Predictors of Undiagnosed and Uncontrolled Hypertension in the Local Community of Byblos, Lebanon

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ABSTRACT

OBJECTIVE: This study aimed to determine the prevalence and predictors of undiagnosed and uncontrolled hypertension (HTN) in a local community in Lebanon.

DESIGN AND METHODS: In this cross-sectional study, we interviewed 911 adults in the local community of Byblos, Lebanon, and 691 were enrolled in the study. Blood pressure (BP), height, and weight were measured. The diagnosis of HTN was based on the 2013 European Society of Hypertension (ESH)/ European Society of Cardiology (ESC) guidelines (systolic BP ⩾140 mm Hg and/or diastolic BP ⩾90 mm Hg). The data collected were analyzed using "Statistical Package for the Social Sciences" software (SPSS).

RESULTS: A total of 260 participants were found to be hypertensive, either previously diagnosed or undiagnosed, yielding an overall prevalence of HTN of 37.62%. Of these participants, 149 (57.31%) were previously diagnosed and had controlled BP, and 111 (42.69%) had undiagnosed or uncontrolled HTN. Of these 111 participants, 44 had undiagnosed HTN and 67 were previously documented as hypertensive but had uncontrolled BP. Younger age and the absence of associated cardiovascular comorbidities were found to be associated with undiagnosed HTN, whereas high body mass index, smoking, and nonadherence to therapy were found to be associated with uncontrolled HTN.

CONCLUSION AND IMPLICATIONS: This study revealed a relatively high prevalence of HTN in the studied population, along with a high prevalence of undiagnosed and uncontrolled HTN. These findings emphasize the need for wider and more efficient screening strategies to better diagnose and control HTN in the general population.

KEYWORDS: Hypertension, Lebanon, uncontrolled, undiagnosed

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Introduction

Hypertension (HTN) is a noncommunicable disease that is relatively prevalent and is often asymptomatic[1]; it is also a significant cause of morbidity and mortality worldwide.[2,3] Known as the "silent killer," HTN was responsible for approximately 9.4 million deaths worldwide in 2010.[4,5] Importantly, being asymptomatic may lead to long-term undiagnosed HTN, which results in increased morbidity and mortality.[6] The 2013 ESH/ESC guidelines for the management of arterial HTN were the latest available during the data collection phase in this study.[7] The new 2017 American college of Cardiology (ACC)/ American Heart Association (AHA) HTN guidelines are more aggressive in the diagnosis of HTN and have a lower target blood pressure (BP) for all categories, including the geriatric population and individuals with low cardiovascular risk.[8] The increasing worldwide prevalence of HTN and the associated morbidity and mortality represent a significant health burden that is still difficult to manage, despite all medical progress.[9,10]

To the best of our knowledge, there are little or no data available on this topic in the Middle East region, particularly regarding the predictors of undiagnosed HTN in Byblos district, Lebanon.[11–13] Accordingly, we sought to explore the prevalence of HTN in a local community in Lebanon and identify the predictors of undiagnosed and uncontrolled HTN. The identification of the predictors of HTN diagnosis helps public health workers tailor more efficient screening and awareness plans.

Methods

Data collection and sample size

Subjects were randomly selected during HTN awareness campaigns in local dispensaries and pharmacies in Byblos district, a tourist area located on the Eastern coast of the Mediterranean Sea. Data were collected during face-to-face interviews, along with physical examinations. Data entry was completed by volunteers (medical students, Red Cross workers, pharmacists assistants, and pharmacists). Automated machines (OMRON M3, Omron Healthcare, Kyoto, Japan) were used to measure BP and heart rate. The diagnosis of HTN was based on the 2013 ESH/ESC guidelines, and accordingly, BP was measured 3 times at rest, and the average was recorded. Waist circumference, height,

and weight were measured using standardized techniques, and body mass index was calculated.

In this cross-sectional study, participant enrollment occurred during spring 2017, and we interviewed 911 subjects from the local community of Byblos, Lebanon. The subjects were Lebanese citizens who provided oral consent to participate in the study. Pregnant and/or lactating women and subjects younger than 18 years old were excluded, in addition to those with incomplete data (primarily regarding HTN history and antihypertensive therapy). Eventually, 260 participants were found to be hypertensive among 691 subjects who fit the inclusion criteria.

