Open Journal of Nephrology, 2026, 16(3), 321-333
https://www.scirp.org/journal/ojneph
ISSN Online: 2164-2869
ISSN Print: 2164-2842

# Physiological Effects of Sauna on Renal and Cardio-Circulatory Functions: A Study Conducted in Six Sauna Facilities in the City of Bujumbura, Burundi

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**How to cite this paper:** Nyandwi, J., Gaturagi, C., Iradukunda, A. and Nyabenda, J.B. (2026) Physiological Effects of Sauna on Renal and Cardio-Circulatory Functions: A Study Conducted in Six Sauna Facilities in the City of Bujumbura, Burundi. *Open Journal of Nephrology*, **16**, 321-333.
https://doi.org/10.4236/ojneph.2026.163029

**Received:** June 11, 2026
**Accepted:** July 19, 2026
**Published:** July 22, 2026



## Abstract

**Introduction:** Sauna bathing is well known for its cardiovascular and metabolic effects. However, limited data exist on its physiological impact in sub-Saharan Africa, particularly in Burundi. This study aims to evaluate the physiological effects of sauna baths on renal and cardio-circulatory functions. **Methods**: A cross-sectional study was conducted among users of six sauna facilities in Bujumbura. Characteristics of the sauna facilities were documented. Anthropometric, sociodemographic, cardiovascular (blood pressure, heart rate), and renal parameters (urea, creatinine) were measured before and after a sauna session. Collected physiological parameters were statistically analyzed using Student's t-test or Wilcoxon test to compare paired means. The chi-square test and Welch's test were used to assess associations and to compare means between independent groups, respectively. Statistical significance was set at $p < 0.05$. **Results**: Six sauna rooms were assessed and showed limited surface area, poor ventilation, and exclusive use of wood heating. Forty-nine participants, predominantly male, were included. Sauna exposure led to a significant decrease in mean arterial pressure ($p = 0.027$), whereas systolic and diastolic blood pressures showed non-significant reductions. Heart rate tended to increase slightly, while body weight did not significantly vary. Renal and hematological parameters remained stable, with no significant changes in creatinine, urea, hemoglobin, platelets, or leukocytes. **Conclusions**: Findings suggest that sauna exposure was associated with a mild acute cardiovascular effect characterized by reduced mean arterial pressure, while renal and hematological functions remained stable, suggesting that short-term sauna use is generally well tolerated in healthy individuals. This indicates that, under the conditions of this study, a single sauna session did not result in acute alterations of either cardiac or renal parameters. However, inadequate temperature control and lack of health education may expose users to potential risks, especially those with comorbidities. Further longitudinal and multicenter studies are required to assess the chronic effects of sauna baths.

## Keywords

Sauna, Cardiovascular Function, Renal Function, Blood Pressure, Burundi

## 1. Introduction

The sauna, also known as the Finnish bath, is a traditional practice that has been carried out mainly in Finland for nearly 2000 years. It is characterized by dry air and high temperatures. It consists of repeated short, and occasionally long, exposure to a hot environment with temperatures ranging from 70˚C to 100˚C. Sauna baths are no longer limited to Nordic countries but have become popular worldwide [1]. In Burundi, sauna practice is especially common in the city of Bujumbura.

There are different types of saunas, such as smoke or underground saunas. The modern sauna consists of a room made mainly of untreated wood, with structures for lying down or sitting, and a heater containing stones. The room measures at least 3 $m^2$ to ensure a proper balance of heat, humidity, and ventilation. The temperature ranges between 70˚C and 100˚C, with the optimal range being around 80˚C to 90˚C at the user's face level and about 30˚C at floor level. Air humidity is usually between 10% and 20%, but it can be temporarily increased by bursts of steam generated when water is poured onto hot stones. Drainage is ensured through the floor. Ventilation must be effective, with frequent air changes (3 to 8 times per hour). A sauna bath consists of a series of short stays inside the sauna lasting from 5 to 20 minutes, depending on the user's tolerance and comfort, interspersed with cooling periods (shower, swimming in cold water, outdoor exposure, or resting in a room at ambient temperature) [2].

The sauna induces acute physiological changes in renal and cardiac function [3]. Profuse sweating appears rapidly, with an average water loss of about 0.5 to 1 liter. Cutaneous blood flow increases, while visceral and muscular blood flow decreases. Renal blood flow decreases by 0.4 L/min. Cardiac output rises along with heart rate. The effects of the sauna on blood pressure are variable. Conversely, cold exposure after leaving the sauna stimulates the sympathetic nervous system, causing cutaneous vasoconstriction, a decrease in heart rate, and an increase in blood pressure. Skin temperature drops to around 33˚C, but core temperature remains stable.

