

## Review

Diana Sunardi\*, Dian Novita Chandra, Bernie Endyarni Medise, Nurul Ratna Mutu Manikam, Dewi Friska, Wiji Lestari and Putri Novia Choiri Insani

# Health effects of alkaline, oxygenated, and demineralized water compared to mineral water among healthy population: a systematic review

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## Abstract

**Objectives:** There are many water types available on the market. They are widely known in public with health claims. The questions are, are those claims scientifically proven or those are just testimonies from the consumers or over-claimed by the producers. This study aims to systematically review evidences on the health effects of alkaline, oxygenated, and demineralized water in comparison with mineral water among healthy population.

**Contents:** Data were obtained from databases PubMed, Cochrane, Scopus, EBSCO, dan Science Direct since January 2000 until July 2022. There were 10 eligible articles, consisted of two articles on alkaline, four articles on oxygenated, and four articles on demineralized water, that furtherly being analyzed.

**\*Corresponding author: Diana Sunardi**, Indonesian Hydration Working Group, Faculty of Medicine Universitas Indonesia, Jakarta, Indonesia; and Department of Nutrition, Faculty of Medicine Universitas Indonesia – Dr. Cipto Mangunkusumo Hospital, Jakarta, Indonesia, E-mail: [diana\\_sunardi@yahoo.com](mailto:diana_sunardi@yahoo.com)

**Dian Novita Chandra, Nurul Ratna Mutu Manikam and Wiji Lestari**, Indonesian Hydration Working Group, Faculty of Medicine Universitas Indonesia, Jakarta, Indonesia; and Department of Nutrition, Faculty of Medicine Universitas Indonesia – Dr. Cipto Mangunkusumo Hospital, Jakarta, Indonesia

**Bernie Endyarni Medise**, Indonesian Hydration Working Group, Faculty of Medicine Universitas Indonesia, Jakarta, Indonesia; and Child Health Department, Faculty of Medicine Universitas Indonesia – Dr. Cipto Mangunkusumo Hospital, Jakarta, Indonesia

**Dewi Friska**, Indonesian Hydration Working Group, Faculty of Medicine Universitas Indonesia, Jakarta, Indonesia; and Occupational Medicine, Department of Community Medicine, Faculty of Medicine Universitas Indonesia, Jakarta, Indonesia

**Putri Novia Choiri Insani**, Indonesian Hydration Working Group, Faculty of Medicine Universitas Indonesia, Jakarta, Indonesia

**Summary:** Compared to consumption of mineral water, consumption of alkaline and oxygenated water did not show any significant difference on gut microbiota, urine pH, blood parameter, or fitness parameter. While, consumption of demineralized water in the long term resulted in lower quality of certain nutrient intake.

**Outlook:** Recent evidences do not prove any additional health effects of alkaline, oxygenated, or demineralized water compared to mineral water. In contrast, demineralized water consumption in the long run was proven to lead to adverse effect.

**Keywords:** alkaline water; demineralized water; health benefit; mineral water; oxygenated water.

## Background

Water is the most abundant component in the human body. Water composed human body in children, adults, and elderly is ranging from 65 to 75%, 55 to 60%, and 50% respectively [1]. Since metabolism only produced a small amount of water, we need to fulfill our water daily requirements from our daily intake, mostly drinking. Dehydration, even in the slightest amount, can affect concentration and cognitive function in children [2–4]. Sufficient amount of water consumption can also lead to mood, feeling, and calm in a positive way [5]. In the long run, inadequate water consumption is proven to be influential in increasing the risk of non-communicable diseases such as urinary tract infection and kidney stones [6, 7]. Pan et al. and Muckelbauer et al. reported that water consumption was a potential protective factor of obesity [8, 9].

Mineral water, alkaline water (AW), oxygen water (OW), and demineralized water (DW) are types of water that are widely known among Indonesians. There were many health benefits claimed by each water company that spread among the general population. For instance, alkaline water can maintain the balance of body and blood pH, while oxygenated water claims to improve physical performance.

