Hospital in Central Ethiopia

Habtemariam Tedla[1], Awraris Hailu[2], Zenebe Abebe[2], Zenawi Hagos[3,4], Kumlachew Mergiaw[2*]

[1] Emory University Ethiopia Country Office, Addis Ababa, Ethiopia, [2] College of Health Sciences, Debre Berhan University, Ethiopia, [3] College of Medicine and Health Sciences, Adigrat University, Ethiopia, [4] Arnold School of Public Health, University of South Carolina, USA.

***Correspondence:** Kumlachew Mergiaw, kumlachew23@gmail.com / kumlachew23@dbu.edu.et

ABSTRACT

Background: Timely blood pressure (BP) control is essential for preventing hypertension-related complications. However, longitudinal evidence on the time required to achieve target BP and its predictors among newly diagnosed hypertensive patients remains limited in Ethiopia. This study assessed the time to BP control and their predictors among newly diagnosed hypertensive adults receiving care at a comprehensive hospital in Central Ethiopia.

Methods: A five-year retrospective cohort study was conducted among 522 newly diagnosed hypertensive adults enrolled between 2021 and 2025. The primary outcome was time to BP control, defined as achieving a BP of <140/90 mmHg at two consecutive follow-up visits. Participants were selected using systematic random sampling, and data were extracted from the medical records by trained personnel. Missing data were handled using hot-deck imputation. Kaplan–Meier survival analysis and the log-rank test were used to compare time to BP control across groups. Variables meeting the proportional hazards assumption and a bivariate screening criterion of $P < 0.25$ were included in a multivariable Cox proportional hazards model to identify the independent predictors. Statistical significance was declared at $P < 0.05$.

Results: Of the 522 patients included, 377 (72.2%) achieved BP control during 191,056 person-days of follow-up, corresponding to an incidence rate of 1.97 BP control events per 1,000 person-days (72 events per 100 person-years). The overall median time to BP control was 375 days (12.5 months; 95% CI: 338–410 days). Males required a longer median time than females (400 vs. 352 days, respectively). Urban residence (adjusted hazard ratio [AHR] = 1.36; 95% CI: 1.05–1.74), initiation with dual antihypertensive therapy (AHR = 1.52; 95% CI: 1.12–2.06), and normal total cholesterol levels (AHR = 2.09; 95% CI: 1.48–2.96) were independently associated with a shorter time to BP control. In contrast, the presence of comorbidities (AHR = 0.23; 95% CI: 0.16–0.33) and advanced baseline BP severity independently prolonged the time required to achieve the target levels. Compared to those with baseline SBP of 140-159 mmHg, patients with SBP of 160-179 mmHg and ≥180 mmHg showed significantly reduced rates of achieving timely BP control (AHR = 0.61; 95% CI: 0.47–0.80 and AHR = 0.36; 95% CI: 0.24–0.54, respectively). Similarly, patients with DBP of 99-109 mmHg and ≥110 mmHg had strongly delayed treatment success (AHR = 0.53; 95% CI: 0.41–0.71 and AHR = 0.36; 95% CI: 0.23–0.56, respectively) compared with patients with DBP of 90-99 mmHg.

Conclusion: Newly diagnosed hypertensive patients experienced substantial delays in achieving target BP, with a median time to control exceeding one year. Early initiation of dual antihypertensive therapy and urban residence were associated with faster BP control, whereas higher baseline systolic and/or diastolic BP levels and comorbidities significantly prolonged the time to achieve target BP. Targeted management strategies for high-risk patients may accelerate BP control and improve the clinical outcomes.

Keywords: Blood pressure control, hypertension, predictors, time to control, Ethiopia.

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INTRODUCTION

Globally, hypertension affects more than 1.3 billion adults, with an estimated prevalence of 31–33%, and the burden falls disproportionately on low- and middle-income countries (1–3). In sub-Saharan Africa, the prevalence exceeds 35% and reaches nearly 46% among adults aged ≥25 years (4-6). Despite this high burden, the hypertension care cascade remains inadequate, with fewer than 12% of diagnosed patients achieving blood pressure (BP) control across the region (4). Data from the Ethiopian National NCDs STEPS Survey underscore that rapid urbanization and an ongoing epidemiological transition have caused the pooled adult hypertension prevalence to climb significantly, cutting across all age cohorts from young adults over 18 to older populations over 50 (7–9).

Uncontrolled hypertension is a major cause of cardiovascular, renal, and cerebrovascular disease and is responsible for approximately 10 million deaths annually worldwide (8,10,11). In Ethiopia, cardiovascular diseases account for about 16% of premature deaths, and hypertension-related complications contribute to more than 62% of these deaths (6,12). To reduce mortality and morbidity, international guidelines recommend early BP control and timely medication adjustments (13). The World Health Organization HEARTS cardiovascular technical package recommends achieving a target BP of <140/90 mmHg within six months of diagnosis (11,14) and advocates protocol-driven treatment adjustment, particularly during the first month after diagnosis (11,15). However, achieving timely BP control in routine clinical practice remains challenging. In Ethiopia, approximately 56.6% of hypertensive patients have uncontrolled BP (8), increasing the risk of progressive target-organ damage (16). Evidence suggests that delays in treatment intensification and follow-up substantially reduce the likelihood of achieving BP control (17). Furthermore, more than one-third of Ethiopian adults are diagnosed only after developing hypertension-mediated organ damage (8).