Within hours after the sauna session, cardio-circulatory function returns to baseline. Fluid loss is compensated by oral hydration after the session [4].

The study aimed to assess the physiological effects of sauna exposure on cardiovascular and renal parameters in apparently healthy adults.

# 2. Methods

## 2.1. Study Design and Settings

This was a multicenter, prospective, pre-post observational study conducted in March 2020 in sauna facilities in the city of Bujumbura, Burundi. All outcome variables were measured during a single study visit, immediately before and immediately after one sauna session.

At the time of the study, the city of Bujumbura was administratively divided into three communes: Muha, Mukaza, and Ntahangwa. These communes hosted a total of 17 sauna facilities, distributed as follows: 3 in Muha, 11 in Mukaza, and 3 in Ntahangwa.

## 2.2. Sampling Methods

### 2.2.1. Sauna Facilities

A stratified two-stage sampling design was used. In the first stage, all three communes of Bujumbura were included as sampling strata. In the second stage, sauna facilities were selected proportionally to the number of facilities available in each commune. Based on the total of 17 facilities, six sauna facilities were selected by simple random sampling while maintaining proportional representation across communes.

The number of facilities selected in each commune was calculated as follows:

$$ni = \left(Ni/N\right)n$$

Where:

- $ni$ = number of facilities selected in commune $i$;
- $Ni$ = total number of facilities in commune $i$;
- $N$ = Total number of facilities in Bujumbura;
- $n$ = Total number of selected facilities.

Accordingly, one facility was selected from Muha, four from Mukaza, and one from Ntahangwa, yielding a total of six participating facilities.

### 2.2.2. Selection of Participants

The source population consisted of all adults attending sauna sessions in the six selected facilities during the study period (N = 65).

The minimum sample size was calculated using Cochran's finite population correction formula with a 95% confidence level, a margin of error of 5%, and a conservative expected proportion of 50%, yielding a required sample size of 49 participants.

The number of participants recruited from each facility was determined using probability proportional to size (PPS) allocation according to the number of users attending each facility during the study period. Within each selected facility, participants were selected by simple random sampling until the required number was reached.

The number of participants selected from each facility was calculated as follows:

$$ni = n \left( Ni/N \right)$$

Where:

- $ni$ = number of participants selected from facility i;
- $n$ = total sample size;
- $Ni$ = number of sauna users in facility i;
- $N$ = total source population.

The final distribution of participants was as follows:

**Table 1.** Distribution of participants.

| Facility | Commune | Number of sauna users (Ni) | Sampling fraction (Ni/N) | Selected participants ni |
|---|---|---|---|---|
| **A** | Muha | 4 | 0.06 | 3 |
| **B** | Mukaza | 5 | 0.08 | 4 |
| **C** | Mukaza | 20 | 0.31 | 15 |
| **D** | Mukaza | 16 | 0.24 | 12 |
| **E** | Mukaza | 4 | 0.06 | 3 |
| **F** | Ntahangwa | 16 | 0.24 | 12 |
| **Total** | | **65** | **1** | **49** |

Thus, the final study sample consisted of 49 participants distributed proportionally across the six selected sauna facilities: 3 participants from Facility A, 4 from Facility B, 15 from Facility C, 12 from Facility D, 3 from Facility E, and 12 from Facility F (see Table 1).

#### 2.2.3. Eligibility Criteria

Eligible participants were adults aged 18 years and older who attended a sauna session during the study period and provided written informed consent.

Individuals were excluded if they had a known history of uncontrolled hypertension, chronic kidney disease, cardiovascular disease, acute febrile illness, severe dehydration, or any medical condition contraindicating sauna exposure. Pregnant women and individuals receiving medications that could substantially affect blood pressure, cardiovascular function, fluid balance, or renal function (including antihypertensive drugs, diuretics, and nephrotoxic medications) were also excluded. These criteria were applied to ensure that the study population represented apparently healthy sauna users and to minimize confounding effects on the physiological outcomes under investigation.

### 2.3. Clinical and Laboratory Examination

For each participant, clinical and laboratory assessments were performed twice during a single visit: immediately before entering the sauna and immediately after completion of the sauna session.

At baseline, demographic characteristics and relevant medical history were recorded. Clinical measurements included systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), and body weight. Venous blood samples were collected for complete blood count, serum creatinine, and blood urea measurements. The same assessments were repeated immediately after sauna exposure.