Measurements

In this study, we analyzed only systemic arterial HTN, with no distinction between essential and secondary HTN, given that such analysis was beyond the study objectives. Hypertension was defined and graded using the 2013 ESH/ESC guidelines,[7] which were the latest available during the enrollment period. Grade 1 was defined as systolic BP ⩾140 and ⩽159 mm Hg and/or diastolic BP ⩾90 and ⩽99 mm Hg, Grade 2 was defined as systolic BP ⩾160 and ⩽179 mm Hg and/or diastolic BP ⩾100 and ⩽109 mm Hg, and Grade 3 was defined as systolic BP ⩾180 and/or diastolic BP ⩾110 mm Hg.

Hypertension was considered to have been diagnosed when the participants declared having HTN and/or taking antihypertensive medications. Individuals found to have elevated BP on examination, despite medical treatment, were classified as having uncontrolled HTN. Individuals found to have elevated BP at presentation and for whom HTN was not previously diagnosed were considered to have undiagnosed HTN. Adherence was considered to be present when the participants reported taking antihypertensive medications according to the physician's prescription. Only active smokers were considered to be smokers. Cardiovascular comorbidities included any cardiovascular conditions reported by the participant during the interview (eg, coronary artery disease, arrhythmias, cardiomyopathy).

Investigators made it clear that study participation was anonymous, confidential, voluntary, and not associated with any risks or benefits, other than the scientific outcome. Oral consent was obtained from every subject before the start of the interview. The Institutional Review Board (IRB) approval was not required because the sample was taken from an outpatient population. This article conforms to the Declaration of Helsinki.

Statistical analysis

Data were entered into Microsoft Excel and then managed and analyzed using the "Statistical Package for the Social Sciences" software (SPSS, version 24). The descriptive statistics were represented as frequencies and percentages for the categorical variables and as the mean and standard deviation (SD) for the continuous variables. Two separate analyses were conducted for the categorical variables. The first used data from all hypertensive individuals, comparing the diagnosed participants with the undiagnosed. The second used data collected from the diagnosed participants only, comparing controlled HTN with uncontrolled HTN. In each analysis, cross-tabulation, Pearson chi-square, and risk estimate were conducted. A *t*-test was used to analyze continuous variables. To find the adjusted odds ratio (OR) and the confidence interval (CI) of the predictors of HTN diagnosis and control, multivariate analyses were performed using logistic regression, with a bivariate significance level of $P < .05$.

Results

The study population consists of 260 hypertensive participants, taken out of 691 participants who were found to fit the inclusion criteria, yielding an HTN prevalence of 37.62%. The mean age of the population was 67.30 ± 11.50 years, with a range between 38 and 92 years; 149 (57.31%) were already diagnosed as hypertensive and had controlled BP at presentation, and among the remaining 111 (42.69%), 67 participants were known to have HTN but had uncontrolled HTN, and 44 participants were not aware of having HTN (undiagnosed) (Figure 1). The characteristics of the studied population are reported in Table 1, and the types of antihypertensive medications reported are shown in Figure 2.

Compared with the participants with diagnosed and uncontrolled HTN, the undiagnosed participants were found to have a higher prevalence of Grade 1 HTN (61% vs 43%) and a lower prevalence of Grade 3 HTN (9% vs 15%). However, the difference was not statistically significant ($P = .172$) (Table 2).

The prevalence of undiagnosed participants was found to be 16.92% (44 of 260). Compared with the participants who were already known to have HTN, the undiagnosed individuals had a statistically significant lower age (58.82 vs 69.03 years), with an adjusted OR of 0.923 (CI = 0.89-0.96; $P = .00$). Moreover, the participants with no cardiovascular comorbidities had a statistically significant higher rate of undiagnosed HTN compared with those with cardiovascular comorbidities (27.2% vs 5.6%), with an adjusted OR of 0.185 (CI = 0.07-0.46; $P = .00$) (Table 3).