Although strategies such as decentralized screening and the implementation of standardized treatment guidelines have been introduced, their effectiveness is constrained by unhealthy lifestyle practices, long travel distances to health facilities, and frequent medication shortages, particularly in rural areas (4,18). In Ethiopia, primary healthcare institutions provide basic hypertension diagnosis, treatment, and follow-up services, whereas referral hospitals deliver advanced diagnostic services with better clinical care by medical specialists (internists). Although this study was conducted at a referral hospital in central Ethiopia, many participants had been referred from primary healthcare facilities from districts, where limited diagnostic capacity, medication shortages, and delays in referral may have contributed to suboptimal blood pressure control before referral. Most Ethiopian studies on hypertension control have been cross-sectional and provide only a snapshot of BP status (19). Consequently, there is limited evidence on how long newly diagnosed patients take to achieve BP control and which factors influence this process. Therefore, this study aimed to determine the time to blood pressure control and its predictors among newly diagnosed hypertensive adults receiving care at a comprehensive hospital in Central Ethiopia.

METHODS

Study setting

This study was conducted at Debre Berhan Comprehensive Specialized Hospital, located approximately 130 km northeast of Addis Ababa, Ethiopia. The hospital serves a catchment population of more than four million people and provides outpatient and inpatient services, including dedicated chronic disease clinics for hypertension, diabetes mellitus, and epilepsy. Hypertension care is delivered using standardized follow-up protocols, including the WHO HEARTS technical package. This retrospective cohort study reviewed patient records from January 1, 2021, to December 31, 2025.

Eligibility criteria

Inclusion criteria: Adults (≥18 years) newly diagnosed with primary hypertension between January 2021 and December 2025 who initiated antihypertensive treatment at the study hospital were eligible. Hypertension was defined as systolic BP ≥140 mmHg and/or diastolic BP ≥90 mmHg documented on at least two separate clinical visits.

Exclusion criteria: Patients with secondary hypertension, gestational hypertension, those referred after initiating antihypertensive treatment elsewhere, patients already receiving antihypertensive medication before enrollment, and records with incomplete follow-up information were excluded.

Sample size and sampling procedure

The sample size was calculated using STATA version 16.1 for survival analysis based on the Cox proportional hazards mod-

el. The calculation assumed a two-sided α of 0.05, 80% power, and an expected event probability of 42% obtained from a previous Ethiopian study(20). After adding 10% for incomplete records, the final sample size was 522.

A sampling frame of 1,485 eligible patients was obtained from the hypertension follow-up registry. Systematic random sampling (every 3rd chronological record) was employed to select study participants using a sampling interval of three after randomly selecting the first chart. Charts with incomplete baseline information or missing follow-up dates were excluded.

Data collection tool and procedure

Data were extracted using a structured checklist implemented in KoboToolbox (21) by three trained professionals nurses. Senior public health professionals strictly monitored data collection, using a checklist adapted from the Ethiopian Federal Ministry of Health's National Guidelines (22,23), the International Society of Hypertension (ISH) Guidelines (24), and a relevant East African study (25) to capture comprehensive data.

Data quality management

Data collectors received one-day training before data collection. The checklist was pretested on 5% of records in another hospital. Supervisors reviewed completed forms daily. Inter-rater agreement was high (Cohen's κ = 0.85). Variables with >10% missing values were excluded, whereas remaining missing data were handled using hot-deck imputation. A sensitivity analysis comparing the primary imputation model against complete cases demonstrated stable hazard ratios, confirming that the missing data handling strategy did not bias survival outcomes.

Operational definitions

The classifications of hypertension for the adult population were adopted from the European Society of Hypertension, Comprehensive Severity Guideline, 2023, as follows (26). Grade 1 Hypertension: 140–159 mm Hg systolic and/or 90–99 mm Hg diastolic, Grade 2 Hypertension: 160–179 mm Hg systolic and/or 100–109 mm Hg diastolic, and Grade 3 Hypertension: ≥ 180 mm Hg systolic and/or ≥ 110 mm Hg diastolic.

Blood pressure control: systolic BP <140 mmHg and diastolic BP <90 mmHg documented at two consecutive follow-up visits (24).

Time to blood pressure control: Time from initiation of antihypertensive treatment to the date of the second consecutive visit at which BP was controlled (BP<140/90 mmHg in two consecutive follow-up visits) (24).

The Event: The first documented achievement of target blood pressure during a scheduled outpatient visit.

Censoring: Applied to patients without blood pressure control from treatment initiation to their last recorded visit.

Comorbidity: The presence of one or more chronic diseases, such as diabetes mellitus, heart failure, renal failure, stroke, or other chronic conditions, occurring concurrently in an individual diagnosed with hypertension during the follow-up period.

Data processing and analysis

Data were exported from KoboToolbox and analyzed using STATA version 16.1. Time-to-event was calculated from treatment initiation until BP control or censoring. Kaplan–Meier survival curves and the log-rank test compared survival experiences between groups. Variables with $P < 0.25$ in bivariable Cox regression were entered into a multivariable Cox proportional hazards model. The presence of collinearity was also checked by the variance inflation factor (VIF). The proportional hazards assumption was assessed using Schoenfeld residuals and log-minus-log plots. Model fit was evaluated using Cox–Snell residuals. Results are presented as adjusted hazard ratios (AHRs) with 95% confidence intervals, and statistical significance was declared at $P < 0.05$.

Ethical considerations

Ethical approval was obtained from the Institutional Review Board of Asrat Woldeyes Health Sciences Campus, Debre Berhan University (IRB No. IRB-19423). Because this was a retrospective review of medical records, the requirement for informed consent was waived by the IRB. Patient confidentiality was maintained through anonymization of data and secure storage of study records.