Mean arterial pressure was calculated using Lian's formula:

$$\text{MAP} = \left(\text{SBP} + 2 \times \text{DBP}\right)/3,$$

where:

- -MAP = mean arterial pressure;
- -SBP = systolic blood pressure;
- -DBP = diastolic blood pressure.

The MAP was interpreted as follows:

70 - 110 mmHg: Normal range in adults

≥65 mmHg: Minimum acceptable perfusion pressure for vital organs

<65 mmHg: May indicate inadequate tissue perfusion or shock

>110 mmHg: May suggest significant hypertension

Blood pressure (BP) and heart rate (HR) were measured automatically using a JZIKI device (JZK-002R). BP was considered normal if 130/85 mmHg, low if < 120/80 mmHg, and high if > 140/90 mmHg. The values of HR were considered normal if 60 - 100 beats per minute (bpm), low if < 60 bpm, and high if > 100 bpm.

Laboratory analyses were performed at the University Teaching Hospital of Kamenge. For creatinine, the considered normal values were 62 - 115 µmol/L for men and 53 - 97 µmol/L for women. Regarding urea, the normal value was 2.5 to 7.8 mmol/L, and for hemoglobin, it was 13.5 - 17.5 g/dL for men and 12 - 15.5 g/dL for women.

Although clinical measurements were obtained for all 49 participants, complete paired laboratory data were available for only 28 participants, because some post-sauna blood samples could not be obtained or were unsuitable for laboratory analysis.

### 2.4. Sauna Exposure

Information regarding sauna exposure was collected for each participant, including total duration of sauna use, type of session (continuous or intermittent), number of heat cycles, duration of heat and rest periods, fluid intake during the session, and subjective appreciation of sauna use. Characteristics of each sauna facility were also documented, including room surface area, ventilation system, construction materials, heating method, and available equipment.

### 2.5. Data Collection and Statistical Analysis

Data were collected using a pre-tested standardized form by trained investigators.

Because all clinical and laboratory outcomes were measured immediately before and after a single sauna session, paired analyses were performed.

Continuous variables were summarized as means ± standard deviations for normally distributed data and as medians with interquartile ranges (IQR) for non-normally distributed data. Normality was assessed using the Shapiro-Wilk test.

For paired comparisons between pre- and post-sauna measurements:

The paired Student's t-test was used for normally distributed continuous variables, including systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR), body weight, serum creatinine, urea, hemoglobin, and hematocrit when the normality assumption was satisfied. The Wilcoxon signed-rank test was used when the distribution of paired differences departed significantly from normality.

For comparisons between males and females, Welch's t-test was used for continuous variables because of unequal sample sizes between sexes and potential heterogeneity of variances. Fisher's exact test was used for categorical variables when expected cell counts were below five; otherwise, the Chi-square test was applied.

All tests were two-sided, and a p-value < 0.05 was considered statistically significant. Statistical analyses were performed using R software version 4.4.3.

### 2.6. Ethical Considerations

The study protocol was approved by the Scientific Committee of the University of Burundi. All participants signed informed consent forms. The study complied with the principles of the Declaration of Helsinki.

## 3. Results

### 3.1. Characteristics of the Study Population

Table 2 noted that a total of 49 sauna users were included in the study, comprising 34 men (69.4%) and 15 women (30.6%), resulting in a male-to-female ratio of 2.3:1. The mean age of participants was 38.36 ± 11.78 years, with men being substantially older than women (42.57 ± 11.24 years vs. 28.87 ± 6.23 years). Similarly, men had a higher mean body weight than women (82.50 ± 11.73 kg vs. 71.66 ± 12.65 kg), resulting in an overall mean weight of 79.18 ± 12.91 kg.

The mean number of heat cycles was three, with an average duration of 3 minutes per cycle. Participants underwent an average of three cooling periods, each lasting approximately 10 minutes. The average fluid intake during a sauna session was 2 liters of water. Sauna room temperatures were not recorded because the facilities were not equipped with thermometers. Frequent sauna use (≥4 sessions/month) was more common among men (61.8%) than women (40.0%), suggesting greater regularity of sauna attendance among male users. The duration of sauna sessions varied across participants. The detailed baseline characteristics of the study population are summarized in Table 2.