The questions are, whether these claims are based on evidence or overclaimed. The objective of this review article is to examine whether the consumption of alkaline water, oxygen water, and demineralized water result have a health benefit and supreme the health benefit of drinking mineral water on healthy population.

## Methods

### Eligibility criteria

Inclusion criteria are studies on healthy population, that compared the benefit of drinking alkaline water, oxygen water, or demineralized water with mineral water. Later, the search will be grouped based on the type of water, so there are three groups that are alkaline water, oxygen water, and demineralized water. Exclusion criteria of the study were including patient or unhealthy people, using water which did not meet the criteria of Indonesia regulation for mineral water, alkaline water, oxygenated water, and demineralized water, and using water in a very little amount for intervention and cannot be considered as drinking water.

### Literature search

Five electronic databases, PubMed, Cochrane, Scopus, EBSCO, and Science Direct, were used to search the studies published in English between January 2000 and July 2022. The search was done by the end of September 2022 for all of the databases. The PICO (Participants, Intervention, Comparators, and Outcomes) model was used to frame the research question.

A number of investigators (DS, DNC, BEM, PNCI, DF, NRMM, and WL) conducted independent literature searches for the title and abstract of the articles for further review based on full-text articles. Each of the studies was reviewed by two reviewers using Microsoft Excel to collect data from the studies. The search strategy represented the concepts of mineral water; alkaline water, oxygen water, demineralized water, and health outcomes.

The SIGN checklist for randomized controlled trials and for case-control and cohort studies was utilized to assess the risk of bias. Studies that lack comparison were excluded from the further review. The effect measured from studies was the change of parameter after intervention between two groups or odd ratio/risk ratio between two groups for observational studies. The GRADE framework was applied to assess the quality of evidence. The comprehensive keywords that were used for searching through databases are shown in Table 1.