RESULTS

Socio-demographic and baseline characteristics

Among the total 522 eligible hypertensive patient charts, 288 (55.17%) were those of males. The study population was a median age of 58.5 years (IQR: 47-70). A total of 227 individuals (43.49%) fell within 46-to-65 years of age, and 123

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(23.5%) participants were under 46 years. Grade-I hypertension was present in 213 (40.8%) systolic and 308 (59.0%) diastolic measurements, while Grade-III hypertension was identified in 105 (20.1%) systolic and 85 (16.3%) diastolic readings. Random blood sugar data were available for the entire cohort (100%). Serum creatinine and total cholesterol tied as the next most frequently captured metrics, each available for 517 individuals (99.04%), while blood urea nitrogen represented the lowest coverage at 515 entries (98.66%). Hypertensive patients who died and those who were censored had comparable baseline sex distribution, blood urea nitrogen, and serum creatinine levels ($p > 0.05$). However, the two groups differed significantly with respect to age, place of residence, random blood glucose level, total cholesterol level, presence of comorbidities, and number of comorbid conditions ($p < 0.05$) (Table 1).

Table 1: Baseline characteristics of newly diagnosed hypertensive patients having follow-up at Debre Berhan Comprehensive Hospital, central Ethiopia, 2025 (n = 522).

Variables		Event status		P-value [a]
		Controlled (n = 377)	Censored (n = 145)	
		Frequency (%)	Frequency (%)	
Age group (years)	< 46	97 (25.73)	26 (17.93)	0.02*
	46-65	169 (44.83)	58 (40.00)	
	> 65	111 (29.44)	61(42.07)	
Sex	Male	203 (53.85)	85 (58.62)	0.33
	Female	174 (46.15)	60 (41.38)	
Residence	Urban	289 (76.66)	96 (66.21)	0.02*
	Rural	88 (23.34)	49 (33.79)	
Baseline systolic BP (mmHg)	140-159	176 (46.68)	37(25.52)	
	160-179	148 (39.26)	56 (38.62)	< 0.0001*
	≥ 180	53 (14.06)	52 (35.86)	
Baseline diastolic BP (mmHg)	90-99	239 (63.40)	69 (47.59)	
	100-109	96 (25.46)	33 (22.76)	< 0.0001*
	≥ 110	42 (11.14)	43 (29.66)	
Random blood sugar (mg/dL)	< 200	329 (87.27)	107 (73.79)	0.0003*
	≥ 200	48 (12.73)	38 (26.21)	
Blood urea nitrogen (mg/dL)	< 49	332 (85.41)	123 (84.83)	0.322
	≥ 49	45 (11.94)	22 (15.17)	
Serum creatinine (mg/dL)	< 1.2	298 (79.05)	110 (75.86)	0.4
	≥ 1.2	79 (20.95)	35 (24.14)	
Total cholesterol (mg/dL)	< 200	332 (88.06)	105 (72.41)	<0.0001*
	≥ 200	45 (11.94)	40 (27.59)	
Combination therapy	Mono	296 (78.51)	105 (72.41)	
	Dual	75 (19.89)	33 (22.76)	0.07
	Triple	6 (1.59)	7 (4.83)	
Comorbidity	Yes	61 (16.18)	64 (44.14)	<0.0001*
	No	316 (83.82)	81 (55.86)	
Number of comorbid conditions (diabetes mellitus, heart failure, renal failure, and/or stroke)	None	316 (83.82)	81 (55.86)	<0.0001*
	One	54 (14.32)	58 (40.0)	
	≥ 2	7 (1.86)	6 (4.14)	

*= P-value < 0.05, **= P-value < 0.001; DBP: diastolic blood pressure, mg/dL: milligram per deciliter, mmHg: millimeter of mercury, SBP: systolic blood pressure.

Survival analysis: Time to blood pressure control

Among the 522 newly diagnosed hypertensive patients, 377 (72.2%) achieved blood pressure control during 191,056 person-days of follow-up, corresponding to an incidence rate of 1.97 BP control events per 1,000 person-days (72 events per 100 person-years). The overall median time to blood pressure control was 375 days (12.5 months; 95% CI: 338–410). Males required a longer median time to achieve BP control than females (400 vs. 352 days).

During the follow-up period, the proportion of patients who had not yet achieved BP control decreased progressively from 97.6% at 3 months to 86.5% at 6 months, 51.2% at 12 months, 18.0% at 24 months, and 3.2% at 36 months. Correspondingly, the cumulative probability of achieving BP control increased from 2.4% at 3 months to 13.5%, 48.8%, 82.0%, and 96.8% at 6, 12, 24, and 36 months, respectively (Figure 1).

