RESEARCH LETTER

Acute hemodynamic effects of salted potato chips in healthy people

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Introduction Sodium chloride (salt) consumption causes water retention and thus affects numerous organs and systems. Excessive dietary salt intake is a risk factor for cardiovascular diseases such as hypertension, left ventricular hypertrophy, heart failure, and stroke.[1-3]

Salt is present in processed and seasoned food, including salty snacks consumed in huge quantities both by children and adults.[3] Frequently, a pack of salted snacks is eaten in a couple of minutes. Although the long-term cardiovascular consequences of excessive salt consumption have been known for years,[1-3] the acute effects of eating salted potato chips on the hemodynamic response in healthy people are unclear. In this physiological study, we assessed the transient hemodynamic response to the intake of salted potato chips by healthy adults.

Patients and methods We enrolled 25 healthy volunteers (15 women) aged at least 19 years who were not taking any medication or using a low sodium diet. The University Ethics Committee approved the study protocol (decision number, 1144/05), and informed consent was obtained from all participants.

Participants abstained from salted snacks for at least 48 hours. During the study, they first rested in the supine position for 20 minutes, and then the noninvasive recording of blood pressure and hemodynamic parameters was started. The first 5 minutes were recorded for the baseline assessment (preingestion). During the next 15 minutes (ingestion), participants ate 110 grams of commercially available salted potato chips (Frito Lay, Poland) containing nearly 2 g of sodium chloride (plus approximately 8 g of proteins, 59 g of carbohydrates, 35 g of fats, and 6 g of plant fibers) and drank 100 ml of water. After the consumption (postingestion), the recording was continued for for 40 minutes.

Beat-to-beat finger systolic blood pressure (SBP), pulse pressure (PP), and the rate pressure product (RPP) were measured by the volume-clamp photoplethysmographic method (Portapres 2, FMS, Enschede, the Netherlands).[4,5] Heart rate (HR), stroke volume (SV), cardiac output (CO), systemic vascular resistance (SVR), and thoracic fluid content (TFC) were measured according to the modified Bernstein formula by cardiac impedance (Niccomo, Medis GmbH, Ilmenau, Germany).[6]

Statistical analysis All continuously measured parameters were averaged for every 5 minutes for the preingestion and postingestion periods. The nonparametric analysis of variance for repeated measures (Friedman test) was used to evaluate the changes in all parameters, and the post-hoc analyses were used to compare measurements from the preingestion with the values recorded 5, 10, 15, 20, 25, 30, 35, and 40 minutes after consumption. The relative maximal changes of all continuous data recorded during the postingestion, compared with the baseline preingestion values, were presented as percentage. A P value of less than 0.05 was considered significant.

Results The median age of participants was 29 years (25th–75th percentiles, 28–32 years); body mass index, 21.9 kg/m^2 (20.3–23.8 kg/m^2); resting brachial SBP, 110.5 mm Hg (105–128 mm Hg); diastolic blood pressure, 61.5 mm Hg (59–66 mm Hg); and HR, 66.5 bpm (57–74 bpm). Except SV, all hemodynamic parameters changed after the consumption of salty chips (FIGURE 1). Compared with the preingestion values, the maximal relative increase was observed for HR (nearly 16%), SBP (9%), PP (17%), RPP (nearly 24%), CO (14%), and TFC (nearly 5%), while the maximal relative reduction was observed in SVR (nearly 22%). The earliest changes triggered by the intake of chips were

