

# Effect of Tooth Loss on Blood Pressure in Congolese Population: A Cross-Sectional Study

Elias Lubadi Tshilumba<sup>1</sup>, Augustin Mantshumba Milolo<sup>1\*</sup>, Pierrot Kumpanya Ntumba<sup>1</sup>, Fidele Nyimi Bushabu<sup>2</sup>, Grace Paka Lubamba<sup>2</sup>, David Kayembe Mwimbi<sup>2</sup>, Em Kalala Kazadi<sup>3</sup>, Pierre Muyembi Muinaninayi<sup>2</sup>, Grevisse Bindele Ndombolo<sup>1</sup>, Dany Kanyana Makolo<sup>4</sup>, Simplot Tubanza Mulongo<sup>2</sup>, Gabriel Bile Bopili<sup>5</sup>, Junior Panoumvita Kapomona<sup>2</sup>, Fifi Balepukayi Mpiana<sup>6</sup>, Monique Nsudila Mpoyi<sup>2</sup>, Pamela Lubula<sup>5</sup>, Dorcas Kilesa Nkanga<sup>2</sup>, Jean Marie Kayembe Bukama<sup>5</sup>, Jean Jacques Malemba Kabasele<sup>7</sup>, Jean Rene M'buyamba Kabangu<sup>7</sup>, Oral Health Section Working Team<sup>8</sup>

<sup>1</sup>Department of Prosthodontics, Affiliated Hospital of the University of Kinshasa, Kinshasa, DR Congo

<sup>2</sup>Department of Oral and Maxillofacial Surgery, Affiliated Hospital of the University of Kinshasa, Kinshasa, DR Congo

<sup>3</sup>Department of Periodontology, Affiliated Hospital of the University of Kinshasa, Kinshasa, DR Congo

<sup>4</sup>Research Sciences and Health Institute of Kinshasa, Kinshasa, DR Congo

<sup>5</sup>Department of Operative Dentistry, Affiliated Hospital of the University of Kinshasa, Kinshasa, DR Congo

<sup>6</sup>Department of Orthodontics, Affiliated Hospital of the University of Kinshasa, Kinshasa, DR Congo

<sup>7</sup>Department of Internal Medicine, Affiliated Hospital of the University of Kinshasa, Kinshasa, DR Congo

<sup>8</sup>Oral Health Section Working Team

Email: \*augustin.mantshumba@unikin.ac.cd

**How to cite this paper:** Tshilumba, E.L., Milolo, A.M., Ntumba, P.K., Bushabu, F.N., Lubamba, G.P., Mwimbi, D.K., Kazadi, E.K., Muinaninayi, P.M., Ndombolo, G.B., Makolo, D.K., Mulongo, S.T., Bopili, G.B., Kapomona, J.P., Mpiana, F.B., Mpoyi, M.N., Lubula, P., Nkanga, D.K., Bukama, J.M.K., Kabasele, J.J.M., Kabangu, J.R.M. and Oral Health Section Working Team (2025) Effect of Tooth Loss on Blood Pressure in Congolese Population: A Cross-Sectional Study. *Open Journal of Stomatology*, 15, 25-38. <https://doi.org/10.4236/ojst.2025.152002>

**Received:** October 31, 2024

**Accepted:** February 23, 2025

**Published:** February 26, 2025

## Abstract

**Background:** Tooth loss results in impaired mastication, which in turn, makes it difficult to chew hard food, consequently leading to deteriorate dietary habits and to develop hypertension. The purpose of this study was to examine the effect of tooth loss on blood pressure among Congolese population. **Methods:** A cross-sectional study was conducted from October 2019 until December 2023 among Congolese population aged at least 30 years reporting to the living in DR Congo. All participants were enrolled from Dental Clinic located in the DR Congo. To be eligible to participate in the study, were the willing to participate and having signed informed consent; had a missing tooth; had carried out blood pressure measurement (hypertension/normotensive). The exclusion criteria were determined: being less than 30 years old, being pregnant for women considering the risk of existing gestational hypertension, obesity, excessive alcohol consumption, smoking, and diabetes. Hypertension was defined as the mean of three measurements of systolic blood pressure (SBP) (140 mmHg or higher), diastolic blood pressure (DBP) (90 mm or higher) or physician diagnosed hypertension confirmed from medical records. We

Copyright © 2025 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0). <http://creativecommons.org/licenses/by/4.0/>



Open Access

determined the number of tooth loss from oral examination. A multivariable logistic regression model was used to investigate the effect of tooth loss on blood pressure. **Results:** In all, 25,396 participants were enrolled among Congolese population for this study. After oral examination, 13,421 were excluded for no tooth loss and 11,975 participants were selected. The average number of tooth loss among study population was 11.06. Among the participants with hypertension had lost an average of 11 teeth, significantly higher than those without hypertension (6.09) ( $p = 0.001$ ). After adjusting for covariates (socio-demographic characteristics), tooth loss ( $>10$ ) was significantly associated with hypertension, with OR = 1.32 (95% CI 1.073 - 2.38). **Conclusion:** Tooth loss maybe associated with severe hypertension among Congolese population adults. Prevention of tooth loss is very important to the overall health of this population.

### Keywords

Tooth Loss, Blood Pressure, Public Health, Hypertension, Congolese Population

---

## 1. Introduction

Hypertension is a medical condition in which blood pressure is chronically 140/90 mmHg or higher and it is estimated to affect more than one billion people in the world and is defined as a persistent high systemic arterial blood pressure [1] [2].

The worldwide prevalence of hypertension has increased two-fold from 1990 to 2019, to more than 30% for men and women aged 30 - 79 years old [3]. The prevalence of hypertension among American is 32% [4], Chinese is 25.2% [5], European is 22% [6], African is 54% [7], Congolese is 25.5% and is rapidly rising in DR Congo [8].