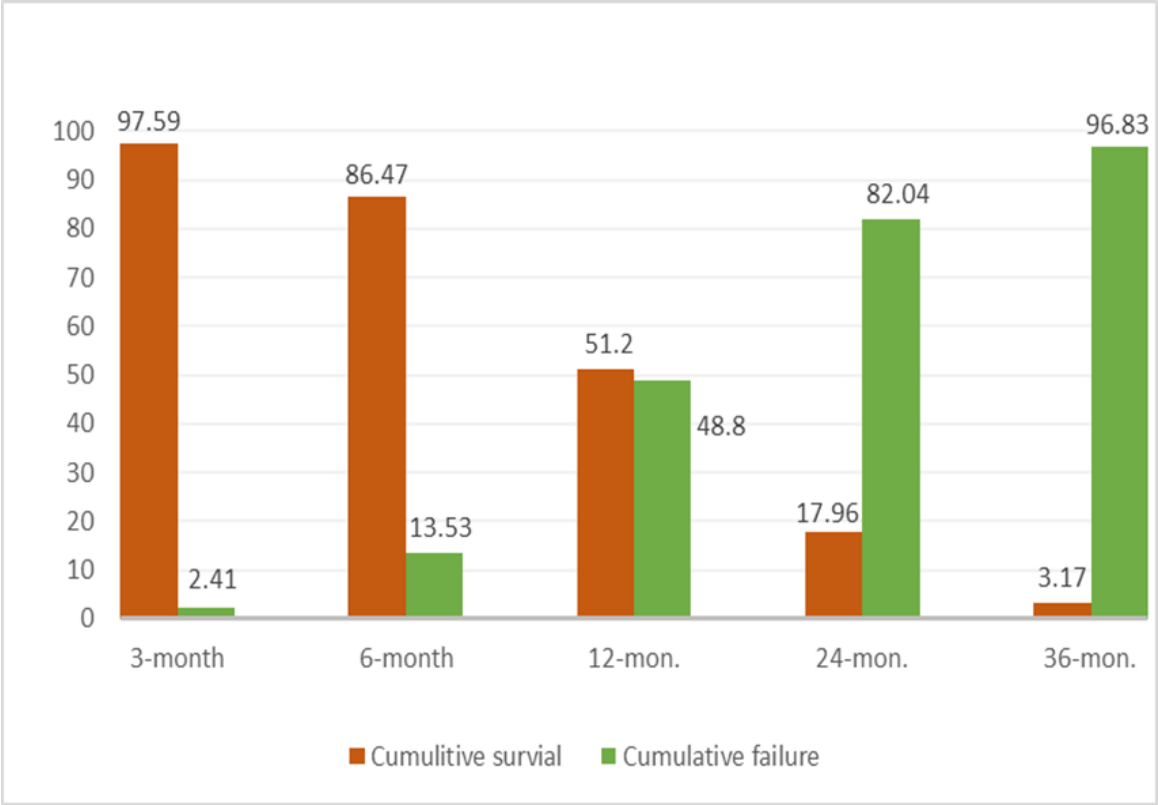

***Figure 1**: Cumulative survival and failure probabilities among hypertensive patients at Debre Berhan Comprehensive Hospital, central Ethiopia, at various follow-up intervals, 2025.*

Kaplan–Meier survival analysis demonstrated significant differences in time to BP control across age groups. Patients under 46 years achieved BP control more rapidly than older age groups, whereas those aged 65 and older years experienced the longest time to BP control. These differences were statistically significant according to the log-rank test (Log-rank = 105.39, df = 2, $P < 0.0001$) (Figure 2).

Similarly, time to BP control differed significantly according to baseline systolic BP levels. Patients with systolic BP ≥ 180mmHg had the longest time to achieve BP control, whereas those with systolic BP 140-159 mmHg reached target BP more rapidly (Log-rank = 105.39, df = 2, $P < 0.001$) (Figure 3).

Patients with baseline serum creatinine levels <1.2 mg/dL tended to achieve BP control sooner than those with higher serum creatinine levels; however, this difference was not statistically significant (log-rank test: $P = 0.07$) (Figure 4).

Log-rank tests further demonstrated significant differences in time to BP control according to place of residence (urban vs. rural), baseline BP levels, antihypertensive treatment regimen, presence of comorbidities, random blood sugar level, blood urea nitrogen, and total cholesterol level (all $P < 0.05$) (Table 2).

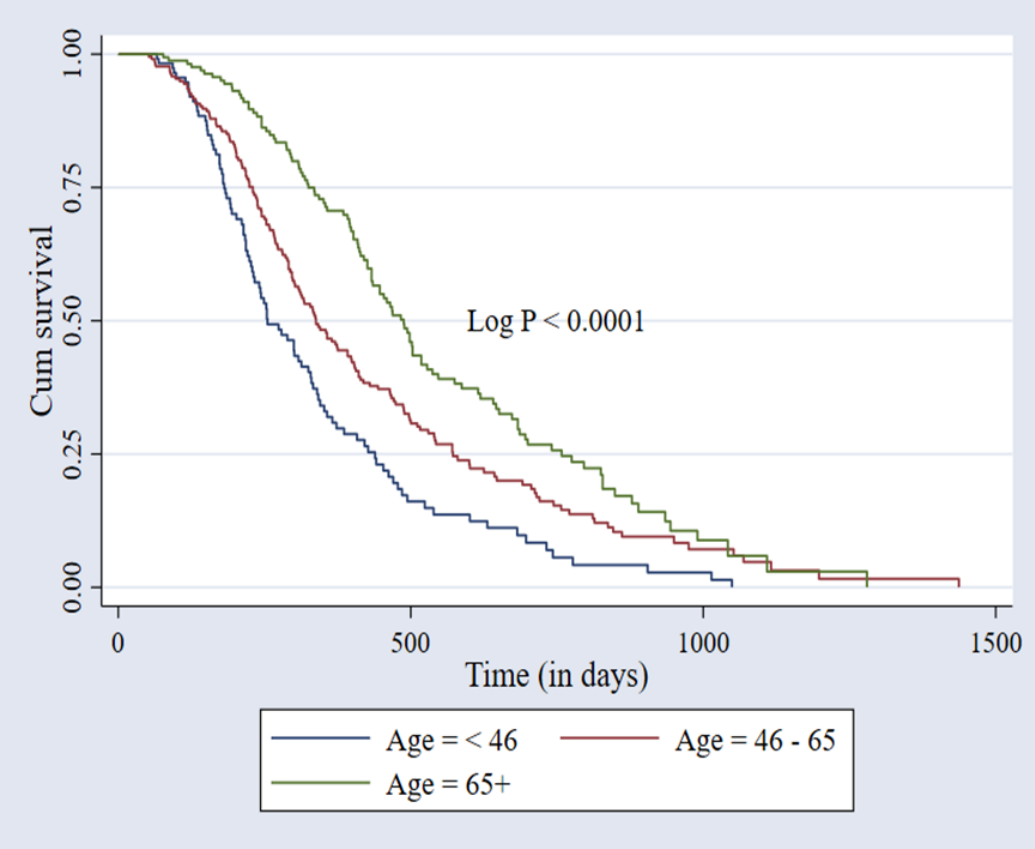

Figure 2: *Kaplan-Meier survival curves by age category for newly diagnosed hypertensive patients at Debre Berhan Comprehensive Hospital, in central Ethiopia, 2025*