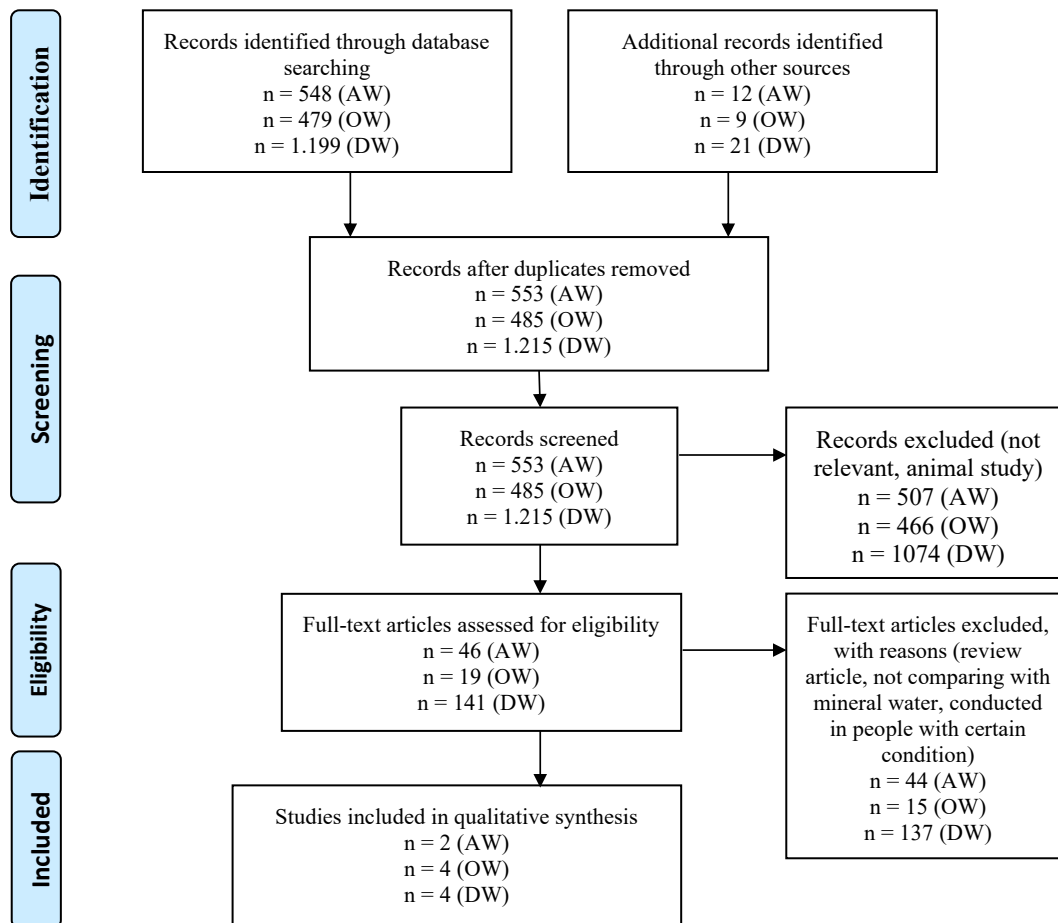
## Results

We worked on a literature search with inclusion and exclusion criteria at each stage using preferred reporting items of systematic reviews and meta-analyses (PRISMA) (Figure 1). There were 2,268 articles identified at the initial search that consisted of 560, 485, and 1,220 articles about

alkaline water (AW), oxygenated water (OW), and demineralized water (DW) respectively. Through other resources and removal of duplicated articles, 2,253 articles in total were

**Table 1:** List of keywords for database searching.

Intervention	Comparison	Outcome
Alkaline water		
“Drinking wa- ter” OR “Bottled water”	AND “Electrolyzed Reduced water” OR “High pH water” OR “Alkaline water”	AND “Health benefit” OR “Health effect” OR “Disease preven- tion” OR “Hydration” OR “Health perfor- mance” OR “Fitness” OR “Wellness”
Oxygenated water		
“Drinking wa- ter” OR “Bottled water”	AND “Oxygen water” OR “Oxygenated water”	AND “Health benefit” OR “Health effect” OR “Disease prevention” OR “Hydration” OR “Health performance” OR “Fitness” OR “Wellness”
Demineralized water		
“Drinking wa- ter” OR “Bottled water”	AND “Demineralized water” OR “Reverse osmosis water” OR “Low mineral water” OR “Low calcium water” OR “Low magnesium water”	AND “Health benefit” OR “Health effect” OR “Disease prevention” OR “Hydration” OR “Health performance” OR “Fitness” OR “Wellness”



**Figure 1:** Study selection flow diagram.

included in the screening step. After being screened, 1,378 articles were excluded because of their irrelevance to the topic or non-human subjects. Out of 259 articles that were eligible for the study, there were 251 studies that were excluded after being assessed through full-text review because they were review articles, the comparison product has not fulfilled the criteria as mineral water, or was conducted among unhealthy people. Furthermore, three studies on alkaline water were excluded because the water pH level was below the criteria of alkaline water [10–12]. Two studies on oxygenated water were excluded because one study used demineralized water as the comparison and the other one only used a small amount of water for intervention, not as drinking water [13, 14]. Thus, this article reports the results of the review on eight studies that consisted of two articles, four articles, and four articles about AW, OW, and DW respectively.

Studies included were not limited to certain design methods. There were six articles that conducted experimental research, two articles were cross-sectional studies, and two were cohort studies. All non-experimental studies

were performed on demineralized water, these might be considered unethical to oblige participants to consume demineralized water because of the health concern.

Studies locations were rather varied, all DW studies were from Asia (China, India, and Iraq), AW study was conducted in Denmark, and Czech Republic, and OW studies were conducted in the United States of America, Austria, Japan, and Germany. The participants varied based on the criteria of the study. Non-experimental studies involved general populations and students, while experimental studies recruited athletes or active subjects because most of the experimental research obliged participants to conduct some kind of exercise.