The risk factors for high blood pressure are dependent such as age, sex, obesity, excessive alcohol consumption, smoking, diabetes, high dietary salt intake, physical inactivity and stress [9]-[19]. In addition, tooth loss is another risk factor that can lead to development of hypertension.

The viewing the mouth separately from the rest of the body must cease because oral health affects general health by causing considerable pain and suffering and by changing what people eat, their speech and their quality of life and well-being [20].

Decline in masticatory function brings insufficient intake of vegetables and fruit and increased intake of fatty foods, which could cause obesity and the number of occluding pairs is an important indicator for oral health [21].

Tooth loss may be seen as the worst-case scenario in oral health and its impacts on blood pressure is estimated to be significant. According to the interplay between tooth loss and hypertension, dental care appointments constitute an environment where blood pressure is commonly measured and therefore, might play

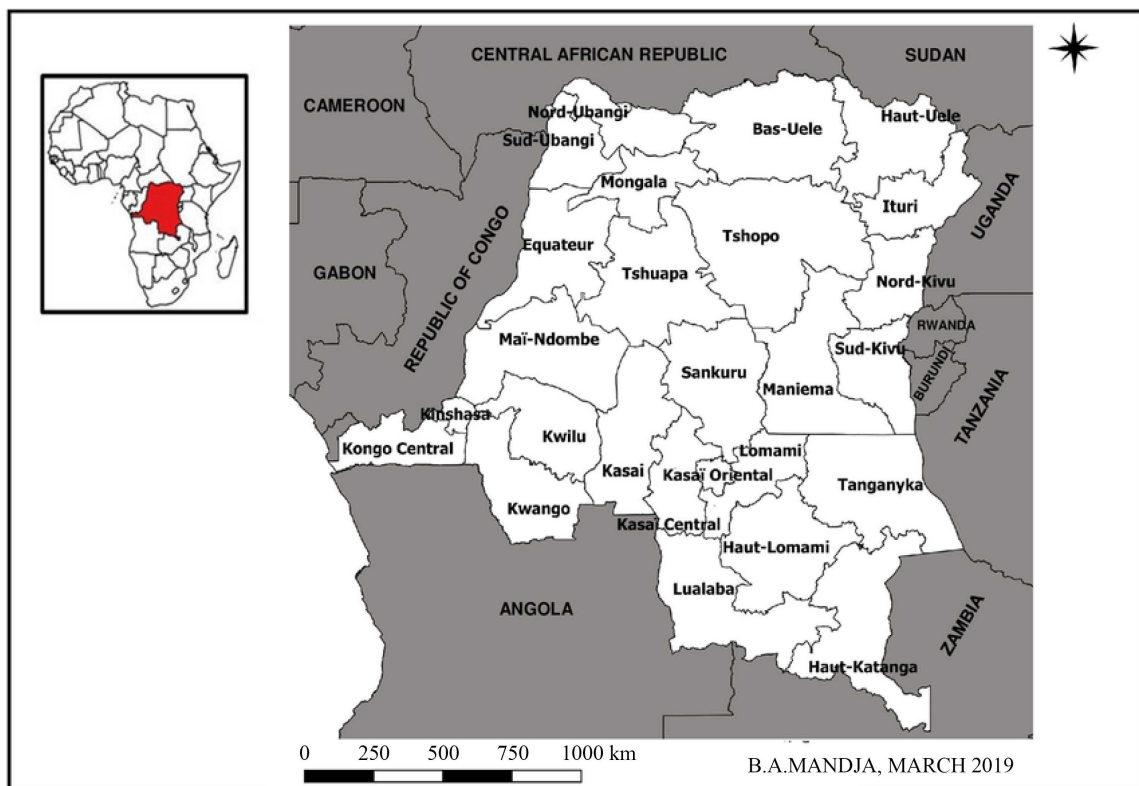
a noteworthy responsibility in forwarding suspected undiagnosed hypertensive patients to seek proper care [22] [23].

Numerous studies on tooth loss and hypertension have been carried out around the world, those conducted in high-income countries showed a great variation in study design, sample sources, and data analyses among population. Considering the differences in health care system, culture, genetic factors and health literacy, it is unclear whether the evidence generated from other countries is not generalizable to Congolese population.

With the present study, we intend to evaluate the impact of tooth loss on blood pressure measurements, on a large cross-sectional study from a national reference dental care clinic in DR Congo.

## 2. Materials and Methods

A cross sectional study was conducted from October 2019 to December 2023 among Congolese aged at least 30 years old reporting to the Congolese living in D R Congo (Kinshasa, Lubumbashi, Matadi, Nioki, Goma, Bukavu, Bunia, Butembo, Kananga, Likasi, Kolwezi, Boma, Mbandaka, Kimpese and Kikwit) (**Figure 1**).



**Figure 1.** Administrative map of the DR Congo including 26 new provinces and bordering country.

The National Center of Research in Oral Health Sciences (Democratic Republic of the Congo) granted ethics approval for this research under the following protocol CNRSBD1504.318. This cross-sectional study was performed following the

Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [24].

### **2.1. Setting**

This study collected data from the DR Congo Dental Clinic (DRCDC), a dental clinic located in fifteen cities in DRC, which provides dental health services to the public. In the DRCDC, the campaign of oral health was organized during 10 days each year including the world oral health day-DRC was observed annually on 20<sup>th</sup> of March and screening took place in several mostly cities in DRC. It is a clinical step for every participant to appropriately diagnose and plan the oral status of the participant.

### **2.2. Study Participants**

All participant were enrolled from Dental Clinic located in the DR Congo.

