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Short Communication

Association of Self-Selected Hydrogen-Rich Water Consumption with 6-Month Changes in Chair-Stand Performance and Gait Speed among Community-Dwelling Older Adults Attending Community Salons

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Abstract

To examine whether self-selected hydrogen-rich water consumption was associated with 6-month changes in physical function among community-dwelling older adults attending community salons. This prospective observational study included 128 older adults in Hiroshima, Japan. Participants were classified as consumers or non-consumers at baseline and completed repeated assessments of the 30-second chair stand test, Timed Up and Go, usual gait speed, one-leg stance time, and grip strength. Primary analyses used analysis of covariance with robust standard errors, adjusting for baseline value, age, sex, fall history, and walking-aid use; mixed-effects and overlap-weighted models were sensitivity analyses. Compared with non-consumers, consumers had better adjusted 6-month chair-stand performance (1.85 repetitions, 95% confidence interval 1.11 to 2.59), gait speed (0.07 m/s, 0.04 to 0.10), one-leg stance time (1.78 s, 0.43 to 3.13), and grip strength (0.80 kg, 0.21 to 1.40). Timed Up and Go did not clearly differ (-0.39 s, -1.23 to 0.45). Self-selected hydrogen-rich water consumption was associated with better chair-stand performance and gait speed in this pragmatic community setting, but residual confounding remains possible.

Keywords: Hydrogen-rich water, Chair stand test, Gait speed, Community-dwelling older adults, Falls risk

Falls in older adults contribute to disability, institutionalization, and the need for long-term care[1,2]. Lower-extremity strength and gait ability are modifiable determinants of falls and functional decline[3-5]. In Japan, resident-led community salons promote social participation, frailty prevention, and light group exercise among older adults[6]. Hydrogen-rich water has been proposed as a supportive health intervention, but evidence for functional outcomes in older adults remains limited and heterogeneous[7]. Studies in athletes and clinical populations suggest possible effects on fatigue or metabolic markers[8,9], and a six-month randomized pilot in older adults reported changes in aging-related biomarkers and lower-extremity muscle strength[10]. However, fall-relevant performance outcomes in pragmatic community settings remain under-studied. We therefore examined whether self-selected hydrogen-rich water consumption was associated with 6-month changes in physical function among community-dwelling older adults attending community salons.

This prospective observational study was conducted in community salons in Hiroshima City, Japan. Hydrogen-rich water was available within routine salon activities and was not assigned or provided by the research team for

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Variable	Consumers (n=64)	Non-consumers (n=64)	Absolute SMD
Age, years	76.3 ± 5.0	75.5 ± 5.1	0.16
Female, n (%)	45 (70.3%)	37 (57.8%)	0.26
History of falls in past year, n (%)	29 (45.3%)	29 (45.3%)	0.00
Any walking aid (cane or walker), n (%)	21 (32.8%)	18 (28.1%)	0.10
CS-30, repetitions	13.08 ± 3.21	12.53 ± 2.98	0.18
TUG, s	10.90 ± 2.53	11.00 ± 2.52	0.04
Usual gait speed, m/s	0.92 ± 0.24	0.91 ± 0.22	0.04
One-leg stance, s	16.45 ± 12.85	15.47 ± 12.60	0.08
Grip strength, kg	20.70 ± 7.16	22.10 ± 7.46	0.19

Data are presented as mean±SD or n (%). SMD, standardized mean difference; CS-30, 30-second chair stand test; TUG, Timed Up and Go.

Table 1. Baseline characteristics by hydrogen-rich water consumption status (N=128).

Outcome	Consumers Baseline	Consumers 6 months	Non-consumers Baseline	Non-consumers 6 months	Adj. difference (95% CI); P
CS-30, repetitions	13.08 ± 3.21	14.62 ± 4.34	12.53 ± 2.98	12.20 ± 3.35	1.85 (1.11 to 2.59)[a]; P<0.001
TUG, s	10.90 ± 2.53	10.72 ± 4.04	11.00 ± 2.52	11.18 ± 2.59	-0.39 (-1.23 to 0.45); P=0.361
Usual gait speed, m/s	0.92 ± 0.24	0.99 ± 0.25	0.91 ± 0.22	0.91 ± 0.23	0.07 (0.04 to 0.10)[a]; P<0.001
One-leg stance, s	16.45 ± 12.85	17.98 ± 13.32	15.47 ± 12.60	15.17 ± 12.71	1.78 (0.43 to 3.13)[a]; P=0.010
Grip strength, kg	20.70 ± 7.16	20.87 ± 7.39	22.10 ± 7.46	21.49 ± 7.53	0.80 (0.21 to 1.40)[a]; P=0.008

Adjusted differences are from analysis of covariance models for the 6-month value, controlling for corresponding baseline value, age, sex, fall history, and walking-aid use. CI, confidence interval; CS-30, 30-second chair stand test; TUG, Timed Up and Go. [a]P<0.05.