## Discussion

This systematic review that collected eight studies found weak evidence that either alkaline water, oxygenated water, or demineralized water provided other health benefits than drinking water to hydrate the body compared to mineral water (Table 2). One study that observed the alkaline water

**Table 2:** Study review and characteristics.

Study (author, year, country)	Intervention and comparison	Study design and risk of bias	Population	Parameter	Outcome
Alkaline water					
Hansen et al. [15] Denmark	CON: received neutral drinking water (pH: 7.19) INT: received alkaline drinking water (pH: 9.06)	Non-blinded randomized cross over study with 2 weeks intervention period and 3 weeks wash out period Water consumption was a minimum 2 L per day	29 male of 18–35 years old participants with BMI 20–27 kg/m <sup>2</sup>	Difference between CON and INT group after intervention on: – gut microbiota – serum insulin – plasma glucose – bowel movement	There was no change on gut microbiota in overall diversity (Shannon's Index) and estimated richness (Chao 1) after intervention neither in CON nor INT group There was no significant difference between CON and INT group in neither plasma glucose (p-value: 0.13) nor serum insulin (p-value: 0.53) There was no significant difference on frequency of bowel movement (p-value: 0.82) between the two groups
Steffl et al. [16] Czech Republic	CON: received regular table water INT: received alkaline water with pH 8.8	Double-blind randomized, placebo-controlled crossover design with three consecutive days of intervention period and 2 weeks wash out period. Water consumption was 2 × 1.5 L bottles for a day	12 healthy young males of 18–25 years old	Difference between CON and INT group after intervention on: – Performance of high-intensity step-test – Rate of Perceived Exertion (RPE) – Blood lactate – Urine specific gravity – Reaction time	There was significant higher performance in first step-test (853.2 W vs. 739.6 W; p-value: 0.002) and second step-test (814.4 W vs. 688.6 W; p-value: 0.005) among INT compared to CON group There was no significant difference of RPE between both groups after the first and the second step-test. There was a significantly increased of RPE after the second step test among CON group (p-value: 0.004) but not in INT group. There was a significant difference in RPE between the first step test among the CON group and the second step test among the INT group (p-value: 0.009) There was no significant difference of lactate change between CON group and INT group after the second step test There was no difference in urine specific gravity and reaction time in CON and INT group compared to before intervention

Table 2: (continued)

Study (author, year, country)	Intervention and comparison	Study design and risk of bias	Population	Parameter	Outcome
Oxygen water					
Gruber et al. [17] Germany	INT: subject received oxygenated water (190.6 mg O <sub>2</sub> /L) CON: subject received normal mineral water of 6.4 mg O <sub>2</sub> /L H <sub>2</sub> O	Prospective, double blinded, randomized study Participant consumed either 3 × 500 mL INT or CON water each day that lasted for 21 days. On day 1, day 7, day 14, and day 21, subjects were assessed for pre and post treatment	24 participants from 18–63 years old	Difference between groups of INT and CON at before, during and after treatment on: Laboratories parameters Ascorbyl radical	There was no difference on laboratories parameters between times in both groups In INT group between day 1 vs. day 28: Erythrocytes: 4.53 T/L vs. 4.47 T/L; p-value: 0.61; Hemoglobin: 14.00 g/dL vs. 13.70 g/dL; p-value: 0.44; Hematocrite: 41.85% vs. 41.31%; p-value 0.63; MCH: 30.92 pg vs. 30.72 pg; p-value: 0.69, MCV: 92.04 fL vs. 92.29 fL; p-value: 0.84; MCHC: 33.57 g/dL vs. 33.25 g/dL; p-value: 0.08; Leukocytes: 5.74 g/dL vs. 5.91 g/dL; p-value: 0.08; Thrombocytes: 265.62 g/dL vs. 268.00 g/dL; p-value: 0.93; Uric Acid: 4.79 mg/dL vs. 4.56 mg/dL; p-value: 0.53; Bilirubin 0.63 mg/dL vs. 0.58 mg/dL; p-value: 0.46 In CON group between day 1 vs. day 28: Erythrocytes: 4.65 T/L vs. 4.53 T/L; p-value: 0.52; Hemoglobin: 14.42 g/dL vs. 14.03 g/dL; p-value 0.45; Hematocrite: 42.92% vs. 42.00%; p-value: 0.54; MCH: 31.16 pg vs. 30.98 pg; p-value: 0.76, MCV: 92.66 fL vs. 92.71 fL; p-value: 0.98; MCHC: 33.61 g/dL vs. 33.41 g/dL; p-value: 0.21; Leukocytes: 5.80 G/dL vs. 6.60 G/dL; p-value: 0.27; Thrombocytes: 263.75 G/dL vs. 260.58 G/dL; p-value: 0.89; Uric Acid: 4.79 mg/dL vs. 4.73 mg/dL; p-value: 0.89; Bilirubin 0.67 mg/dL vs. 0.59 mg/dL; p-value: 0.49 There was significant increase in day 14 and day 21 of ascorbyl radicals in INT group compared to day 1, but no difference in CON group
Leibetseider et al. [18] Austria	INT: received oxygenated water (180 mg O <sub>2</sub> /L) CON: received untreated water	Double blind, cross-over experimental study Participants performed 4 exhaustive bicycle spirometric exercises every 2 weeks. Participants received	20 from 22 to 26 years old participants	Difference between 2 groups after exercise of submaximum and maximum level on: – Achievable power – Heart rate	There was significant difference of blood lactate concentration after exercise between 2 groups at maximal level. Other than that, no difference was