Among the 260 hypertensive participants, there were 44 with undiagnosed and 216 with previously diagnosed HTN. Among the 216 participants who were previously diagnosed with HTN, there were 149 with controlled BP and 67 with uncontrolled BP (Figure 1). Compared with the participants who had well-controlled HTN, the individuals with uncontrolled HTN were found to have a statistically significant higher body mass index (32.48 vs 28.85 kg/m2), with an adjusted OR = 1.295 (CI = 1.14-1.47; $P = .00$). Similarly, smokers were found to have a statistically significant lower rate of HTN control compared with those who do not smoke (61.0% vs 79.6%), with an adjusted OR of 2.54 (CI = 1.28-5.03; $P = .007$) (Table 4). The rate of nonadherence to medications among the previously diagnosed hypertensive individuals was found to be 26.9% (58 participants) (Table 5). The association

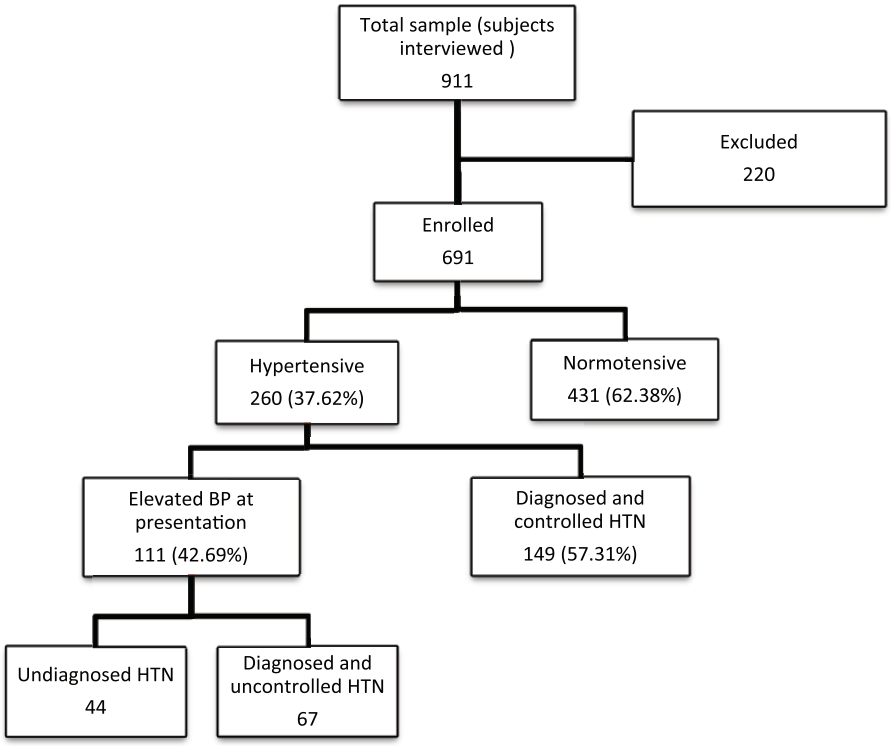

Figure 1. Chart illustrating the participant selection process and prevalence results; each case contains the representative number (± percentage) of participants with the specified category in the studied population. BP indicates blood pressure; HTN, hypertension.

Table 1. Hypertensive population characteristics, expressed as the mean ± SD for continuous variables and as percentages for categorical variables.

CHARACTERISTICS	N (%)/MEAN ± SD
Male (gender)	171 (65.76%)
Age (year)	67.30 ± 11.50
BMI (kg/m^2)	30.15 ± 4.25
Waist circumference (cm)	105.56 ± 8.68
Heart rate (bpm)	75.81 ± 15.10
Dyslipidemia	129 (49.6%)
Diabetes mellitus	101 (38.8%)
Cardiovascular comorbidities	124 (47.7%)
Smoking	155 (59.6%)
Sedentary lifestyle	192 (73.8%)
Family history of HTN	112 (43.07%)

Abbreviations: BMI, body mass index; HTN, hypertension.

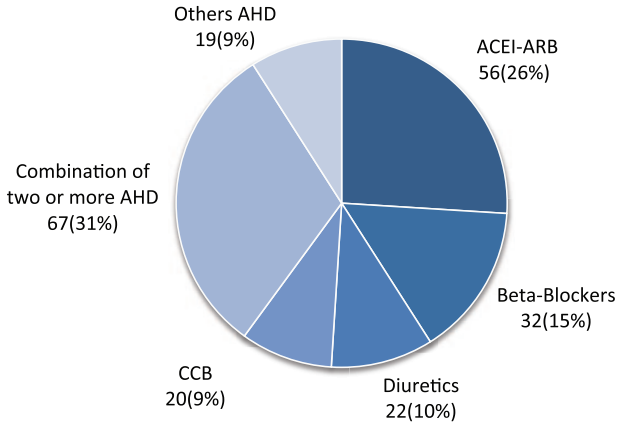

Figure 2. Antihypertensive drugs distribution among the 216 participants with diagnosed HTN. ACEI indicates angiotensin converting enzyme inhibitor; AHD, antihypertensive drugs; ARB, angiotensin receptor blockers; CCB, calcium channel blockers; HTN, hypertension.