To be eligible to participate in the study, the following inclusion criteria were determined: willing to participate and having signed informed consent; had a tooth loss and had carried out blood pressure measurement. The exclusion criteria were as follows: being less than 30 years old, being pregnant for women considering the risk of existing gestational hypertension in this case [25], in their medical records: obesity, excessive alcohol consumption, smoking, and diabetes.

### **2.3. Observation of Tooth Loss**

Participants in the study received an oral examination about their numbers of missing teeth by Oral Health Experts (Oral Health Section Working Team). Interviews and dental exams were carried out in the dental clinic rooms during the day. Participants were categorized for tooth loss severity based on how many teeth they had lost: severe (>10); moderate (6 - 10); non-severe (<6).

### **2.4. Blood Pressure Measurement**

In a seated position, with the feet planted on the floor, left arm relaxed and supported on a table at heart level, and with the palm facing upward. Blood pressure was measured three times after at least 5 minutes of rest using a digital electronic tensiometer (M4; OMRON Corp., Kyoto, Japan). Hypertension was defined as the mean of three measurements of systolic blood pressure (SBP) (140 mmHg or higher), diastolic blood pressure (DBP) (90 mmHg or higher) (mean of the second and third readings) or taking antihypertensive medication. When necessary, multiple imputation was used to estimate participants' mean blood pressure [26] [27].

### **2.5. Data Collection**

Oral Health Expert interviewed the participants face to face in order to obtain all relevant information including demographic variables (age, sex and education level).

## 2.6. Statistical Analysis

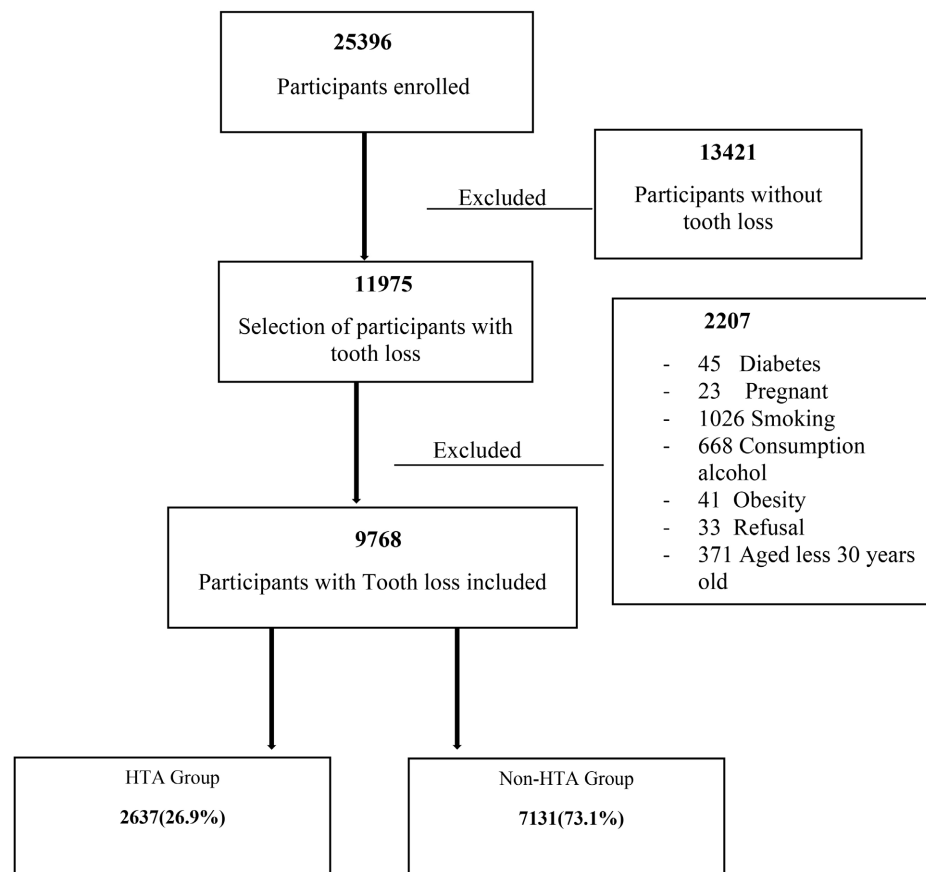
We used the student t-test, Pearson Chi-squared test, analysis of variance (ANOVA).

Multivariate logistic regression analyses were used to model the influence of potential factors in the relationship between tooth loss and hypertension. Odds ratio (OR) and 95% confidence intervals (95% CI) were calculated within the logistic regression analyses; for different adjustment levels, by using multiple linear regression analyses, we investigated the possible linear relationship between SBP and DBP and age, education level and tooth loss.

## 3. Results

In all, 25,396 participants were enrolled among Congolese population for this study. After oral examination, 13,421 were excluded for no tooth loss and 11,975 participants were selected.

Among 11,975 participants with tooth loss, 2207 were excluded among them 45 for diabetes, 23 for pregnant, 1026 smokers, 668 for consumption alcohol, 41 for obesity, 33 refusal and 371 aged less than 30 years old (**Figure 2**).



**Figure 2.** Flow chart of participants enrolled in the study.

The final sample consisted of 9768 participants, with an average of 46.2 (SD 6.2)

years of age, and predominantly female 5402 (55.3%) and the mean of education level was high school 4521 (46.3%) (**Table 1**).

The participants with tooth loss were divided into two groups: A group with hypertension (HTA group) and a group without hypertension (Non-HTA group) (**Figure 2**).

Among all the participants, 2637 (26.9%) (HTA group) were diagnosed with hypertension had significantly more tooth loss (mean 11.06) than those without hypertension (Non-HTA group) (mean 6.09) ( $p < 0.001$ ) (**Table 1**).

