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SHORT COMMUNICATION

A week of *Danjiki* (Buddhist fasting ritual) on cardiometabolic health: a case report

Hirofumi Tanaka[1] · **Tsubasa Tomoto**[2] · **Jun Sugawara**[2]

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Abstract *Danjiki* is an ascetic traditional fasting ritual in the Japanese Buddhism training. Here we present a case of a 48-year-old man who underwent a 1-week-long *Danjiki* fasting ritual in a remote Buddhist temple. The daily ritual consisted of waking up at 3:30 am, hiking strenuously in the steep mountains followed by meditations on the rocks, focused calligraphy of religious drawings and documents, recital of Buddhist prayer chanting, and standing under waterfalls while reciting prayers. He was allowed to drink water ad libitum and a cup of carrot juice a day. After a week of the *Danjiki* ritual, his body weight decreased by 5 kg. Resting metabolic rate did not change. Fasting blood glucose did not change but plasma triglyceride decreased 35 %. There were no changes in blood pressure. Arterial stiffness increased 15–25 % and endothelium-dependent vasodilation decreased 5 %. These results indicate that the *Danjiki* ritual produced significant weight loss but unexpectedly reduced vascular functions.

Keywords Starvation · Lifestyle · Exercise · Religion

✉ Hirofumi Tanaka
htanaka@austin.utexas.edu

[1] Department of Kinesiology and Health Education, The University of Texas at Austin, 2109 San Jacinto Blvd, D3700, 78712 Austin, TX, USA

[2] National Institute of Advanced Industrial Science and Technology, Ibaraki, Japan

Introduction

Lifestyle and dietary modifications are the first-line approaches for the primary and secondary prevention of cardiovascular and metabolic diseases [1]. One such intervention that has been gradually gaining popularity is fasting therapy [2, 3]. Fasting has been an integral part of most religions since ancient times. Among them, *Danjiki* is an ascetic traditional ritual in the Japanese Buddhism training that involves fasting, meditation, and strenuous physical training. It requires substantial mental and physical discipline to fuse mind, body, and spirit in order to attain enlightenment. In recent years, there are a variety of *Danjiki* rituals ranging from short-term (2–3 days long) fasting, protocols that are conducted at a hotel with a clinical supervision, to longer-term (a week or longer) fasting and exercise protocols conducted at a Buddhist temple. There is abundant anecdotal evidence indicating the a variety of benefits of the *Danjiki* ritual, including weight loss, sharpened senses, happiness, and detoxification. However, the rigor and the strenuous nature of the ritual may negate or even antagonize the potential benefits of fasting. In spite of the popularity of this lifestyle modification, there are no research data concerning the effect of the long-term *Danjiki* fasting ritual on adiposity and cardiometabolic health markers. It is unlikely that the research intervention involving this kind of potentially risky Buddhist ritual in a large number of subjects can be approved by the IRB. Accordingly, here we present a case of a 48-year-old man who underwent a 1-week-long *Danjiki* ritual in a remote Buddhist temple. Based primarily on the anecdotal evidence, the working hypothesis was that the Danjiki ritual would result in significant weight loss and improvements in a variety of cardiometabolic risk factors. We reasoned that such findings would provide preliminary data and facilitate future large-scale systematic research studies.

Methods

The subject was a 48-year-old male (HT, one of the authors) who was apparently healthy and recreationally active. He underwent a week of *Danjiki* ritual at a remote Buddhist temple in the mountains where no cell phone or Internet connections were available. The dairy routine consisted of waking-up at 3:30 am, strenuous hiking in the steep mountains followed by meditation on the big rocks (~2 h), calligraphy (hand copying of religious drawings and documents) (~1 h), household chores and various duties within the temple (e.g., thorough cleaning of the temple, collection of sticks and woods for the fire to heat up the bath water), recital of Buddhist prayer chanting (~1 h), standing under waterfalls while reciting/shouting prayers (including ~1 h hiking on the steep mountain to get to and come back from the waterfalls), and going to bed before 9:00 pm. He was allowed to drink water ad libitum and a cup of carrot juice (<90 kcal) a day. Every 3 days, a cup of miso soup was taken instead of carrot juice in order to replenish sodium and other electrolytes.