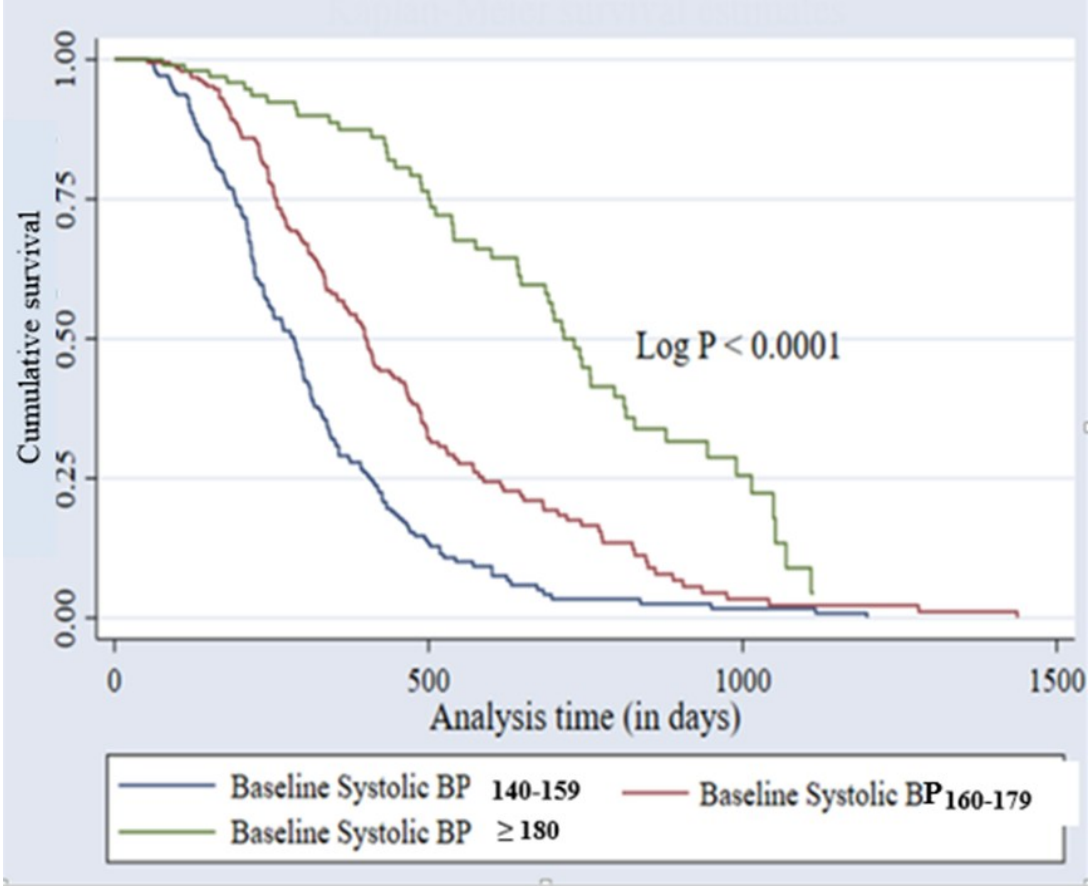

Figure 3*: Kaplan-Meier survival curves illustrating baseline systolic blood pressure outcomes for newly diagnosed hypertensive patients at Debre Berhan Comprehensive Hospital, Central Ethiopia, 2025*

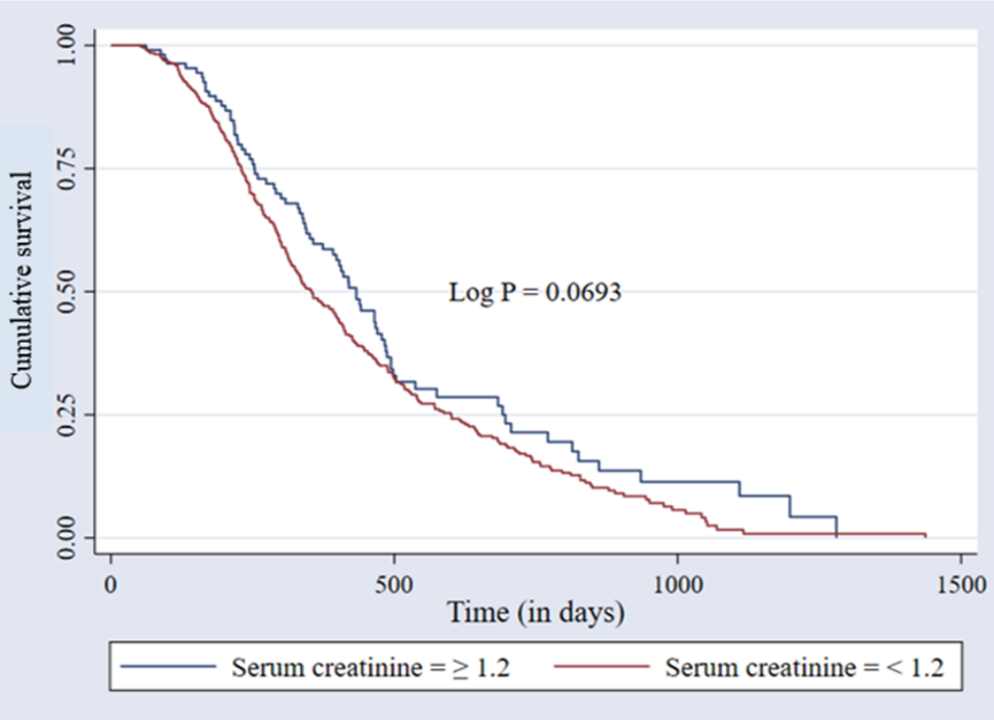

Figure 4: *Kaplan-Meier curve illustrates survival estimates categorized by serum creatinine levels for newly diagnosed hypertensive patients at Debre Berhan Comprehensive Hospital, central Ethiopia.*