**Table 1.** Characteristics of the participants with tooth loss and hypertension and non-hypertension.

Variates	N = 9768 n (%)	Tooth loss ≤ 5 N1 = 4574	Tooth loss 6 - 10 N2 = 2296	Tooth loss > 10 N3 = 2898	p value
<b>Sex</b>					
Men	4366 (44.7)	1735 (37.9)	<b>1243 (54.1)</b>	<b>1507 (52)</b>	
Women	<b>5402 (55.3)</b>	<b>2839 (62.1)</b>	1053 (45.9)	1391 (48)	
<b>Age (years)</b>					
30 - 39	2461 (25.2)	786 (17.2)	<b>697 (30.4)</b>	<b>978 (33.7)</b>	
40 - 49	1367 (13.9)	683 (14.9)	281 (12.2)	403 (13.9)	
50 - 59	1582 (16.2)	792 (17.3)	373 (16.2)	417 (14.4)	
60 - 69	<b>2741 (28.1)</b>	<b>1547 (33.8)</b>	433 (18.9)	761 (26.3)	
≥70	1617 (16.6)	766 (16.8)	512 (22.3)	339 (11.7)	<0.0001
<b>Education level</b>					
Illiterate	783 (8.1)	160 (34.9)	215 (9.3)	408 (14.1)	
Primary school	1268 (12.9)	545 (11.9)	484 (21.1)	239 (8.2)	
Middle school	1551 (15.9)	1021 (22.3)	378 (16.5)	152 (5.2)	0.003
High school	<b>4521 (46.3)</b>	<b>1779 (38.9)</b>	<b>1114 (48.5)</b>	<b>1628 (56.2)</b>	
University	1645 (16.8)	1069 (23.4)	105 (4.6)	471 (16.3)	
<b>Tension status</b>					
No hypertension	<b>7131 (73.1)</b>	<b>4205 (92)</b>	<b>1764 (76.9)</b>	1162 (40.1)	
Hypertension	2637 (26.9)	369 (8)	532 (23.1)	<b>1736 (59.9)</b>	<0.0001

Participants with severe tooth loss (>10) were older ( $p < 0.001$ ) BP ( $p < 0.001$ ). The prevalence of hypertension at examination was found higher, tooth loss participants (>10) ( $p < 0.001$ ). In contrast, participants with normal blood pressure were more prevalent in participants with less than 6 teeth. We confirmed a consistent association of BP with tooth loss in Congolese participants. Additionally, older adults were more associated with severe tooth loss and higher measures of BP. There was evidence that the association between tooth loss and blood pressure (SBP and DBP) was mediated by age (**Table 2**). A significant model was obtained

when age was included as a mediator of the association between tooth loss and BP (Tooth loss, age  $p < 0.001$ ; age BP,  $p < 0.001$ ; and tooth loss, BP,  $p < 0.001$ ).

**Table 2.** Mean systolic and diastolic blood pressure by dental status.

Dental status	Mean systolic pressure (mmHg) Mean (SE)	Mean diastolic pressure (mmHg) Mean (SE)
Tooth loss $\leq 5$	134 (0.29)	84 (0.17)
Tooth loss 6 - 10	146 (0.54)	85 (0.33)
Tooth loss $> 10$	162 (0.82) $p < 0.001$	91 (0.43) $p < 0.001$

For the overall sample, when considering a crude model (Model 1) the presence of hypertension (OR = 2.64, 95% CI: 1.50 - 4.29) was associated with the number of tooth loss (Table 3). Then, multiple linear regression analyses investigated the linear relationship between SBP and DBP with age and tooth loss for the overall sample (Table 3).

**Table 3.** Multivariable logistic regression models for association of tooth loss and hypertension (N = 9768).

Dental status	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Tooth loss $\leq 5$	1	1	1
Tooth loss 6 - 10	2.25 (1.69 - 3.29)	1.70 (1.20 - 2.41)	1.70 (1.19 - 2.43)
Tooth loss $> 10$	2.64 (1.50 - 4.29)	1.45 (0.82 - 2.54)	1.32 (0.73 - 2.38)

Model 1: univariate; Model 2: adjusted for sex and age; Model 3: adjusted for age, sex, education level.

## 4. Discussion

The goal of our study was to determine the impact of tooth loss on blood pressure among Congolese population.

This cross-sectional study found that the number of tooth loss more than ten teeth may have a positive association with the risk of development of hypertension. Individuals having greater tooth loss exhibiting a high prevalence of hypertension and high blood pressure. In our study, the prevalence of hypertension was 26.9%. This study has confirmed the key reported traditional lifestyle factors associated with high BP in DRC [8] [28]. The reason is that tooth loss causes a decrease in masticatory function and decreased consumption of vegetables and fruits, and higher consumption of high energy food, tend to cause obesity compared to those with adequate mastication [29]-[32]. Tooth loss may lead to alterations of dietary patterns, such as low intake of citrus fruit, beta-carotene, folate, vitamin C and fiber. These undesirable eating habits are closely related to the development of high blood pressure via many factors. Another reason is that the reduction in chewing leads to a decrease in diet-induced thermogenesis and

inactivation of neuronal histamine, which may consequently lead to obesity [33]-[35]. According to previous studies, 20 natural teeth is used as a criterion for severe tooth loss. Sheiham *et al.* reported that individuals with  $\geq 21$  natural teeth can optimize nutritional intake. The cut-off point in the number of teeth in our study was similar to that of Sheiham *et al.* [36]. However, the cut-off in the number of teeth differed among all studies. Having 20 or more teeth is enough for masticatory function [21]. Therefore, the association between tooth loss and high blood pressure may be explained by nutritional intake [37].