In order to evaluate the effects of the *Danjiki* ritual, the following measurements were performed before and after the intervention. The measurements were performed in a quiet laboratory setting away from the remote temple. The subject was fasted and well hydrated (judged indirectly by the color of urine, which was clear) prior to the measurements. Body fat percentage was assessed using bioelectrical impedance (HBF-354, Omron Healthcare, Kyoto, Japan). Resting metabolic rate was measured using a metabolic cart (AE300S, Minato Medical Science, Osaka, Japan). Blood glucose, triglyceride, and cholesterol concentrations were analyzed using the Cholesterol/Glucose Analyzer (Techno Medica Co., Kanagawa, Japan). Blood pressure, pulse wave velocity (PWV) (an index of arterial stiffness), and ankle-brachial index (an index of peripheral artery disease) were measured using the vascular screening device (VP-1000plus, Omron Healthcare, Kyoto, Japan) [4, 5]. Measures of arterial compliance (cross-sectional arterial compliance, ß-stiffness index) were determined via simultaneous application of carotid artery tonometry (VP-1000plus, Omron Healthcare, Kyoto Japan) and ultrasound imaging on the contralateral carotid artery (CX50 xMatrix, Philips Ultrasound, Bothell, WA) [5]. Flow-mediated dilation (FMD), an index of endothelium-dependent vasodilation, was assessed using the ultrasound machine (CX50 xMatrix, Philips Ultrasound, Bothell, WA) [5]. FMD normalized for shear stress was also presented [6]. Beat-to-beat heart rate and radial artery blood pressure data were collected on electrocardiogram (Bio-Amps, ADInstruments, Nagoya, Japan) and tonometry blood pressure monitor (JENTOW, Nihon Colin Co., Komaki, Japan), and hearty rate and blood pressure variability was analyzed using DADiSP software (Newton, MA, USA). Respiratory rates were standardized before and after the intervention. The coefficients of variation for two trials were 5 % for cfPWV, 3 % for faPWV, 4 % for baPWV, 3 % for ankle-brachial index, and 5 % for arterial compliance and ß-stiffness index.

Results

After a week of the *Danjiki* ritual, body mass was reduced by 5.0 kg without any change in body fat percentage (Table 1). Resting metabolic rate did not change but respiratory exchange ratio declined. Fasting blood glucose did not change but plasma triglyceride decreased 35 %. There were no appreciable changes in blood pressure. Arterial stiffness, as estimated by carotid-femoral PWV, increased 15 %. ß-stiffness index increased 24 %. Endothelium-dependent vasodilation as assessed by normalized FMD decreased 5 %. Low frequency power of systolic blood pressure variability, an index of sympathetic-adrenergic vasoconstrictor tone, increased 21 %.

Discussion

In the present case report, after a week of the *Danjiki* ritual that included fasting and strenuous hiking, the subject lost 5 kg of body weight. However, body fat percentage did not decrease and most of the decreased body weight came from lean body mass. This may be rather surprising, especially when respiratory exchange ratio decreased slightly, suggesting that fat oxidation increased, but the present finding is consistent with the previous observation that in general, fasting results in minimal loss of fat tissue compared with other forms of weight loss interventions and is accompanied by rather substantial loss of lean tissue [7]. These findings do have important implications for those people who are undergoing a fasting ritual for weight loss purposes. Most individuals participating in the *Danjiki* ritual may attribute the weight loss to fat mass loss but this may not be so.

To the best of our knowledge, this is the first clinical study (albeit a case report) investigating the influence of the *Danjiki* fasting ritual on health outcomes. Studies on simple organisms and animals demonstrated beneficial impact of fasting [3], while a limited number of human studies remain highly controversial. In order to capture potential changes induced by the short-term fasting ritual of *Danjiki*, we selected and utilized robust indicators of vascular functions. In marked contrast to the anecdotal evidence, most of the vascular functions assessed in the

Table 1 Changes in physiological characteristics with the *Danjiki* Buddhist ritual: a case of a 48-year-old man

	Pre	Post
Physical characteristics		
Height (cm)	177	–
Body weight (kg)	83.7	78.7
BMI (kg/m^2)	26.6	25.4
Body fat (%)	24.4	25.8
Resting metabolic rate		
VO_2 (ml/min)	249	265
VCO_2 (ml/min)	239	236
RER	0.95	0.89
Blood chemistry		
Total cholesterol (mg/dl)	238	257
LDL cholesterol (mg/dl)	157	144
Triglyceride (mg/dl)	219	141
Glucose (mg/dl	74	74
Blood pressure		
Brachial SBP (mmHg)	114	114
Brachial DBP (mmHg)	74	75
Brachial PP (mmHg)	40	39
Carotid SBP (mmHg)	95	98
Carotid PP (mmHg)	29	31
Cardiac function		
Heart rate (bpm)	70	63
PEP (ms)	83	92
ET (ms)	285	272
ET/PEP	3.4	3.0
Heart rate and blood pressure variability		
LF power RRI	27133	23963
HF power RRI	9102	7852
Total power RRI	57867	90684
LF power SBP	326	396
HF power SBP	45	118
Total power SBP	1022	1029
Arterial function		
cfPWV (cm/s)	824	949
faPWV (cm/s)	960	1030
baPWV (cm/s)	1344	1489
Ankle-brachial index	1.12	1.13
FMD (%)	10.8	11.6
Normalized FMD (%)	4.1	3.9
CS compliance (mm^2/mmHg)	0.17	0.13
β-stiffness index (U)	4.46	5.51