Table 2: Log-rank test for equality of survivor function among newly diagnosed hypertensive patients who have follow-up at Debre Berhan Comprehensive Hospital, Central Ethiopia, 2025 (n = 522).

Covariates	Category	Observed event	Expected event	x^2 (df)	P-value
Age group	< 46	97	59.38	38.19(2)	<0.001**
	46-65	169	161.05		
	> 65	111	156.57		
Sex	Female	174	155.25	3.88(1)	0.0489*
	Male	203	221.75		
Residence	Rural	88	119.92	12.81(1)	0.003*
	Urban	289	257.08		
Baseline Systolic BP (mmHg)	140–159	176	100.59	105.39(2)	<0.001**
	160–179	148	153.03		
	≥180	53	123.38		
Baseline Diastolic BP (mmHg)	90–99	239	160.67	81.03(2)	<0.001**
	100–109	96	117.15		
	≥110	42	99.17		
Combination Therapy	Mono	296	247.15	34.32(2)	<0.001**
	Dual	75	104.89		
	Triple	6	24.95		
Comorbidity	No	316	219.36	116.05(1)	<0.001**
	Yes	61	157.64		
Random blood sugar (mg/dL)	< 200	329	295.84	17.82(1)	<0.001**
	≥ 200	48	81.16		
Blood urea nitrogen (mg/dL)	< 49	332	308.72	10.08(1)	0.002 *
	≥ 49	45	68.28		
Serum creatinine (mg/dL)	< 1.2	298	282.86	3.30(1)	0.0693
	≥ 1.2	79	94.14		
Total cholesterol (mg/dL)	< 200	332	286.34	32.07(1)	<0.001**
	≥ 200	45	90.66		

** = P < 0.05, ** = P<0.001. DBP: diastolic blood pressure, mg/dL: milligram per deciliter, mmHg: millimeter of mercury, SBP: systolic blood pressure.*

Predictors of time to blood pressure control

Variables associated with time to BP control in the bivariable analysis ($P < 0.25$) were entered into the multivariable Cox proportional hazards regression model. After adjustment for potential confounders, place of residence, antihypertensive treatment regimen, total cholesterol level, presence of comorbidities, and higher values of baseline systolic and/or diastolic blood pressure levels, independent predictors of time to BP control remained (Table 3).

Patients residing in urban areas achieved BP control more rapidly than rural residents (AHR = 1.36; 95% CI: 1.05–1.74). Similarly, patients initiated on dual antihypertensive therapy had a 52% higher rate of achieving BP control than those receiving monotherapy (AHR = 1.52; 95% CI: 1.12–2.06). Participants with normal total cholesterol levels also achieved BP control more rapidly than those with elevated cholesterol (AHR = 2.09; 95% CI: 1.48–2.96).

In contrast, the presence of comorbidities was associated with a substantially lower rate of BP control (AHR = 0.23; 95% CI: 0.16–0.33). Baseline BP levels also significantly influenced the time to BP control. Compared with patients with SBP ranging 140-159 mmHg, those having SBP of 160-179 mmHg and ≥180 mmHg had 39% (AHR = 0.61; 95% CI: 0.47–0.80) and 64% (AHR = 0.36; 95% CI: 0.24–0.54) lower rates of achieving BP control, respectively. Baseline diastolic BP of 100-109 and ≥110 mmHg were also associated with a lower rate of BP control compared with those having diastolic BP of 90-99mmHg (AHR = 0.36; 95% CI: 0.23–0.56 and AHR=0.53; 95% CI: 0.41–0.71 respectively) (Table 3).

The Cox proportional hazards model adequately fitted the data, as demonstrated by the Cox–Snell residual plot (Figure 5).

Table 3: Multivariable Cox proportional hazards regression analysis of predictors of time to blood pressure control among newly diagnosed hypertensive adults attending Debre Berhan Comprehensive Hospital, Central Ethiopia, 2021–2025 (n = 522).