The present study suggests that tooth loss is associated with an increased risk of hypertension and higher systolic blood pressure. Our results are similar to other previous study [38]. This association was also observed in younger participants than 65 years [39]. Another study reported that tooth loss was related to severe hypertension in participants aged 50 years or more in China [40]. Hye-sun-shin study involving the Korean population showed that a decrease in the number of teeth may be independently associated with hypertension [41]. Our results are similar to those of these previous studies and provide additional information on the positive association between tooth loss and an increase in the risk of developing hypertension in a longitudinal study.

Other studies have shown a differential association of gender in the relationship between severe tooth loss and blood pressure. German studies found this association to be significant only in males [42]. The same investigators also argued that higher degrees of osteoporosis in women may lead to early tooth extraction, thus reducing the risk of long-lasting periodontitis. Other studies including only women have found an association between severe tooth loss and hypertension [43].

Additionally, older adults were more associated with severe tooth loss and higher measures of SBP and DBP. We assessed the distribution of blood pressure according to the number of tooth loss. Interestingly, mean systolic blood pressure increased gradually as the number of teeth decreased, whereas diastolic blood pressure showed a non-linear pattern that increased to teeth and then decreased in cases of  $< 20$  teeth [44] [45].

In other observational studies, a strong association between tooth loss and hypertension was observed after controlling for a number of confounding variables. A cross sectional study in Indian adults indicated that participants with partial tooth loss had 1.62 times (95%, higher OR of developing hypertension after adjusting for all confounders, compared to those with no tooth loss [46]. Moreover, the study of Peres *et al.* observed that edentulous people have an 8.3 mmHg higher SBP compared to individuals with more than 10 teeth in both arches after adjustment [47]. In South African, Ayo-Yusuf *et al.*, found that total tooth loss was significantly associated with hypertension [48].

Tooth loss may be certainly a risk factor for hypertension by the result of an indirect influence, which is highly remote from physiological point of view. Oral diseases such as dental caries and periodontal disease may participate in this

mechanism, as they are the main responsible for tooth loss [49].

In our study, the participants had an average of 11 missing teeth, comparable to the findings from large national oral health surveys using clinical examination data in China, in which adults aged 60 - 74 years had an average of 10 missing teeth [50]. Tooth loss and hypertension are both common among older adults, it is possible that the association between hypertension and tooth loss is bidirectional among those with significant tooth loss those who lost >10 teeth [51].

In addition, education can be considered a modifying factor of health outcomes, influencing health knowledge, behaviors, employment, social beliefs, standing, and networks [52].

Moreover, the periodic dental appointment reduced the chance of tooth loss in individuals with chronic disease. Although the barriers of access to oral health care services were not fully assessed in our investigation, it is suggested that this event occurs due to cost, availability of oral health care services in DR Congo and the fear of dentists. Dental services have low acceptance among the population, this fact is a consequence of individual and community factors.

The reality of our study shows the necessity of expanding the available primary care, treating these individuals in a holistic way. Moreover, it would be necessary to reinforce the importance attached to general and oral health services, including a periodic schedule of evaluation for interdisciplinary team-based care.

Considering the relationship between hypertension and tooth loss, dental care appointments constitute an environment where BP is commonly measured and, therefore, might play a noteworthy responsibility in forwarding suspected undiagnosed hypertensive patients to seek proper care. As in Machado *et al.* study, these results validate dental units as potential primary care locations for detecting cases of undiagnosed hypertension and, possibly, expanding to other clinical situations (such as diabetes and oral cancers) [53].

Despite these limitations, this study provides, for the first time in a large national representative sample, useful information on tooth loss as a risk indicator for hypertension, while controlling for multiple risk factors.

The strengths of our study are the relatively large sample size for a study of such scale. We adjusted for relevant confounders sequentially in our three models.

However, the study has certain limitations. Firstly, hypertension is known to be a punctual measurement so that the absence of years of hypertension of an individual may be a disadvantage. Secondly, it is better to use inadequate dentition with individuals with fewer than 20 teeth to categorize tooth loss. Thirdly, the place, as a study conducted in urban cities, participants have a higher level of education than other areas in the DR Congo. Therefore, the study findings may not be generalizable to the wider older population in the Congo. Finally, our findings were based on a cross-sectional study; therefore, we were only able to examine the association between tooth loss and hypertension.

Longitudinal and prospective cohort studies are needed to further elucidate the causal association between tooth loss and hypertension.

## 5. Conclusion

Among Congolese adults, we observed a strong association between tooth loss and high blood pressure. Low numbers of remaining teeth might be considered as an impact factor for high blood pressure among the population. This study demonstrated that the loss of 10 or more teeth was associated with a higher risk of developing hypertension.

## Acknowledgements

We thank all participating Oral Health Experts (referred to as Oral Health Section Working Team) for their time and valuable contributions including C. Mbantshi, A. Mutombo, C. Musawu, A. Mufwar, V. Kaseka, G. Bimpe, C. Nkongolo, G. Nguala, G. Nyanguile, E. Ngalula, E. Mafuta, G. Mbumba, G. Shako, I. Luboa, B. Kabungu, D. Bokele, D. Nsumbu, F. Kayembe, P. Ekili, A. Cilambu, F. Mbumba, J. Dihulu, A. Katende, F. Salumu, V. Mukendi, J. Yamba, C. Mutombo, E. Mukenge, P. Mandiangu, D. Bwalungu, A. Kizangula, R. Kankolongo, I. Kalolo, F. Ndaya, J. Mawa, M. Mwayuma, B. Kazadi, CR. Mopamboli.

## Author Contributions

Authors ELT, AMM, FNB, DKM, EKK, JKB, FBM contributed to the conception, design of the study, acquisition of data, interpretation of data, and manuscript revisions. GPL, PMM, STM, PKN, GBB, JPK, JJMK, JRMK contributed to the writing.