**Table 2.** Characteristics of participants at baseline.

| Characteristics | M/F | Total | F | M |
|---|---|---|---|---|
| **Mean age (years)** | 34/15 | 38.36± 11.78 | 28.87 ± 6.23 | 42.57 ± 11.24 |
| **Mean weight (Kg)** | 34/15 | 79.18 ± 12.91 | 71.66 ± 12.65 | 82.50 ± 11.73 |
| **Smokers** | 34/15 | 1 (2.0%) | 0 (0.0%) | 1 (2.9%) |
| **Alcool use** | 34/15 | 29 (59.1%) | 9 (60.0%) | 20 (58.8%) |
| **Medical history** | 34/15 | 26 (53.0%) | 7 (46.6%) | 19 (55.8%) |
| **Knowledge of sauna benefits** | 34/15 | 25 (51.0%) | 8 (53.3%) | 17 (50.0%) |
| **Knowledge of sauna risks** | 34/15 | 9 (18.3%) | 2 (13.3%) | 7 (20.5%) |
| **Managers** | 34/15 | 6 (12.2%) | 5 (33.3%) | 1 (2.9%) |
| **Self documentation** | 34/15 | 13 (26.5%) | 4 (26.6%) | 9 (26.%7) |
| **Friends** | 34/15 | 19 (38.7%) | 6 (40.0%) | 13 (38.2%) |
| **Frequency per month** | 34/15 | | | |
| **1** | | 10 (20.4%) | 4 (26.6%) | 6 (17.6%) |
| **2 - 3** | | 12 (24.4%) | 5 (33.3%) | 7 (20.6%) |
| **≥ 4** | | 27 (55.1%) | 6 (40.0%) | 21 (61.8%) |
| **Duration of the session (minutes)** | 34/15 | | | |
| **≤20** | | 11 (22.5%) | 3 (20.0%) | 8 (23.5%) |
| **20 - 39** | | 26 (53.1%) | 10 (66.6%) | 16 (47.1%) |
| **40 - 59** | | 7 (14.3%) | 1 (6.7%) | 6 (17.7%) |
| **≥60** | | 5 (10.2%) | 1 (6.7%) | 4 (11.8%) |

M = male; F = female.

In Table 3, cardiac parameters showed no statistically significant differences between males and females. Regarding renal parameters, serum creatinine was significantly higher in males compared to females ($p < 0.05$), while urea levels showed a borderline, non-significant trend toward higher values in males ($p = 0.056$).

**Table 3.** Cardiac and renal functions at baseline.

| Characteristics | (M/F) | Total | F | M | P-value |
|---|---|---|---|---|---|
| | | | **Cardiac function** | | |
| HR | 34/15 | 80.75 ± 12.49 | 83.33 ± 12.32 | 79.52 ± 12.71 | 0.317 |
| SBP | 34/15 | 128.06 ± 15.77 | 122.44 ± 16.2 | 127.74 ± 15.7 | 0.428 |
| DBP | 34/15 | 83.73 ± 10.47 | 78.88 ± 12.11 | 84.21 ± 9.47 | 0.267 |
| | | | **Renal function** | | |
| Urea | 19/9 | 5.68 ± 2.07 | 4.56 ± 2.00 | 6.21 ± 1.93 | 0.056 |
| Creatinine | 19/9 | 86.21 ± 23.04 | 64.88 ± 8.66 | 96.32 ± 20.69 | <0.05 |

HR: heart rate, SBP: systolic blood pressure, DBP: diastolic blood pressure.

### 3.2. Description of Sauna Facilities

The mean surface area of the visited sauna rooms was 9.7 ± 3.7 $m^2$, with a mean ceiling height of 2.7 ± 0.4 meters. Two-thirds of the facilities lacked windows, and most were built with locally available materials. Firewood was the most frequently used source for heating. Although rooms were not equipped with thermometers, few sauna managers provided water to participants during sessions, and seating arrangements were often basic. A full description of the structural and functional characteristics of the sauna rooms is provided in Table 4.

Table 4. Characteristics of the visited sauna rooms.

| Characteristics | Type | Frequency | Percent |
|---|---|---|---|
| **Construction materials** | Permanent materials | 6 | 100% |
| | Wood | 0 | 0% |
| **Heater type** | Electricity | 0 | 0% |
| | Wood | 6 | 100% |
| **Heating system** | External | 6 | 100% |
| | Internal | 0 | 0% |
| **Thermometer** | Available | 0 | 0% |
| | Absent | 6 | 100% |
| **Water supplier during the session** | Individual | 5 | 83.3% |
| | Sauna manager | 1 | 16.7% |
| **Seating** | Benchs | 6 | 100% |
| | Chairs | 0 | 0% |

### 3.3. Cardiac and Renal Parameters before and after Sauna Use

Cardiovascular analyses included all 49 participants, whereas renal and hematological analyses were restricted to the 28 participants with complete paired laboratory measurements. Regarding cardiovascular parameters, systolic blood pressure, diastolic blood pressure, and heart rate did not change significantly after sauna exposure. However, a small but statistically significant reduction in mean arterial pressure was observed, decreasing from 98.52 ± 3.38 mmHg before sauna exposure to 96.93 ± 3.18 mmHg after the session ($p = 0.027$). The renal function markers remained stable (Table 5).