Table 2: (continued)

Study (author, year, country)	Intervention and comparison	Study design and risk of bias	Population	Parameter	Outcome
		intervention 2 weeks between exercise 1 and 2 or between exercise 3 and 4. Intervention water ingestion was 1.5 L/day in the morning before exercise		<ul style="list-style-type: none"> <li>– Oxygen uptake</li> <li>– Respiratory exchange rate</li> <li>– O<sub>2</sub> equivalent</li> <li>– Blood lactate</li> </ul>	observed between 2 groups. Difference between group after exercise at maximum level: p-value of W <sub>max</sub> : 0.920; p-value of HR: 0.050; p-value of VO <sub>2</sub> : 0.485; p-value of VO <sub>2</sub> /kg: 0.496; p-value of RER: 0.662; p-value of VEO <sub>2</sub> : 0.414; p-value of Lactate: 0.007
Wing-Gaia [19] United States of America	INT: purified oxygenated water CON: regular bottled water	Randomized double-blind placebo-controlled study. Intervention was given 3 days prior to exercise with 2 weeks washout Exercise was conducted on an electromagnetically braked cycle ergometer Subjects received water as much as 35 mL/kg of BW per day. 2 h before exercise, subjects were instructed to consume 500 mL of EXP or CON water	9 active males from age 22 to 29 years old	Difference in 2 groups between pre and post exercise performance of: <ul style="list-style-type: none"> <li>– Heart rate</li> <li>– VO<sub>2</sub></li> <li>– Exercise intensity</li> <li>– Blood lactate</li> <li>– SaO<sub>2</sub></li> <li>– PcO<sub>2</sub></li> </ul> Urine specific gravity	There was no significant improvement in heart rate, VO <sub>2</sub> , exercise intensity, blood lactate, and SaO <sub>2</sub> in both groups. Difference between CON vs. INT group after exercise: Heart rate 167.3 bpm vs. 164.9 bpm; VO <sub>2</sub> : 27.7 mL/kg/min vs. 26.5 mL/kg/min; Exercise intensity: 59.4% VO <sub>2max</sub> vs. 57.0% VO <sub>2max</sub> Difference between baseline vs. change after 300 kJ vs. after 600 kJ in CON group: Blood lactate: 6.1 mmol/L vs. 8.3 mmol/L vs. 6.6 mmol/L; SaO <sub>2</sub> : 95.3% vs. 71.9% vs. 72.3%; PcO <sub>2</sub> : 66.6% vs. 34.6% vs. 41.3% Difference between baseline vs. change after 300 kJ vs. after 600 kJ in INT group: Blood lactate: 4.0 mmol/L vs. 8.6 mmol/L vs. 6.9 mmol/L; SaO <sub>2</sub> : 95.6% vs. 71.6% vs. 70.7%; PcO <sub>2</sub> : 68.2% vs. 34.3% vs. 40.5% There was significant increasing of USG (Urine Specific Gravity) after exercise compared to before exercise in both groups. Urine Specific Gravity of CON group between pre vs. post exercise: 1.013 g/cm <sup>3</sup> vs. 1.016; p-value <0.05. Urine Specific Gravity of INT group between pre vs. post exercise: 1.013 g/cm <sup>3</sup> vs. 1.016; p-value <0.05 INT group showed a significantly lower reduction of SpO <sub>2</sub> mean change 15–40 min after walking compared to CON group INT group showed a
Izawa et al. [20] Japan	INT: received oxygenated water (110 mg O <sub>2</sub> /L) CON: received normal mineral water	Randomized placebo-controlled single-blinded trial Participants were instructed to drink allocated water of 200 mL 10 min before walking, 100 mL 6 min before walking, 100 mL	22 participants of healthy men and women with average 22.4 years old	Difference of SpO <sub>2</sub> and pulse rate between CON and INT group during 30 min walking	INT group showed a significantly lower reduction of SpO <sub>2</sub> mean change 15–40 min after walking compared to CON group INT group showed a