between nonadherence to medications and uncontrolled HTN was statistically significant (OR = 42.346; CI = 17.852-100.446; P = .00); however, the agreement was not absolute. Finally, among the 216 participants previously diagnosed with HTN, 9 were found to have controlled BP despite reporting nonadherence to medications, and 18 were adherent but had uncontrolled HTN.

Discussion

The importance of assessing the predictors of HTN diagnosis and HTN control stems from the rapidly increasing prevalence of undiagnosed and uncontrolled HTN.[14] To the best of our knowledge, the present study is the first to investigate the predictors of HTN diagnosis and control in the studied community in Lebanon. While the classical risk factors for developing

Table 2. Percentage distribution of the different grades of HTN.

HTN	GRADE 1 N (%)	GRADE 2 N (%)	GRADE 3 N (%)	TOTAL N (%)
Undiagnosed	27 (61%)	13 (30%)	4 (9%)	44 (100%)
Diagnosed and uncontrolled	29 (43%)	28 (42%)	10 (15%)	67 (100%)

Abbreviation: HTN, hypertension.
Pearson χ^2, $P = .172$.

Table 3. Characteristics and multivariate analysis of the hypertensive participants: diagnosed versus undiagnosed HTN.

CHARACTERISTICS	DIAGNOSED HTN N = 216 (83.08%)	UNDIAGNOSED HTN N = 44 (16.92%)	ADJUSTED OR	95% CI	*P* VALUE
Diastolic BP, mm Hg	85.36 ± 6.16	90.50 ± 6.10	–	–	–
Systolic BP, mm Hg	135.10 ± 22.76	158.70 ± 13.30	–	–	–
Age, year	69.03 ± 10.69	58.82 ± 11.70	0.923	(0.892–0.955)	.000
Gender					
Male	142 (83.0%)	29 (17.0%)	–		–
Female	74 (83.1%)	15 (16.9%)	0.936	(0.428–2. 049)	.869
Family history					
Yes	96 (85.7%)	16 (14.3%)	–	–	–
No	114 (81.4%)	26 (18.6%)	–		
BMI, kg/m^2	29.97 ± 4.33	31.05 ± 3.75	1.045	(0.971–1.192)	.507
Waist circumference, cm	105.23 ± 8.93	107.20 ± 7.23	1.012	(0.949–1. 078)	.722
Heart rate, bpm	74.18 ± 14.91	83.84 ± 13.50	–	–	–
Sedentary lifestyle					
Yes	158 (82.3%)	34 (17.7%)	–	–	–
No	58 (85.3%)	10 (14.7%)	–		
CV comorbidities					
Yes	117 (94.4%)	7 (5.6%)	0.185	(0.074–0.463)	.000
No	99 (72.8%)	37 (27.2%)	–		
Smoking status					
Yes	123 (79.4%)	32 (20.6%)	1.705	(0.760–3.827)	.196
No	93 (88.6%)	12 (11.4%)	–		–
Diabetes mellitus					
Yes	89 (88.1%)	12 (11.9%)	0.531	(0.232–1.216)	.134
No	127 (79.9%)	32 (20.1%)	–		–

Abbreviations: BMI, body mass index; BP, blood pressure; CI, confidence interval; CV, cardiovascular; HTN, hypertension; OR, odds ratio.
Data are expressed as the mean ± SD for continuous variables and as numbers and percentages for categorical variables.

HTN are relatively common worldwide, the predictors of being undiagnosed and/or uncontrolled are more specific to personal awareness and culture, adherence to lifestyle and therapy, genetic predisposition, socioeconomic level, and the health system in every region and country.[15]

The prevalence of HTN in the regional district of Byblos was found to be 37.62%, a result comparable with the worldwide reported HTN prevalence.[8] However, our result is significantly lower than that reported by other authors studying prevalence of cardiovascular diseases, including HTN, in

Table 4. Characteristics of participants with controlled versus uncontrolled HTN and multivariate analysis targeting the predictors of uncontrolled HTN.