Table 5. Cardiac and renal parameters before and after sauna sessions.

| Parameter | H/F | N | Before | After | p |
|---|---|---|---|---|---|
| **Cardiac and anthropometric parameters** | | | | | |
| SBP (mmHg) | 34/15 | 49 | 128.08± 4.80 | 126.71±4.19 | 0.138 |
| DBP (mmHg) | 34/15 | 49 | 83.73± 2.94 | 82.04±2.92 | 0.071 |
| MAP (mmHg) | 34/15 | 49 | 98.52±3.38 | 96.93±3.18 | 0.027 |

**Continued**

| | | | | | |
|---|---|---|---|---|---|
| HR (bpm) | 34/15 | 49 | 78.41± 3.38 | 80.10±3.87 | 0.132 |
| Weight (Kg) | 34/15 | 49 | 79.18± 3.62 | 78.90±30 | 0.128 |
| **Renal and hematological parameters** | | | | | |
| Creatinine (µmol/l) | 19/9 | 28 | 86.21± 8.54 | 86.39±8.03 | 0.687 |
| Urea (mmol/l) | 19/9 | 28 | 5.68±0.77 | 5.68± 0.79 | 0.579 |
| Hemoglobin(g/dl) | 19/9 | 28 | 14.93± 0.66 | 14.89±0.71 | 0.672 |
| Platelets/µl | 19/9 | 28 | 232.46±19.64 | 227.29± 21.26 | 0.766 |
| Leucocytes/µl | 19/9 | 28 | 4.29±0.70 | 4.32± 0.66 | 0.411 |

SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure; MAP = Mean Arterial Pressure; HR = Heart Rate.

## 4. Discussion

This study aimed to explore the physiological effects of a sauna session on cardiocirculatory and renal functions among users of six sauna facilities in Bujumbura. The results provide interesting insights both into the immediate physiological responses to sauna use and the structural characteristics of local facilities.

The characteristics of the sauna rooms showed partial compliance with standard norms, with an average surface area of less than 10 m$^2$, ventilation often missing, and heating exclusively by wood. These factors may influence air quality and heat distribution, and therefore the physiological response of users [4]. The absence of thermometers in all observed facilities is particularly concerning, as it prevents precise control of temperature, an essential factor for both safety and efficacy of sauna sessions [2].

From an anthropometric and sociodemographic perspective, men represented two-thirds of the sample and were older and more corpulent than women. Most participants were unaware of the risks associated with sauna practice, reflecting poor health education, as also reported in other low-income countries [1].

The present study found a statistically significant decrease in mean arterial pressure after sauna exposure, whereas systolic and diastolic blood pressure remained unchanged. This pattern suggests that sauna exposure may induce a modest acute reduction in vascular resistance without producing clinically meaningful changes in conventional blood pressure measurements. Similar transient hemodynamic responses have been reported in previous studies and are generally attributed to heat-induced vasodilation and redistribution of peripheral blood flow [5] [6]. Nevertheless, the magnitude of the observed MAP reduction was small, and therefore the findings should not be interpreted as evidence of a substantial hypotensive effect of sauna use. However, in a literature review on both healthy individuals and patients with heart disease, Ptak *et al.* [6] concluded that sauna use, particularly Waon therapy, helps reduce blood pressure, improve vascular function and myocardial perfusion, decrease symptoms of heart failure, and enhance exercise tolerance among patients. Heart failure patients therefore represent a target population that may derive significant clinical benefits from such approaches. Moreover, some studies suggest that regular sauna use may also have a preventive effect in healthy individuals, protecting them against future development of hypertension [7]. Finally, this finding suggests a mild acute vasodilatory effect of heat exposure, consistent with previous studies reporting transient reductions in vascular resistance following sauna use [6] [8].

