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Blood pressure fluctuations and the indoor environment

with a highly insulated and airtight model house during the cold winter season

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At cold temperatures, blood vessels constrict to suppress heat dissipation to maintain a constant core body temperature, leading to increased blood pressure (BP). Increased BP affects the increased mortality from cardiovascular disease in cold seasons [1-3]. Umishio et al. conducted a large nationwide survey on home BP and indoor temperatures in Japan, showing that morning systolic BP had significantly higher sensitivity to changes in the indoor temperature [4, 5]. We examined the effect of the indoor environment on BP fluctuations with an automatic BP monitor (A&D TM-2441) during the cold winter season (Mar 3rd to 10th in 2019), both at home and in a highly insulated and airtight model house (Model House; Asahi Kasei Construction Materials Corporation). The indoor environments were recorded by installing data loggers equipped with temperature sensors in various rooms and taking continuous measurements at 10-minute intervals. BP was measured once per hour in the daytime (from 3 or 4 pm to 12 pm and from 6 am to 1 pm) and once every two hours in the nighttime (from 12 pm to 6 am). This study protocol was approved by the Nara Hospital, Kindai University Ethics Committee (No. 527). Four subjects (two couples) (Subject 1-4: 60, 59, 59, 56 years old, respectively) were enrolled, who took no medication for high BP. The room temperature at the home of Subjects 1 and 2 was low. In contrast, the room temperature of the Model House was high and stable throughout the day, even if the outside temperature at nighttime was very low on that day

(Figure 1). The 24-hour BP of Subject 1 tended to be higher in their home than in the Model House [average ± SD (standard deviation) of the systolic BP (mmHg):131 ± 21.7 vs. 120 ± 16.6, diastolic BP (mmHg): 87 ± 14.6 vs. 82 ± 16.4]. Surprisingly, the 24-hour BP of Subject 2 was quite high throughout the day and was extremely higher in their home than in the Model House [systolic BP (mmHg): 171 ± 33.8 vs. 148 ± 22.7, diastolic BP (mmHg): 102 ± 20.4 vs. 88 ± 11.4]. The same trend was observed for Subject 2 in the blood pressure variation (CV) which was defined as SD divided mean BP [CV of the systolic BP (%):19.4 vs. 15.3, diastolic BP (%): 20.0 vs. 13.0]. Compared with that of Subjects 1 and 2, the room temperature at the home of Subjects 3 and 4 was relatively high in the living room, and the BPs of Subjects 3 and 4 tended to be similar in both their home and the Model House [Subject 3: systolic BP (mmHg): 128 ± 14.0 vs. 141 ± 15.3, diastolic BP (mmHg): 93 ± 10.5 vs. 94 ± 9.6; Subject 4: systolic BP (mmHg): 114 ± 11.5 vs. 107 ± 16.2, diastolic BP (mmHg): 70 ± 9.9 vs. 68 ± 8.5.]

To prevent cardiovascular events at home, a suitable indoor thermal environment for BP management should be proposed, especially in the winter season.

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Author contributions: H.N., H.A., H.O., A.I., H.Y.: study design and concept analysis. H.A., H.O.: data collection and support for analysis. H.N. wrote the manuscript. All authors drafted the manuscript and approved the final version for submission.

Compliance with ethical standards

Conflict of interest statement

The Department of Health Development and Medicine is an endowed department supported by Anges, Daicel, and FunPep. Hiroshi Akiyama and Hiroki Otsuka are employees of the Asahi Kasei Construction Materials Corporation. They did not have any additional role in the study for data analysis, the decision to publish, or the description of the results section of manuscript.

References

1. The Eurowinter Group. Cold exposure and winter mortality from ischaemic heart disease, cerebrovascular disease, respiratory disease, and all causes in warm and cold regions of Europe. Lancet 1997; 349:1341–6.
2. Modesti PA, Rapi S, Rogolino A, Tosi B, Galanti G. Seasonal blood pressure variation: implications for cardiovascular risk stratification. Hypertens Res**.** 2018; 41: 475–82.
3. Modesti PA. Season, temperature and blood pressure: a complex interaction. Eur J Intern Med**.** 2013; 24: 604–7.
4. Umishio W, Ikaga T, Kario K, Fujino Y, Hoshi T, Ando S, et al. Cross-Sectional Analysis of the Relationship Between Home Blood Pressure and Indoor Temperature in Winter: A Nationwide Smart Wellness Housing Survey in Japan. Hypertension. 2019; 74:756-66.
5. Umishio W, Ikaga T, Fujino Y, Ando S, Kubo T, Nakajima Y, et al. Disparities of indoor temperature in winter: A cross-sectional analysis of the Nationwide Smart Wellness Housing Survey in Japan. Indoor Air. 2020; 30: 1317-28.

Figure legend

Fig 1. BP and temperature were monitored throughout the day.

(A and B) The indoor temperatures of the home of Subjects 1 and 2, were measured in the different heights of the living room (foot level, 1 m, 1.5 m), which is shown by the red, yellow, and gray lines, and the bedroom (foot level and bed level), which is shown by the light blue and green lines. The temperature in the toilet and bathroom was also measured, shown by the brown, dark gray line. The outdoor temperature is shown as a blue line. (C-F) The systolic BP, diastolic BP and mean BP of Subjects 1 and 2 are shown as dark blue lines (mmHg). The PR (pulse rate) is shown in the orange circle

(bpm). The temperature was also measured by a sensor built into the blood pressure monitor, shown by the purple line. Physical activity was also measured by a sensor built into the blood pressure monitor, shown by the orange line (g/min).