Table 2: (continued)

Study (author, year, country)	Intervention and comparison	Study design and risk of bias	Population	Parameter	Outcome
		1 min before walking, and 100 mL after starting walking			significantly higher increase of pulse rate mean change 15–35 min after walking compared to CON group
Demineralized water					
Gupta et al. [21] India	Group 1: 79 participants who drink RO water Group 2: 171 participants who drink tap water	Cross-sectional study	250 participants with age >18 years	Vitamin B12 deficiency prevalence between 2 groups	Group 1 showed significantly higher prevalence of vitamin B12 deficiency compared to group 2. Participants who were vitamin B12 deficiency in group 1 vs. group 2 was 50.6% vs. 17.5%; p-value <0.001
Huang et al. [22] China	Group 1: 7,608 children were not exposed to low mineral direct drinking water (DDW) Group 2: 22,476 children were exposed to low mineral DDW	Eco-epidemiological study from 2008 to 2012	29,882 children (aged 10–12 years) from 25 schools	Difference between groups from 2008 until 2012 of the parameters; Height Weight BMI Dental caries	There was no difference of BMI between 2 groups in every year measurement. Significance difference of BMI between 12 years old girls in group 1 and 12 years old girls in group 2 in 2008 vs. 2009 vs. 2011 vs. 2012 was 0.105 vs. 0.111 vs. 0.926 vs. 0.274. Significance difference of BMI between 12 years old boys in group 1 and 12 years old boys in group 2 in 2008 vs. 2009 vs. 2011 vs. 2012 was 0.244 vs. 0.088 vs. 0.028 vs. 0.217. There was significant difference of height increase between 2 groups after 3 years (from 2008 to 2012) where group 1 showed higher height increase compared to group 2. Significance difference of height between 12 years old girls in group 1 and 12 years old girls in group 2 in 2008 vs. 2009 vs. 2011 vs. 2012 was 0.273 vs. 0.119 vs. <0.001 vs. <0.001. Significance difference of BMI between 12 years old boys in group 1 and 12 years old boys in group 2 in 2008 vs. 2009 vs. 2011 vs. 2012 was 0.481 vs. 0.757 vs. <0.001 vs. <0.001. Group 2 showed significantly higher prevalence of hypoevolutism and dental caries after 3 years compared to group 1. Significance difference of hypoevolutism

Table 2: (continued)