CHARACTERISTICS	CONTROLLED HTN N = 149 (69%)	UNCONTROLLED HTN N = 67 (31%)	ADJUSTED OR	95% CI	*P* VALUE
Diastolic BP, mm Hg	82.77 ± 4.43	91.10 ± 5.56	–	–	–
Systolic BP, mm Hg	122.39 ± 10.73	163.36 ± 15.96	–	–	–
Age, year	69.60 ± 10.51	67.78 ± 11.06	0.985	(0.956–1.015)	.335
Gender					
Male	97 (68.3%)	45 (31.7%)			
Female	52 (70.3%)	22 (29.7%)	0.780	(0.387–1.571)	.487
Family history					
Yes	66 (68.6%)	30 (31.3%)	–	–	–
No	79 (69.3%)	35 (30.7%)	–		
BMI, kg/m^2	28.85 ± 3.67	32.48 ± 4.67	1.295	(1.144–1.466)	.000
Waist circumference, cm	103.68 ± 8.44	108.66 ± 9.10	0.974	(0.920–1.030)	.974
Heart rate, bpm	68.52 ± 11.52	86.75 ± 13.93	–	–	–
Sedentary lifestyle					
Yes	107 (67.7%)	51 (32.3%)	–	–	–
No	42 (72.4%)	16 (27.6%)			
Dyslipidemia					
Yes	77 (69.4%)	34 (30.6%)	–	–	–
No	72 (68.6%)	33 (31.4%)			
CV comorbidities					
Yes	85 (27.6%)	32 (27.4%)	–	–	–
No	64 (64.6%)	35 (35.4%)			
Smoking status					
Yes	75 (61.0%)	48 (39.0%)	2.542	(1.284–5.029)	.007
No	74 (79.6%)	19 (20.4%)			
Diabetes mellitus					
Yes	64 (71.9%)	25 (28.1%)	–	–	–
No	85 (66.9%)	42 (33.1%)			

Abbreviations: BMI, body mass index; BP, blood pressure; CI, confidence interval; CV, cardiovascular; HTN, hypertension; OR, odds ratio.
Data are expressed as the mean ± SD for continuous variables and as numbers and percentages for categorical variables.

Table 5. A cross-tabulation showing adherence to antihypertensive therapy among controlled and uncontrolled participants for whom HTN was previously diagnosed (N = 216).

ADHERENCE TO MEDICATION	CONTROLLED HTN	UNCONTROLLED HTN	TOTAL
Not adherent	9	49	58 (26.9%)
Adherent	140	18	158 (73.1%)
Total	149	67	216 (100.0%)

Abbreviations: HTN, hypertension; OR, odds ratio; CI, confidence interval.
OR = 42.346; 95% CI = (17.852-100.446); *P* value = .00.

Lebanon.[16] In this respect, we estimate that regional differences (urban vs rural) and population selection criteria may explain this difference. Byblos district represents an urban area with relatively easier access to medical facilities and a relatively high socioeconomic level, yielding a potentially higher health care awareness.

In this study, 44 (16.92%) participants were unaware of their HTN, and this rate is significantly lower than that reported in a study conducted in Oman in 2008.[17] The higher awareness rate in our study can be explained by the higher mean age in our study, the difference in the study time (2008 vs 2017) and the regional differences in health systems.

Older age is a known risk factor for developing HTN and, as shown in the present study, it is positively associated with diagnosed HTN.[15] This study revealed that younger individuals, although less likely to have HTN, are more likely to have undiagnosed HTN. This finding is consistent with other studies[17] and can be explained by 2 facts: the higher number of health care visits among the elderly and the increasing probability for diagnosing HTN with the increased duration of the disease. The presence of cardiovascular comorbidities was found to be positively associated with diagnosed HTN. Patients with cardiovascular comorbidities are more likely to seek medical advice and, therefore, to have their HTN diagnosed earlier than those without cardiovascular conditions.