## Conflicts of Interest

The authors declare no competing interests.

## References

- [1] Tshilumba, E.L., Milolo, A.M., Bushabu, F.N., Kazadi, E.K., Ntumba, P.K., Ndombolo, G.B., *et al.* (2024) Association between Tooth Loss and Hypertension: A Systematic Review. *Open Journal of Stomatology*, **14**, 393-403. <https://doi.org/10.4236/ojst.2024.1410033>
- [2] WHO (2020) Hypertension.
- [3] NCD Risk Factor Collaboration (2021) Worldwide Trends in Hypertension Prevalence and Progress in Treatment and Control from 1990 to 2019: A Pooled Analysis of 1201 Population-Representative Studies with 104 Million Participants. *The Lancet*, **398**, 957-980.
- [4] Ostchega, Y., Cheryl, D.R.N., *et al.* (2020) Hypertension Prevalence among Adults Aged 18 and over: United States, 2017-2018. *NCHS Data Brief*, **2020**, Article No. 364.
- [5] Wang, J., Zhang, W., Li, Y. and Liu, L. (2023) Hypertension in China: Epidemiology and Treatment Initiatives. *Nature Reviews Cardiology*, **20**, 531-545. <https://doi.org/10.1038/s41569-022-00829-z>
- [6] Nemcsik, J., Takács, J., Pásztor, D., Farsang, C., Simon, A., Páll, D., *et al.* (2024) Frequency of Office Blood Pressure Measurements and the Seasonal Variability of Blood Pressure: Results of the Hungarian Hypertension Registry. *Blood Pressure*, **33**, Article

2337170. <https://doi.org/10.1080/08037051.2024.2337170>
- [7] Olowoyo, P., Barango, P., Moran, A., Williams, B., Whelton, P.K., Owolabi, M., *et al.* (2024) Priorities to Reduce the Burden of Hypertension in Africa through Achieve. *The Lancet Global Health*, **12**, e192-e193. [https://doi.org/10.1016/s2214-109x\(23\)00540-5](https://doi.org/10.1016/s2214-109x(23)00540-5)
- [8] M'Buyamba-Kabangu, J., Katamba, F.K., Ntambwe, M.L., Ngoyi, G.N., Tshiswaka, T.M., Bayauli, P.M., *et al.* (2021) May Measurement Month 2019: An Analysis of Blood Pressure Screening Results from the Democratic Republic of the Congo. *European Heart Journal Supplements*, **23**, B52-B54. <https://doi.org/10.1093/eurheartj/suab050>
- [9] Aronow, W.S. (2017) Association of Obesity with Hypertension. *Annals of Translational Medicine*, **5**, Article 350. <https://doi.org/10.21037/atm.2017.06.69>
- [10] Grillo, A., Salvi, L., Coruzzi, P., *et al.* (2019) Sodium Intake and Hypertension. *Nutrients*, **11**, 1970. <https://doi.org/10.3390/nu11091970>
- [11] He, F.J., Tan, M., Ma, Y. and MacGregor, G.A. (2020) Salt Reduction to Prevent Hypertension and Cardiovascular Disease. *Journal of the American College of Cardiology*, **75**, 632-647. <https://doi.org/10.1016/j.jacc.2019.11.055>
- [12] Mcfadden, C., Brensinger, C., Berlin, J. and Townsend, R. (2005) Systematic Review of the Effect of Daily Alcohol Intake on Blood Pressure. *American Journal of Hypertension*, **18**, 276-286. <https://doi.org/10.1016/j.amjhyper.2004.07.020>
- [13] Sesso, H.D., Cook, N.R., Buring, J.E., Manson, J.E. and Gaziano, J.M. (2008) Alcohol Consumption and the Risk of Hypertension in Women and Men. *Hypertension*, **51**, 1080-1087. <https://doi.org/10.1161/hypertensionaha.107.104968>
- [14] Egan, B.M. (2017) Physical Activity and Hypertension. *Hypertension*, **69**, 404-406. <https://doi.org/10.1161/hypertensionaha.116.08508>
- [15] Börjesson, M., Onerup, A., Lundqvist, S. and Dahlöf, B. (2016) Physical Activity and Exercise Lower Blood Pressure in Individuals with Hypertension: Narrative Review of 27 RCTs. *British Journal of Sports Medicine*, **50**, 356-361. <https://doi.org/10.1136/bjsports-2015-095786>
- [16] Liu, M., Li, N., Li, W.A. and Khan, H. (2017) Association between Psychosocial Stress and Hypertension: A Systematic Review and Meta-Analysis. *Neurological Research*, **39**, 573-580. <https://doi.org/10.1080/01616412.2017.1317904>
- [17] Sparrenberger, F., Cichelero, F.T., Ascoli, A.M., Fonseca, F.P., Weiss, G., Berwanger, O., *et al.* (2008) Does Psychosocial Stress Cause Hypertension? A Systematic Review of Observational Studies. *Journal of Human Hypertension*, **23**, 12-19. <https://doi.org/10.1038/jhh.2008.74>
- [18] Lanau, N., Mareque-Bueno, J. and Zabalza, M. (2020) Does Periodontal Treatment Help in Arterial Hypertension Control? A Systematic Review of Literature. *European Journal of Dentistry*, **15**, 168-173. <https://doi.org/10.1055/s-0040-1718244>
- [19] Forman, J.P. (2009) Diet and Lifestyle Risk Factors Associated with Incident Hypertension in Women. *Journal of the American Medical Association*, **302**, 401-411. <https://doi.org/10.1001/jama.2009.1060>
- [20] Makolo, D.K., Mutombo, A.M., Bushabu, F.N., Lubamba, G.P., Yemweni, B.K., Inganya, E.E., *et al.* (2024) Dental Tissues of Sickle Cell Anemia and Its Impact on the Quality of Life Related to Oral Health. *Hematology, Transfusion and Cell Therapy*, **46**, 408-414. <https://doi.org/10.1016/j.htct.2023.08.004>
- [21] Augustin, M.M., Joke, D., Bourleyi, S.I., Shenda, L.P., Fidele, N.B., Van, T.M., *et al.* (2016) The Effect of Partial Removable Denture Use on Oral Health Related Quality