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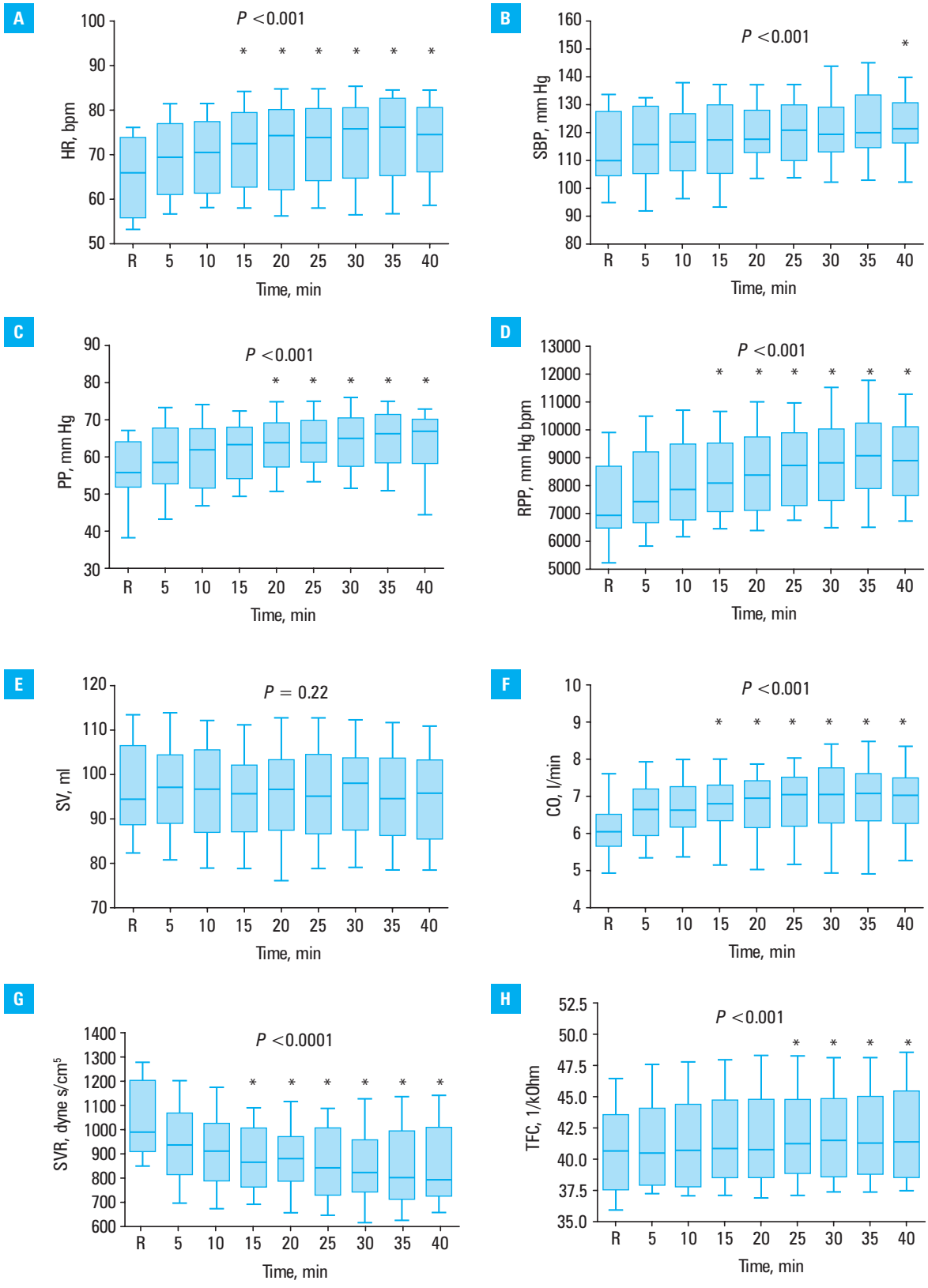

FIGURE 1 Acute changes of the hemodynamic parameters before (R) and after (5–40 minutes) consumption of 110 grams of salted potato chips: **A** – heart rate (HR); **B** – systolic blood pressure (SBP); **C** – pulse pressure (PP); **D** – rate pressure product (RPP); **E** – stroke volume (SV); **F** – cardiac output (CO); **G** – systemic vascular resistance (SVR); **H** – thoracic fluid content (TFC). Asterisks indicate a significant difference in the post-hoc analyses comparing the values measured at rest (R) and a specific point in time after the intake of chips. The box and whisker plots represent quartiles with the median value inside, and the ends of the whiskers represent the 10th and 90th percentiles.

observed after 15 minutes for HR, CO, RPP, and SVR; after 20 minutes for PP; after 25 minutes for TFC; and after 40 minutes for SBP.