Covariates		Event status		AHR [95% CI]	P-value
		Controlled n (%)	Censored n (%)		
Gender	Female	174 (33.33)	60 (11.49)	1.00	—
	Male	203 (38.89)	85 (16.28)	0.82 [0.67, 1.01]	0.068
Residence	Rural	88 (16.86)	49 (9.39)	1.00	
	Urban	289 (55.36)	96 (18.39)	1.35 [1.05, 1.74]	0.018*
Baseline Systolic BP (mmHg)	140–159	176 (33.72)	37(7.09)	1.00	—
	160–179	14 8 (28.35)	56 (10.73)	0.61 [0.47, 0.80]	<0.001**
	≥180	53 (10.15)	52 (9.96)	0.36 [0.24, 0.54]	<0.001**
Baseline Diastolic BP (mmHg)	90–99	239 (45.79)	69 (13.22)	1.00	—
	100–109	96 (18.39)	33 (6.32)	0.53 [0.41, 0.71]	<0.001**
	≥110	42 (8.05)	43 (8.24)	0.36 [0.23, 0.56]	<0.001**
Random blood sugar (mg/dL)	≥ 200	48 (9.20)	38 (7.28)	1.00	—
	<200	329 (63.03)	107 (20.50)	1.07 [0.77, 1.50]	0.685
Blood urea Nitrogen (mg/dL)	≥ 49	45 (8.62)	22 (4.21)	1.00	—
	<49	332 (63.60)	123 (23.56)	1.16 [0.83, 1.63]	0.388
Serum Creatinine (mg/dL)	≥ 1.2	79 (15.13)	35 (6.70)	1.00	—
	< 1.2	298(57.09)	110 (21.07)	0.90 [0.70, 1.19]	0.481
Total Cholesterol (mg/dL)	≥ 200	45 (8.62)	40 (7.66)	1.00	—
	< 200	332 (63.60)	105 (20.11)	2.09 [1.48, 2.96]	<0.001**
Combination therapy	Mono	296 (56.70)	105 (20.11)	1.00	—
	Dual	75 (14.37)	33 (6.32)	1.51 [1.12, 2.06]	0.007**
	Triple	6 (1.15)	7 (1.34)	0.97 [0.39, 2.42]	0.950
Co-morbidity	No	316 (60.54)	81 (15.52)	1.00	—
	Yes	61 (11.69)	64 (12.26)	0.23 [0.16, 0.33]	<0.001**

** = P-value < 0.05 **= P-value < 0.001;* ***Abbreviations:*** *AHR, adjusted hazard ratio; CI, confidence interval; Ref., reference category.*

Note: *Hazard ratios greater than 1 indicate a higher rate (shorter time) of achieving blood pressure control, whereas hazard ratios less than 1 indicate a lower rate (longer time) to blood pressure control. Percentages are based on the total study population.*

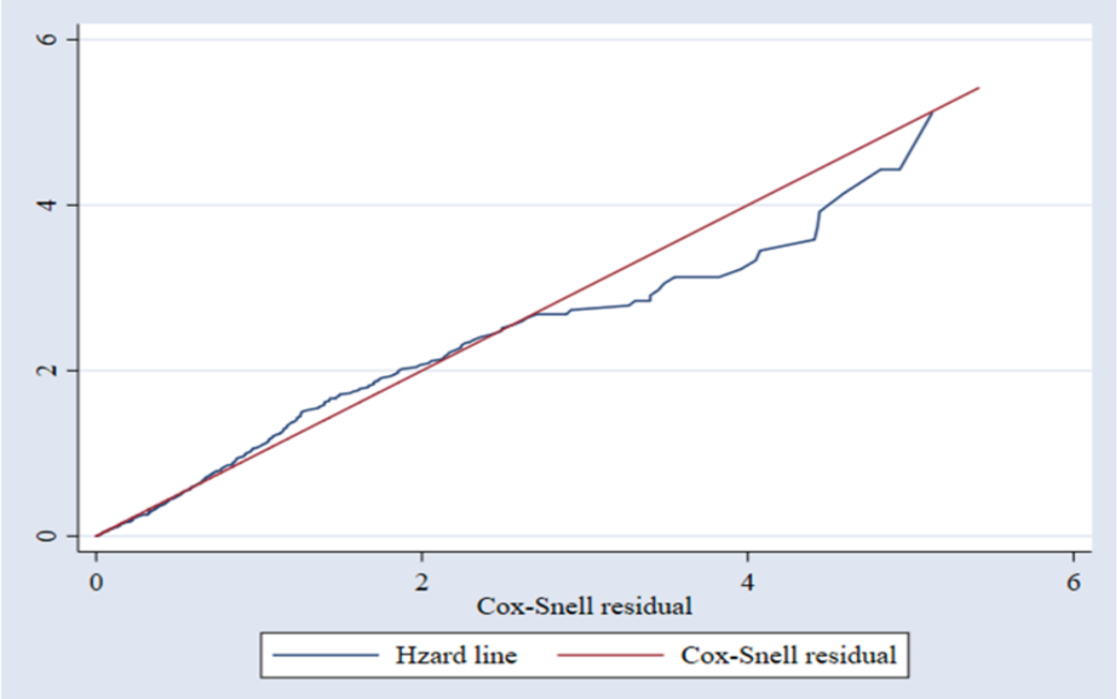

Figure 5: Goodness of fit test by Cox-Snell residual plot for newly diagnosed hypertensive patients at Debre Berhan Comprehensive Hospital, Central Ethiopia, 2025.

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DISCUSSION

This retrospective cohort study evaluated the time to BP control and its predictors among newly diagnosed hypertensive adults receiving follow-up care at a comprehensive hospital in Central Ethiopia. The median time to BP control was 375 days (12.5 months), substantially exceeding the six-month target recommended by the WHO HEARTS technical package. Urban residence, initiation of dual antihypertensive therapy, and normal total cholesterol levels were associated with faster BP control. In contrast, higher baseline systolic and/or diastolic blood pressure levels and the presence of comorbidities such as diabetes mellitus, renal failure, heart failure or stroke significantly delayed BP control.