Note that some authors have reported that female gender and sedentary lifestyle are positively associated with HTN diagnosis; however, we did not find any significant association with these factors.[17] Likewise, we did not find any statistically significant association between smoking status and HTN diagnosis, contrary to the results reported by other authors.[18]

This study revealed that high body mass index, along with tobacco smoking status, predisposes individuals to uncontrolled HTN, with a statistically significant association, and this finding reinforces the results of other studies.[19,20] Overweight and obesity are conditions known to predispose individuals to both the development and poor control of HTN, and these conditions are related to the consecutive increase in afterload and endothelial dysfunction, along with atherosclerotic arterial rigidity.[7,10] Similarly, smoking status usually reflects a special psychological profile, often with poor lifestyle control, such as the overconsumption of salt; additionally, smoking alone predisposes one to atherosclerotic changes that increase afterload and, therefore, predisposes patients to poor BP control.[7]

While data from the literature have revealed a controversial association between gender and HTN control, our data revealed no significant association.[21,22] Similarly, we did not find any association between age and HTN control, although many authors have reported that aging is associated with poor BP control.[21] This difference could be attributed to our small sample size, along with the relatively elevated mean age of our population, which does not allow for valuable comparison between older and younger hypertensive individuals.

To the best of our knowledge, our study is the first to address the prevalence of each of the 3 grades of HTN in both diagnosed and undiagnosed subjects from a local community in Lebanon. Grade 1 HTN was found to be more prevalent among undiagnosed participants (61% in undiagnosed HTN vs 43% in diagnosed HTN); however, this trend in differences was not statistically significant, and this finding may be related to the small sample size, thereby warranting further investigation. The higher prevalence of Grade 1 HTN in undiagnosed individuals suggests that the diagnosis of mild HTN is often missed either because it is mostly asymptomatic or because BP at this stage is often labile and, thus, may be easily misdiagnosed.[8]

In this study, nonadherence to therapy, as declared by the participants, was 26.9%, a finding that is comparable with the results reported by other authors.[23] This finding reflects the lack of awareness about the deleterious effects of uncontrolled HTN and raises the real need for awareness campaigns for HTN. Note that 9 participants reported being nonadherent to antihypertensive medications; however, they were found to have controlled BP—assuming that the self-reported participant data are reliable, this phenomenon may be explained by various factors, such as the effect of adequate lifestyle modification or, quite simply, an initial misdiagnosis (normal BP diagnosed as HTN). In addition, 8 participants were found to have uncontrolled BP despite being adherent to medications, and this finding may be explained by either insufficient antihypertensive therapy or the presence of resistant HTN.

Strategic public health plans for local communities and worldwide are required for HTN screening and prevention programs, particularly those targeting individuals with undiagnosed and uncontrolled HTN. In addition, social, demographic, and economic factors should be investigated specifically to address the wide variability of the predictors of HTN diagnosis and control in each local community to achieve maximum efficiency in prevention of noncommunicable disease in the populations who tend to have less visits to health care facilities.

Conclusion

The burden of HTN is significant worldwide, despite all medical progress. Among the 260 participants who were found to be hypertensive, there were 44 (16.92%) participants who were previously undiagnosed and 67 (25.77%) with uncontrolled HTN. This study revealed that HTN diagnosis is positively associated with age and cardiovascular comorbidities, while HTN control is negatively associated with increased body mass index, nonadherence, and smoking status.

Limitations

The cross-sectional study design limited our results to revealing associations rather than establishing causality. The sample

size was not large, and the population was limited to the Byblos district, thus compromising the external validity. Additional demographic and lifestyle factors, such as educational level and socioeconomic status, were not addressed in the survey. The lack of ambulatory BP monitoring hinders the study from addressing white coat HTN and masked HTN. Separate analysis of predictors of undiagnosed and uncontrolled systolic BP versus diastolic BP was not performed in this study. Using self-reported data documented during the interview might have affected the results. The adherence to medications depended only on the participants' claim that he or she take the medications as prescribed, making the adherence results subject to reporting bias. Note that the newly released HTN guidelines,[8] which define and warrant treatment at a lower BP threshold, render the results in this study an underestimation and consequently increasing the significance of the results.

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Author Contributions

AK conceived and designed the experiments. HK, AKH, MK and AK analyzed the data. HK, AKH, MK and AK wrote the first draft of the manuscript. HK, AKH, MK and AK contributed to the writing of the manuscript. HK, AKH, MK and AK agree with manuscript results and conclusions. HK, AKH, MK and AK jointly developed the structure and arguments for the paper. HK, AKH, MK and AK made critical revisions and approved final version. All authors reviewed and approved of the final manuscript.

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