- of Life and Masticatory Function, after 5 Years Use. *Open Journal of Stomatology*, **6**, 201-210. <https://doi.org/10.4236/ojst.2016.610026>
- [22] Baseer, M., Anbarserri, N., Ismail, K., Anbarserri, H., Alanazi, D., AlSaffan, A., *et al.* (2020) Impact of Severity of Tooth Loss on Oral-Health-Related Quality of Life among Dental Patients. *Journal of Family Medicine and Primary Care*, **9**, 187-191. [https://doi.org/10.4103/jfmipc.jfmipc\\_909\\_19](https://doi.org/10.4103/jfmipc.jfmipc_909_19)
- [23] Kim, J.K., Baker, L.A., Davarian, S. and Crimmins, E. (2013) Oral Health Problems and Mortality. *Journal of Dental Sciences*, **8**, 115-120. <https://doi.org/10.1016/j.jds.2012.12.011>
- [24] von Elm, E., Altman, D.G., Egger, M., Pocock, S.J., Gøtzsche, P.C. and Vandenbroucke, J.P. (2014) The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for Reporting Observational Studies. *International Journal of Surgery*, **12**, 1495-1499. <https://doi.org/10.1016/j.ijssu.2014.07.013>
- [25] Kintiraki, E., Papakatsika, S., Kotronis, G., Goulis, D.G. and Kotsis, V. (2015) Pregnancy-Induced Hypertension. *Hormones*, **14**, 211-223. <https://doi.org/10.14310/horm.2002.1582>
- [26] Tada, A. and Miura, H. (2018) Association of Mastication and Factors Affecting Masticatory Function with Obesity in Adults: A Systematic Review. *BMC Oral Health*, **18**, Article No. 76. <https://doi.org/10.1186/s12903-018-0525-3>
- [27] Iwasaki, M., Kimura, Y., Yoshihara, A., *et al.* (2015) Association between Dental Status and Food Diversity among Older Japanese. *Community Dental Health*, **32**, 104-110.
- [28] Mukoso, N.F., Nkodila, A.N., *et al.* (2021) Prevalence and Associated Factors of Hypertension among Adults Living in the City of Bandundu, Democratic Republic of the Congo: A Population-Based Cross-Sectional Study. *Open Access Library Journal*, **8**, e7303.
- [29] Yoshida, M., Kikutani, T., Yoshikawa, M., Tsuga, K., Kimura, M. and Akagawa, Y. (2011) Correlation between Dental and Nutritional Status in Community-Dwelling Elderly Japanese. *Geriatrics & Gerontology International*, **11**, 315-319. <https://doi.org/10.1111/j.1447-0594.2010.00688.x>
- [30] Tada, A., Tano, R. and Miura, H. (2022) The Relationship between Tooth Loss and Hypertension: A Systematic Review and Meta-Analysis. *Scientific Reports*, **12**, Article No. 13311. <https://doi.org/10.1038/s41598-022-17363-0>
- [31] Moynihan, P., Thomason, M., Walls, A., Gray-Donald, K., Morais, J.A., Ghanem, H., Wollin, S., Ellis, J., Steele, J., Lund, J. and Feine, J. (2009) Researching the Impact of Oral Health on Diet and Nutritional Status: Methodological Issues. *Journal of Dentistry*, **37**, 237-249. <https://doi.org/10.1016/j.jdent.2008.12.003>
- [32] Lee, J.S., Weyant, R.J., Corby, P., Kritchevsky, S.B., Harris, T.B., Rooks, R., *et al.* (2004) Edentulism and Nutritional Status in a Biracial Sample of Well-Functioning, Community-Dwelling Elderly: The Health, Aging, and Body Composition Study. *The American Journal of Clinical Nutrition*, **79**, 296-303. <https://doi.org/10.1093/ajcn/79.2.295>
- [33] Hamada, Y., Kashima, H. and Hayashi, N. (2014) The Number of Chews and Meal Duration Affect Diet-Induced Thermogenesis and Splanchnic Circulation. *Obesity*, **22**, E62-E69. <https://doi.org/10.1002/oby.20715>
- [34] Morton, G.J., Cummings, D.E., Baskin, D.G., Barsh, G.S. and Schwartz, M.W. (2006) Central Nervous System Control of Food Intake and Body Weight. *Nature*, **443**, 289-295. <https://doi.org/10.1038/nature05026>
- [35] Sakata, T., Yoshimatsu, H. and Kurokawa, M. (1997) Hypothalamic Neuronal