Study (author, year, country)	Intervention and comparison	Study design and risk of bias	Population	Parameter	Outcome
Muhsin [23] Iraq	Group 1: 126 subjects who drink RO water (pH: 6.60) Group 2: 126 subjects who drink tap water (pH: 7.52)	Cross sectional comparative study	252 healthy men	Bone mineral density between 2 groups	prevalence between group 1 and group 2 in 2008 vs. 2009 vs. 2011 vs. 2012 was 0.554 vs. 0.515 vs. 0.103 vs. <0.001. Significance difference of dental caries prevalence between group 1 and group 2 in 2008 vs. 2009 vs. 2011 vs. 2012 was 0.610 vs. 0.115 vs. 0.185 vs. <0.001 Group 1 showed significantly higher prevalence of low BMD compared to group 2 Participants who were osteopenia in group 1 vs. group 2 was 71.4% vs. 4.0%; p-value <0.001. Participants who were osteoporosis in group 1 vs. group 2 was 16.7% vs. 0.8%; p-value <0.001
Huang et al. [24] China	Group 1: 229 children who drink normal mineral content water (conductivity: 345 $\mu$ S/cm) Group 2: 431 children who drink very low mineral water (conductivity: 40 $\mu$ S/cm)	Retrospective cohort study that lasted 4 years	660 10–13 years old children	Difference between group after 2 groups of the parameters: Serum calcium Serum magnesium Calcium modulating hormones Height Height increase	Group 1 showed significantly higher value of serum calcium, serum magnesium, and cholecalciferol to group 2, but showed same value of calcitonin and parathyroid hormone compared to group 2. Difference of blood serum between group 1 vs. group 2: serum Ca: 106 mg/L vs. 111 mg/L; p-value <0.001; serum Mg: 25.3 mg/L vs. 24.4 mg/L; p-value <0.001; Cholecalciferol: 143 ng/L vs. 134 ng/L; p-value: 0.017; serum calcitonin: 721 ng/L vs. 749 ng/L; p-value: 0.186; parathyroid hormone: 141 ng/L vs. 141 ng/L; p-value: 0.899. Group 1 showed significantly higher height and height increase after 4 years of observation compared to group 2. Height and height increase after 4 years observation between group 1 vs. group 2: height: 152 cm vs. 146 cm; p-value <0.001; Height Increase: 22.3 cm vs. 16.6 cm; p-value <0.001

INT, intervention; CON, control; CI, confidence interval.



effect on health benefits did not show any difference compared to mineral water. One out of three studies of oxygenated water even showed that consumption of oxygenated water with 190 mL/g dissolved oxygen in at least 14 days increased ascorbyl radicals in the body. Two other studies didn't appear to display a significant difference of measured parameters between the oxygenated water group and mineral water group after exercise and intervention. In demineralized water, all four studies showed resemblance, where the regular intake of demineralized water resulted in inferior consequences compared to mineral water.

## Alkaline water

Indonesia National Agency of Drug and Food Control (BPOM) (2019) defined that the range of pH level mineral water in Indonesia regulation was from 8.6 to 9.5 without additional mineral and oxygen or carbon dioxide [25]. In his article, Weidman et al. didn't explain any further about the water pH consumed in the intervention [12]. On the other side, excluded articles mentioned its pH value of alkaline water and mineral water as control, yet its pH value did not resemble BPOM regulation [10, 11]. Nonetheless, none of the excluded articles showed any significant difference of outcome value. There was no significant difference found in the study of Weidman et al. [12] and Hansen et al. [15] between intervention group and control group. Steffl et al. in their article, showed a significantly different result between group who received alkaline water (INT) and regular table water (CON) where INT group displayed better performance of high-intensity step-test [16]. Nonetheless, this study did not include the baseline data as a comparison before and after intervention.

The alkaline diet was the initial idea of alkaline water to be popular among consumers. The alkaline diet itself was the attempt for people to balance acid-base equilibrium in the body, after high consumption of an acidic diet that mostly involved animal-based food. Previous studies showed diverse and unclear results of alkaline diet impact to health benefit after intervention in some groups of community [26–29].