BMI body mass index, *VO_2* oxygen consumption, *VCO_2* carbon dioxide production, *RER* respiratory exchange ration, *SBP* systolic blood pressure, *DBP* diastolic blood pressure, *PP* pulse pressure, *PEP* left ventricular pre-ejection period, *ET* left ventricular ejection time, *LF* low frequency, *HF* high frequency, *RRI* R–R interval, *cfPWV* carotid-femoral pulse wave velocity, *faPWV* femoral-ankle pulse wave velocity, *baPWV* brachial-ankle pulse wave velocity, *FMD* flow-mediated dilation, *CS* cross-sectional

present study became worse or less favorable after the *Danjiki* fasting ritual. One of the hypothesized physiological mechanisms of fasting is hormesis. That is, fasting triggers adaptive stress responses, which would result in favorable cellular and molecular adaptations that can combat disease processes [3]. Indeed, such stress resistance mechanisms can be fostered by diverse environmental factors, including physical exercise and low levels of toxins [8]. Undoubtedly, fasting can also be such a factor, but it is possible that the rigorous and strenuous daily routine in the Buddhist ritual may have placed too much stress on non-Buddhist monks, analogous to some naive athletes experiencing the overtraining syndrome in the beginning of the competitive season [9] or during intensive training camps [10]. Indeed, the spectral analyses of blood pressure variability indicate that low-frequency power of systolic blood pressure variability, which reflects sympathetic-adrenergic vasomotor tone, was elevated at the end of the *Danjiki* ritual. A previous study that assessed 3 days of fasting in humans also reported an increase in plasma catecholamine levels [11]. Most vascular functions can be modulated by the contractile state of smooth muscle cells in the arterial walls, and increased alpha-adrenergic tone and reduced nitric oxide bioavailability can reduce vascular function via influences on vasoconstrictor tone [12].

At the first glance, increased sympathetic nerve activity as assessed by blood pressure variability appears to conflict with the reduction in heart rate (often accompanied by an increase in sympathetic nervous system activity) observed in the present study. However, this may not be surprising for a few reasons. Studies using the norepinephrine spillover techniques have demonstrated that sympathetic nervous system responses are regionally regulated, with activation in one regional outflow sometimes accompanying no change or even sympathetic inhibition in another region [13]. In a recent study, heart rate was not significantly related to vasoconstrictor activity as assessed by muscle sympathetic nerve activity [14]. The investigators' hypothesized explanation is that as muscle sympathetic bursts are cardiac cycle-dependent, a given burst will be likely to have a longer duration (and more noradrenaline release) during longer cardiac cycles (slower heart rates) than in shorter cardiac cycles (faster heart rates).

One of the major limitations of the present study is that it is not possible to tease out the influence of fasting, physical training, and religious meditation in the overall *Danjiki* ritual. However, this experimental design is also a strength of the study, as more people have been and will be following such multi-modality rituals, so the results should be more generalizable to larger populations. Additionally, to the best of our knowledge, there have not been systematic studies investigating the effects of prolonged fasting alone or religious meditation on arterial function. There

are a number of different fasting rituals in the Japanese Buddhist training. The idea behind this practice is that by bringing monks closer to death, they would develop extraordinary power of all senses in the path to enlightenment. However, it will be difficult to obtain IRB approval to conduct large-scale fasting interventions, including the present study, especially when starvation is associated with a number of serious complications, including lactic acidosis and ventricular fibrillation [15].

In summary, the present case report indicated that the Japanese Buddhist ritual of *Danjiki* for a week resulted in a loss of 5 kg of body weight without any reduction in body fatness. Plasma triglyceride level decreased but there were no other reductions in plasma cholesterol concentrations. Key vascular functions decreased to unfavorable directions accompanied by the elevations in sympathetic-adrenergic vascular tone. These results indicate that the *Danjiki* ritual would produce favorable effects on weight loss and some metabolic profile but could also induce unfavorable influences on vascular functions. The present case report does not support the notion that the fasting ritual of *Danjiki* will result in a number of health benefits. Clinical supervision during the fasting ritual may also be recommended for those who have compromised cardiovascular and physical functions.

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Compliance with ethical standards

Conflict of interest None of the authors has any conflicts of interest to report.

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