- Histamine: Implications of Its Homeostatic Control of Energy Metabolism. *Nutrition*, **13**, 403-411. [https://doi.org/10.1016/s0899-9007\(97\)91277-6](https://doi.org/10.1016/s0899-9007(97)91277-6)
- [36] Sheiham, A., Steele, J.G., Marcenes, W., Lowe, C., Finch, S., Bates, C.J., *et al.* (2001) The Relationship among Dental Status, Nutrient Intake, and Nutritional Status in Older People. *Journal of Dental Research*, **80**, 408-413. <https://doi.org/10.1177/00220345010800020201>
- [37] Woo, H.G., Chang, Y., Lee, J.S. and Song, T. (2021) Tooth Loss Is Associated with an Increased Risk of Hypertension: A Nationwide Population-Based Cohort Study. *PLOS ONE*, **16**, e0253257. <https://doi.org/10.1371/journal.pone.0253257>
- [38] Taguchi, A., Sanada, M., Sueti, Y., Ohtsuka, M., Lee, K., Tanimoto, K., Tsuda, M., Ohama, K., Yoshizumi, M. and Higashi, Y. (2004) Tooth Loss Is Associated with an Increased Risk of Hypertension in Postmenopausal Women. *Hypertension*, **43**, 1297-1300. <https://doi.org/10.1161/01.HYP.0000128335.45571.ce>
- [39] Darnaud, C., Thomas, F., Pannier, B., Danchin, N. and Bouchard, P. (2015) Oral Health and Blood Pressure: The IPC Cohort. *American Journal of Hypertension*, **28**, 1257-1261. <https://doi.org/10.1093/ajh/hpv025>
- [40] Dar-Odeh, N., Borzangy, S., Babkair, H., Farghal, L., Shahin, G., Fadhalmawla, S., *et al.* (2019) Association of Dental Caries, Retained Roots, and Missing Teeth with Physical Status, Diabetes Mellitus and Hypertension in Women of the Reproductive Age. *International Journal of Environmental Research and Public Health*, **16**, Article 2565. <https://doi.org/10.3390/ijerph16142565>
- [41] Shin, H. (2018) Association between the Number of Teeth and Hypertension in a Study Based on 13,561 Participants. *Journal of Periodontology*, **89**, 397-406. <https://doi.org/10.1002/jper.17-0413>
- [42] Völzke, H., Schwahn, C., Dörr, M., Schwarz, S., Robinson, D., Dören, M., *et al.* (2006) Gender Differences in the Relation between Number of Teeth and Systolic Blood Pressure. *Journal of Hypertension*, **24**, 1257-1263. <https://doi.org/10.1097/01.hjh.0000234104.15992.df>
- [43] Al-Ahmad, B.E.M., Kashmoola, M.A., Mustafa, N.S., Hassan, H. and Arzmi, M.H. (2018) The Relationship between Tooth Loss, Body Mass Index, and Hypertension in Postmenopausal Female. *European Journal of Dentistry*, **12**, 120-122. [https://doi.org/10.4103/ejd.ejd\\_322\\_17](https://doi.org/10.4103/ejd.ejd_322_17)
- [44] Hosadurga, R., Kyaw Soe, H., Peck Lim, A., Adl, A. and Mathew, M. (2020) Association between Tooth Loss and Hypertension: A Cross-Sectional Study. *Journal of Family Medicine and Primary Care*, **9**, 925-932. [https://doi.org/10.4103/jfmpc.jfmpc\\_811\\_19](https://doi.org/10.4103/jfmpc.jfmpc_811_19)
- [45] Del Pinto, R., Pietropaoli, D., Munoz-Aguilera, E., D'Aiuto, F., Czesnikiewicz-Guzik, M., Monaco, A., *et al.* (2020) Periodontitis and Hypertension: Is the Association Causal? *High Blood Pressure & Cardiovascular Prevention*, **27**, 281-289. <https://doi.org/10.1007/s40292-020-00392-z>
- [46] Singh, A., Gupta, A., Peres, M.A., Watt, R.G., Tsakos, G. and Mathur, M.R. (2015) Association between Tooth Loss and Hypertension among a Primarily Rural Middle Aged and Older Indian Adult Population. *Journal of Public Health Dentistry*, **76**, 198-205. <https://doi.org/10.1111/jphd.12136>
- [47] Peres, M.A., Tsakos, G., Barbato, P.R., Silva, D.A.S. and Peres, K.G. (2012) Tooth Loss Is Associated with Increased Blood Pressure in Adults—A Multidisciplinary Population-Based Study. *Journal of Clinical Periodontology*, **39**, 824-833. <https://doi.org/10.1111/j.1600-051x.2012.01916.x>
- [48] Ayo-Yusuf, O.A. and Ayo-Yusuf, I.J. (2008) Association of Tooth Loss with

- Hypertension. *South African Medical Journal*, **98**, 381-385.
- [49] Mendes, J.J., Viana, J., Cruz, F., Pereira, D., Ferreira, S., Pereira, P., *et al.* (2021) Blood Pressure and Tooth Loss: A Large Cross-Sectional Study with Age Mediation Analysis. *International Journal of Environmental Research and Public Health*, **18**, Article 285. <https://doi.org/10.3390/ijerph18010285>
- [50] Da, D., Wang, F., Zhang, H., Zeng, X., Jiang, Y., Zhao, Q., *et al.* (2019) Association between Tooth Loss and Hypertension among Older Chinese Adults: A Community-Based Study. *BMC Oral Health*, **19**, Article No. 277. <https://doi.org/10.1186/s12903-019-0966-3>
- [51] Xu, K., Yu, W., Li, Y., Li, Y., Wan, Q., Chen, L., *et al.* (2022) Association between Tooth Loss and Hypertension: A Systematic Review and Meta-Analysis. *Journal of Dentistry*, **123**, Article 104178. <https://doi.org/10.1016/j.jdent.2022.104178>
- [52] World Health Organization (2020) Oral Health. <https://www.who.int/news-room/fact-sheets/detail/oral-health>
- [53] Machado, V., Aguilera, E.M., Botelho, J., Hussain, S.B., Leira, Y., Proença, L., *et al.* (2020) Association between Periodontitis and High Blood Pressure: Results from the Study of Periodontal Health in Almada-Seixal (Sophias). *Journal of Clinical Medicine*, **9**, Article 1585. <https://doi.org/10.3390/jcm9051585>