The overall median duration to achieve target blood pressure, observed in this cohort (12.5 months) is longer than timelines reported in Malaysia (7.2 months) and Uganda (1 month) (28,29). Differences may reflect variations in patient characteristics, treatment protocols, healthcare accessibility, follow-up schedules, definitions of BP control, health system capacity across settings, and study designs used. For example, the Ugandan study used a prospective cohort that could control several factors (29). On the other hand, our recorded timeline is shorter than those reported by retrospective cohorts from Northwest Ethiopia (48 months) and Nigeria (33.6 months) (20,30), These regional differences indicate the variations in study settings and local prescribing patterns. These differences may also reflect variations in healthcare facility capacity, as many participants were referred to the study hospital from primary healthcare facilities where limited diagnostic resources, medication shortages, and referral delays may have contributed to inadequate or delayed blood pressure control. The clinical setting directly affects facility accessibility and diagnostic tool availability. Patient socioeconomic or dietary profiles also influence treatment compliance. Our results align with a recent report from Northeastern Ethiopia, which documented a comparable median time-to-control of 13 months (31). This study, however, revealed a significant delay in blood pressure stabilization among rural inhabitants compared to urban residents, which is in agreement with studies from Nigeria (30) and the broader sub-Saharan African nations (32). This disparity between rural and urban settings is likely due to changes in healthcare accessibility and follow-up frequency patterns. Although both groups utilized the same hospital (study area) in this study, urban dwellers benefit from nearby clinics, pharmacies, and diagnostic centers. In contrast, rural residents depend on distant, under-resourced local health facilities and face lower awareness about healthy living practices.

Male participants showed a longer median time to BP control than females (400 vs, 352 days); however, sex was not an independent predictor after multivariable adjustment. This sex-based inconsistency is in line with previous literature that reported unique pathophysiological pathways, estrogen-mediated vascular mechanisms in premenopausal women, and variation in adherence patterns in cardiovascular healthcare utilization contribute a lot (3,27).

Baseline blood pressure severity predicted the duration to control hypertension: patients who had systolic BP ranging 160-179 mmHg showed a 39% lower hazard (or rate) of achieving BP control compared to those having systolic BP of 140-159 mmHg (AHR = 0.61). In comparison, those with systolic BP ≥180 mmHg faced a 64% reduction in the probability of timely control (AHR = 0.36). This agrees with a study from Northwest Ethiopia (20). This similarity confirms the clinical realities that patients presenting with Grade II or III hypertension are usually older and have advanced vascular remodeling or target organ injury. Consequently, they need multiple treatment adjustments with drug combinations for a relatively extended follow-up window to attain the target blood pressure (1,3). Patients with a baseline diastolic blood pressure (DBP) of 100–109 mmHg and those with a DBP ≥110 mmHg demonstrated a 47% and 64% reduction in the likelihood of achieving timely control, respectively. Notably, these findings contrast with a previous report from Uganda (29). This might be due to differences in study design, patient characteristics, and severity of baseline hypertension, treatment protocols, healthcare delivery system capacity, follow-up practices, and definitions of blood pressure control. Moreover, studies from Malaysia (28) and Nigeria (30) revealed no significant differences regarding the baseline levels of BP and time to achieve target blood pressure. This discrepancy might be attributed to variation in patient selection criteria (exclusion or lower prevalence of metabolic comorbidities in the study populations).

Metabolic and lipid profiles also had a central role in influencing therapeutic timelines. Patients with a normal total

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cholesterol level achieved target blood pressure values faster than those with hypercholesterolemia. A high serum cholesterol speeds-up arterial wall stiffness, compromises nitric oxide-dependent pathways, and limits endothelial responsiveness, which all directly reduce the clinical efficacy of antihypertensive drugs (3,33). However, a previous report from Malaysia indicated no significant relationship between lipid dynamics and time-to-control (28). The discrepancy might be due to distinct socioeconomic or dietary variations among study subjects.

Our study demonstrated that dual combination of antihypertensive therapy augmented the chance of timely blood pressure control by 50% compared to the use of monotherapy (AHR = 1.52). This matches with a report from Malaysia (28) and aligns with international consensus guidelines including the WHO HEARTS package, ESC/ESH and ISH), which confirm that simultaneous targeting of multiple vasoconstrictive pathways shortens the timeline to therapeutic stabilization (2).

Finally, the presence of one or more co-existing diseases among **diabetes mellitus, renal failure, heart failure, and stroke** along with hypertension reduced the likelihood of attaining timely optimal control of blood pressure by 77% (AHR = 0.23). This finding aligns with trends in Sub-Saharan Africa, showing that hypertensive patients with diabetes and kidney disease significantly had delayed blood pressure control. This occurs via two mechanisms: first, complex polypharmacy for multiple comorbidities decreases patient adherence; second, competing clinical priorities during brief visits often delay important medication adjustments (1,33).

Clinical implication

Clinically, these findings highlight the need for immediate treatment strengthening and closer monitoring for newly diagnosed patients presenting with high baseline systolic blood pressure values, comorbidities, or rural residency. To minimize delays in achieving blood pressure control, health systems should systematically adhere to the WHO HEARTS package, secure uninterrupted medication supplies, and expand hypertension care infrastructure within the rural settings.

Limitations of the study

This study has some limitations, such as the retrospective nature of the study, which depends on patient charts, missing unrecorded clinical or behavioral data; filling in the missing baseline values using hot-deck median imputation might cause an artificially tapered true biological variation. Lastly, because the patients were selected from one hospital, these findings may not apply to rural communities or primary care clinics causing less generalizability. Nevertheless, the study used a relatively large cohort and survival analysis methods that allowed estimation of the timing of BP control rather than simply its prevalence.

Conclusions and recommendation

Newly diagnosed hypertensive patients faced critical delays in achieving blood pressure control, with a median time to target exceeding one year, more than double the six-month threshold recommended by the WHO. While urban residency, dual antihypertensive therapy, and normal cholesterol levels significantly accelerated time to control, higher levels of baseline systolic and/or diastolic blood pressure values and comorbidities delayed therapeutic success. These data underscore an urgent need for proactive treatment intensification, structured follow-up protocols, and targeted management strategies for high-risk cohorts to expedite blood pressure stabilization and reduce the burden of cardiovascular complications.

Availability of data and materials: The dataset of this study is freely available from the principal investigator and can be accessed with a reasonable request.

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