Discussion We demonstrated that the consumption of salted potato chips and drinking of only 100 ml of water cause significant acute

hemodynamic changes in healthy individuals: the values of HR, CO, RPP, PP, SBP, and TFC increase, while SVR decreases. It appears that the increase of CO (HR × SV) and RPP (HR × SBP) was caused mainly by HR acceleration, since no significant change was observed for SV or the change was very late for SBP. Compared with CO, the increase of TFC was delayed by 10 minutes. Both CO and TFC depend on the amount of fluid. However, CO reflects mainly changes in the whole intravascular space, while TFC measures alterations in total (ie, intravascular and extravascular) fluid amount but only in the chest. In other words, only TFC reflects alterations in fluid amount in the extravascular compartment. Therefore, a delay between the increase of CO and TFC suggests that salted snacks cause hemodynamic changes first in the intravascular compartment and later in the extravascular space secondary to the shift of water and sodium.

Salted potato chips have diverse ingredients, including proteins, carbohydrates, fats, and salt, which are absorbed from the alimentary tract, transferred into the circulation, and may trigger different hemodynamic effects. In general, different types of meals, for instance rich in proteins, carbohydrates, or fats, cause an increase in CO and HR with a concomitant reduction in blood pressure and SVR.[7-9] Our observations are in line with others for HR, CO, and SVR but different for SBP, which gradually increased. Because the relative content of salt in the 110-g pack of chips is very high (nearly 2 g) and it corresponds to daily requirements for adults, in our opinion, an acute sodium overload within several minutes might overdrive blood pressure reduction observed after eating other nutrients, for example, carbohydrates. The absorption of salt from the alimentary tract leads to a sudden shift of sodium (from the intestines) and water (from both the intestines and extravascular space) to the intravascular space as well as an increase in plasma osmolality.[10,11] The intravascular mobilization of fluid translates into an increased plasma volume. The additional amount of plasma requires extra intravascular space, which leads to the reduction of SVR and more effective cardiac function reflected by an increased HR. A higher HR and gradually increasing SBP also cause a rise in the RPP, which reflects myocardial oxygen and energy consumption.[5]

Our study has some limitations. First, it was an experimental study designed to assess hemodynamic changes and not to search for the potential mechanisms; therefore, most of our physiological considerations are speculations only. Second, although we assume that salt is the main factor responsible for the hemodynamic changes, the potato chips have other active ingredients that contributed to final results, for example, carbohydrates or proteins. Therefore, the observed hemodynamic consequences represent rather a mixed effect of all nutrients, with some dominant influence of salt. One might also speculate that the observed hemodynamic changes were caused by water ingestion and not by the intake of chips.[10,12] However, the participants were allowed to drink only 100 ml of water. Very recently, we have reported a comparison of drinking 500 ml of beer and tap water by healthy people and found that there was no change in SBP even 60 minutes after consumption.[12] Therefore, in our opinion, drinking of 100 ml water had rather negligible physiological effects in our study. Furthermore, we showed the averaged hemodynamic response of all studied participants, but some of the individual responses were different, for example, flat or short-lasting hemodynamic responses (data not shown). This might have been caused by different sodium sensitivity, which determines the blood pressure response to salt consumption.[2,4] To overcome this problem, we used the repeated measures tests in statistical analysis to partially limit the effects of interpersonal differences on final results. Finally, we used indirect hemodynamic measures by cardiac impedance and volume-clamp methods, which are commonly used in physiological and clinical studies. These methods are completely noninvasive and safe and allow for a recording of cardiovascular signals in a continuous way.[4,6]

In summary, the consumption of a 110-gram pack of salted potato chips containing nearly 2 g of sodium chloride triggers several significant acute hemodynamic responses in healthy people, including a significant increase in SBP and retention of water in the extravascular space (increase in TFC).

We hope that this study will contribute to the discussion on the role of excessive sodium in our diet as well as on the effects of dietary behavior, particularly the role of snacking during the day. Although the question of the role of dietary salt intake in hypertension is far from being answered, it seems necessary to underline that the consumption of salted snacks is not without effects on the cardiovascular system. A significant shift in the amount of water in the lungs (increase in TFC) caused by gradual retention of fluids in the extravascular space shows that other organs and tissues may be affected as well. It may partially explain acute hemodynamic decompensation occurring in patients with heart failure, renal failure, or severe hypertension who do not follow the medical recommendations on the dietary restriction of salt intake.[1-3]

ARTICLE INFORMATION

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CONFLICT OF INTEREST None declared.

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