## Oxygen water

Oxygenated water in Indonesia is required to contain dissolved oxygen at least 40 mg/L in the factory and 20 mg/L in the market place [25]. There were only Gruber, Axmann, and Schoenberg, Leibetseider et al. and Izawa et al. that disclosed oxygen content in the intervention water, which was

190.6 mL/L and 180 mL/L respectively [17, 18, 20]. Leibetseider et al. and Wing-Gaia et al. didn't show any notable found between intervention group and control group [18, 19]. Leibetseider et al. stated that the difference in blood lactate concentration between the two groups was not because of the intervention effect, but due to the statistic test [18]. In contrast, Gruber, Axmann, and Schoenberg appeared with a significant value of ascorbyl radicals whereas the oxygenated water group showed a higher value significantly [17]. It invalidated the hypothesis stated that oxygenated water can act as an antioxidant or help improve the immune system.

On the other hand, Izawa et al. [20] showed a significant result regarding  $SpO_2$  and pulse rate between group who received oxygenated water and regular table water. A significantly lower decrease of  $SpO_2$  was presented in the oxygenated group during walking might be beneficial. However, this group also displayed a significantly higher increase of pulse rate which must be a concern for the consumer.

Oxygen water was utilized as ergogenic aid among athletes or people who exercise. The extra oxygen contained in the water was expected to replace the loss of oxygen more efficiently and resulted in gaining better performance. Piantadosi disapproved this hypothesis for several reasons [30]. First was for the practical reason that oxygen content in the water will be significantly reduced once the bottle was opened. The second one was for a physiological reason where intestine was not designed for gas exchanging, unlike lung. The oxygen absorbed in the intestine would appear in insignificant amounts, thus it could be neglected.

## Demineralized water

Demineralized water is obtained by the purification process through distillation, deionization, reversed osmosis, or other equal processes. In the further process, demineralized water might be added with oxygen or carbon dioxide [25]. Demineralized water was developed for laboratory and technical purposes in the first place and started to expand for drinking water in some areas such as coastal and inland areas where available drinking water was limited. It was also recommended that demineralized water needed to meet the requirements as listed: (1) minimum content of bicarbonate ion was 30 mg/L and calcium was 30 mg/L; (2) maximum level of alkalinity was 6.5 meq/L, sodium was 200 mg/L, boron was 0.5 mg/L, and bromine 0.01 mg/L; and (3) contained dissolved salt from 100 to 250 mg/L [31].

Results in demineralized studies in this study showed that there is no beneficial effects for their long term consumers [21–24]. Results of this study assemble with what World Health Organization had demonstrated that the long-

term consumption of demineralized water resulted in health adverse effects [31]. The consequences were commenced by lower intake of calcium, magnesium, and other microelements along with loss of calcium, magnesium, and other microelements in prepared food. Furthermore, low mineral content in water leads to a negative effect on the homeostasis mechanism. Another aspect that was also a concern was that demineralized water had poor taste. It might lead people to drink less than the actual recommendation.

Several limitations of this study need to be acknowledged. As this study only included the studies which were published after 2000, we found a limited number of available studies to be reviewed. Besides, this study showed results that covered varied population groups and countries. However, we applied Indonesia regulation for water type definitions made the conclusion drawn may be different from other countries. We recognized that studies in this review were conducted in a short duration of intervention, thus more robust design studies are required. However, this study covers the review of studies that presented the comparison of health benefits between mineral water and other types of water, which to our knowledge, is the first one.

## Conclusions

This review clarifies many theories that widely escalated among the general population regarding health benefits obtained by consuming various types of water. The available studies that we analyzed did not show any convincing evidence that supported the idea of preventing disease, improving performance, or even curing disease by consuming alkaline, oxygen, or demineralized water. In contrast, studies displayed notable adverse effects from demineralized water after a long time of consumption. This review suggests that neither alkaline, oxygen, nor demineralized water is superior compared to mineral water. Future research should focus on how to diminish the belief that had been perceived among the general population. Food and drug administration is also expected to put more attention on advertisement of water products because the overclaims asserted by the company contribute a big role to people's belief.

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