From a renal standpoint, no significant changes were observed in urea or creatinine levels, indicating short-term stability of renal function. These findings are consistent with the work of Kunutsor SK *et al.* [9], who showed that well-monitored sauna sessions do not impair renal function nor increase the risk of future chronic kidney disease. However, it is important to note that the studied population was mostly young and without major medical history. In individuals with chronic kidney disease or susceptibility to dehydration, the effects may differ considerably. Indeed, fluid loss from intense sweating may cause hemoconcentration, reduced renal blood flow, or even transient increases in creatinine among sensitive subjects [4]. The absence of significant change in this study could also be explained by rapid rehydration or by the short exposure time. Nevertheless, it should be emphasized that hyperthermia puts the kidneys in a state of vulnerability. As body temperature rises, blood flow is redirected to the skin to promote cooling, thereby diverting blood from internal organs such as the kidneys in order to maintain blood pressure regulation. At the same time, hyperthermia and dehydration increase metabolic demands to conserve fluids and electrolytes. Together, these mechanisms can create a local imbalance between supply and demand, leading to tissue hypoxia potentially damaging to renal tissues. These findings highlight that heat-related hyperthermia may cause subclinical kidney injury, with possible long-term consequences on renal function [10]. Studies with prolonged exposure, longitudinal follow-up, or targeting specific populations are needed to better assess the nephrological implications in the medium and long term [9]. It is well known that sauna users usually ensure adequate hydration during their sessions. Furthermore, although hematological results (hemoglobin, leukocytes, platelets) did not change significantly, this may reflect either a rapid adaptive response or insufficient sensitivity of the tests to detect subtle variations after a single session.

The absence of significant variation in hemoglobin, platelets, leukocytes, and red blood cells indicates that immediate hematological changes remain minimal after a single exposure. This contrasts with some reports of moderate hemoconcentration following heavy sweating, often observed after longer or repeated exposures [11] [12]. Moreover, although the mean weight loss was small and not significant, it can be mainly attributed to acute dehydration due to sweating, as observed in other heat exposure contexts. Post-session rehydration is therefore essential to avoid hydro-electrolytic imbalances.

The modest effect observed on cardiovascular parameters may be related to the moderate duration of sessions and their intermittent nature for most participants. Even a single sauna session provides immediate cardiovascular benefits, reducing arterial stiffness and blood pressure without disturbing electrolytes. This may help explain why regular sauna practice is associated with a reduced risk of cardiovascular events [13]. In more intensive studies, involving several weekly sessions or prolonged exposure, more pronounced effects have been observed, including improved blood pressure profile, heart rate variability, and endothelial function [14]-[16].

Note also that the psychological or subjective impact, not evaluated here, remains an important area for further exploration. Several studies have demonstrated improved well-being, reduced stress, and significant anxiolytic effects after sauna use [17]-[19].

This study has several limitations. The relatively small sample size may have limited the statistical power to detect subtle changes in some physiological and biochemical parameters. The study assessed only the immediate effects of a single sauna session and therefore cannot provide information on long-term cardiovascular or renal outcomes. The sauna exposure was not completely standardized across facilities, as session duration, heat cycles, cooling periods, and environmental conditions may have varied between establishments, potentially introducing exposure heterogeneity. Direct markers of hydration status and electrolyte balance, such as serum sodium, potassium, osmolality, or urine-specific gravity, were not measured. Consequently, the absence of significant changes in serum creatinine and urea should be interpreted cautiously, as subclinical fluid and electrolyte shifts may have occurred without being captured by the available biomarkers. Finally, the study was conducted among apparently healthy sauna users in a single city, which may limit the generalizability of the findings to other populations.

## 5. Conclusion

This study evaluated the acute cardiovascular, renal, and hematological effects of sauna use among adults attending six sauna facilities in Bujumbura. Most sauna facilities showed suboptimal conditions, including inadequate ventilation and the absence of thermometers. Men constituted the majority of participants, and many users were unaware of potential sauna-related health risks. Sauna exposure produced a modest but significant reduction in mean arterial pressure, suggesting transient heat-induced vasodilation. However, systolic and diastolic blood pressure remained unchanged. No significant changes were observed in serum creatinine, urea, hemoglobin, leukocytes, platelets, or red blood cells, indicating short-term physiological stability in healthy individuals. Weight loss after the session was minimal and likely related to mild dehydration. These findings support the short-term safety of sauna use in healthy adults. Nevertheless, individuals with renal disease or a risk of dehydration may require caution. Further large-scale and longitudinal studies are needed to evaluate the long-term cardiovascular, renal, and psychological effects of sauna exposure.

## Funding

This study was funded by the University of Burundi.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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