Table 2. Physical function outcomes at baseline and 6 months, with adjusted between-group differences.

research purposes. Participants were 128 Japanese older adults who could complete the assessments and agreed to participate. Individuals with long-term care/support certification, severe cognitive impairment precluding valid assessment, unsafe conditions for testing, or other investigator-judged ineligibility were excluded. At baseline, participants were classified as consumers if they routinely consumed salon-distributed hydrogen-rich water and as non-consumers otherwise. According to product labeling, dissolved hydrogen concentration was approximately 1.05 mg/L, and typical intake among consumers was up to 600 mL/day. This estimate reflects the maximum amount routinely distributed within the salon program (used as an approximate upper bound) and was not based on direct measurement of daily intake volume. The primary outcome was the 30-second chair stand test (CS-30). Secondary outcomes were Timed Up and Go (TUG), usual gait speed, one-leg stance time, and grip strength. All outcomes were assessed at baseline and 6 months. Continuous variables are presented as mean±SD and categorical variables as n (%). Baseline imbalance was described using absolute standardized mean differences. The primary analysis used analysis of covariance for each outcome, with the 6-month value as the dependent variable and consumption group as the main independent variable, adjusting for the corresponding baseline value, age, sex, history of falls in the past year, and walking-aid use. Robust HC3 standard errors were used. Average salon attendance during follow-up was not included because it was a post-baseline measure rather than a baseline confounder. Sensitivity analyses used linear mixed-effects models with group, time, and group×time terms plus a participant-level random intercept, and propensity score overlap-weighted analysis of covariance using the same baseline covariates. Holm-

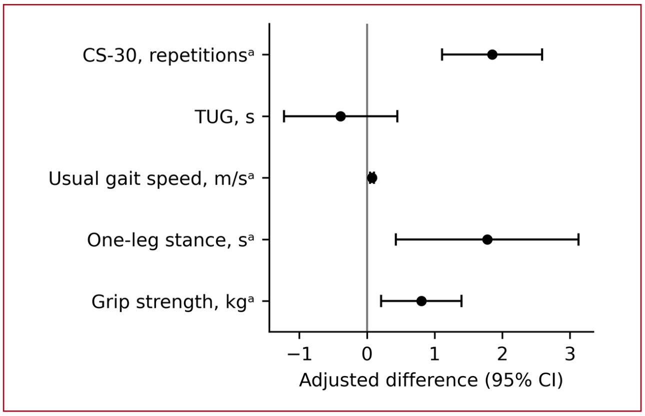

Figure 1. Adjusted between-group differences in physical function outcomes at 6 months. Estimates are from analysis of covariance models for the 6-month value, controlling for the corresponding baseline value, age, sex, history of falls in the past year, and walking-aid use. Positive values favor consumers for CS-30, usual gait speed, one-leg stance, and grip strength; negative values favor consumers for TUG. Error bars show 95% confidence intervals. aP<0.05 for the adjusted between-group difference.

adjusted P values were examined across the five outcomes. No imputation was required because all prespecified outcomes were complete. Analyses were performed in Python 3.13.5.

Consumers and non-consumers included 64 participants each. Baseline characteristics were broadly similar (Table 1). In the primary analysis of covariance, consumers had higher adjusted 6-month CS-30 than non-consumers (difference 1.85 repetitions, 95% confidence interval 1.11 to 2.59; P<0.001) and faster usual gait speed (0.07 m/s, 0.04 to 0.10; P<0.001). Consumers also had higher adjusted one-leg stance time (1.78 s, 0.43 to 3.13; P=0.010) and grip strength (0.80 kg, 0.21 to 1.40; P=0.008). Adjusted TUG did not clearly differ between groups (-0.39 s, -1.23 to 0.45; P=0.361) (Table 2, Figure 1). Mixed-effects and overlap-weighted analyses yielded directionally similar estimates, and findings for CS-30, gait speed, one-leg stance, and grip strength remained significant after Holm correction. Notably, the adjusted gait speed difference (0.07 m/s) exceeded the commonly cited threshold for a small meaningful change (~0.05 m/s) and approached a substantial change (~0.10 m/s) in older adults[11]. The CS-30 difference (1.85 repetitions) was close to the proposed minimum clinically important difference of 2 repetitions for the 30-s sit-to-stand test reported in pulmonary rehabilitation cohorts[12].

The main signal in this pragmatic cohort was seen in chair-stand performance and gait speed, two outcomes closely related to lower-extremity function, mobility, and falls risk[4,5]. These effect sizes suggest potential real-world relevance for mobility and independence in older adults. The concordance of the primary and sensitivity analyses supports internal consistency. The positive findings for one-leg stance and grip strength should be interpreted as supportive rather than definitive because these were secondary outcomes and the study was not randomized. These findings do not establish causality. Hydrogen-rich water use was self-selected, so healthy-user effects and residual confounding remain plausible. Baseline frequency of salon participation and habitual exercise outside the salon were not systematically assessed, so health-conscious behavior differences may remain unmeasured. The close baseline matching of measured performance variables may reflect that all participants were active salon attendees, but it does not preclude self-selection by more health-conscious individuals. Chronic comorbidities, nutritional status, medications, and detailed cognitive function were not comprehensively measured. Nevertheless, molecular hydrogen has been proposed to act as a selective antioxidant and modulate inflammatory pathways[13], providing a plausible framework whereby reduced oxidative stress or improved recovery could support repeated sit-to-stand performance and habitual walking, consistent with prior reports in athletes and older adults[8,10]. Mechanistic interpretation is also limited because intermediate biomarkers were not collected. Exposure classification was based on usual salon-related intake, and actual adherence and hydrogen concentration at the time of consumption were not directly verified. Nevertheless, the study reflects a real-world community setting and used repeated performance-based outcomes directly relevant to frailty and falls prevention. In conclusion, self-selected hydrogen-rich water consumption was associated with better 6-month chair-stand performance and gait speed among community-dwelling older adults attending community salons. Larger studies with stronger control of confounding and preferably randomized or cluster-randomized designs are needed.

Ethics approval

This study was approved by the Chiba University Ethics Committee (Approval No. M846) and was conducted in accordance with the Declaration of Helsinki 1964 and its later amendments.

Consent to participate

The requirement for written informed consent was waived by the ethics committee. The data used were anonymized, and study information was publicly disclosed to provide an opt-out opportunity.

Authors' contributions

Yuusuke Harada conceived the study, curated and analyzed the data, and drafted the manuscript. Michiko Miyakawa contributed to study design, interpretation of the *data, and critical revision of the manuscript. Both authors read and approved the final version of the manuscript.*

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