

# Effect of Education and Provision of Drinking Water on Adolescents' Drinking Consumption and Hydration Status

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**Abstract**— Water is an essential substance for body health. A body fluid imbalance leads to dehydration, which is not only detrimental to fitness level and cognitive performance but is also related to psychological disorders and various other chronic diseases. Incidence of dehydration is higher among adolescents (48.1%) than among adults (44.5%). A study of multi-strategic interventions to improve drinking water consumption and hydration status in adolescents is therefore needed. This study measures the effect of education and drinking water provision on the drinking water consumption and hydration status of adolescents. This quasi-experimental research applied a pretest-posttest group design to three treatment groups and one control group. A significant difference was evident in drinking water consumption between the treatment and control groups at post-intervention ( $p < .05$ ) but not during the follow-up period. A significant difference was also found between the treatment and control groups' hydration status based on urine color during post-intervention ( $p < .05$ ). Education combined with drinking water provision was a multi-strategic intervention, which led to greater improvements in the drinking water consumption and hydration status of adolescents compared to previous intervention.

**Keywords:** adolescents, dehydration, drinking, water, education

## I. INTRODUCTION

Water is a critical nutritional substance for human health and has several roles, including as a solvent and catalytic agent, a lubricant, a body temperature regulator, and a mineral and electrolyte provider<sup>1</sup>. A water imbalance can lead to dehydration—a condition caused by the body losing more water than it takes in<sup>2</sup>—which is characterized by dizziness, weakness, fatigue, nausea, vomiting, anorexia, thirst, mental confusion, rapid heart rate, increased body temperature, and constipation. When not promptly treated, dehydration can lead to kidney damage and death<sup>3,4</sup>. Dehydration is also closely related to coronary heart

disease, kidney disease<sup>5</sup>, body fitness index, cognitive performance, and psychological and mood disorders<sup>6</sup>, which can lead to lower productivity<sup>7</sup>. Adequate water consumption is therefore essential for preventing these conditions, and increased drinking water consumption has been found to positively improve mood, vigilance level, brain memory performance, and attention during task completion<sup>8-13</sup>.

An individual's water requirement level is affected by gender and age<sup>14</sup>, outdoor physical activities, time spent in intense heat<sup>15</sup>, and climate<sup>16,17</sup>. Dehydration prevalence is higher in adolescents (48.1%) than in adults (44.5%)<sup>18</sup>, with the highest rate of 70.1% occurring among college students<sup>19</sup>, who are considered to be in their late adolescence years<sup>20</sup>. Adolescence is the transitional stage between puberty and legal adulthood, also known as the teenage years, when individuals experience growth spurts that are characterized by significant physical, psychological, and cognitive changes and development<sup>20,21</sup>. Adolescents are susceptible to nutritional deficiencies when they fail to receive the required nutrients. A study conducted in Indonesia found that the drinking water consumption of adolescents was low<sup>22</sup>.

An education intervention to improve children's hydration status was found to significantly increase their exercise endurance performance<sup>23</sup> because the education increased the teenagers' knowledge of hydration behavior. However, an intervention to change the teenagers' hydration behavior cannot be applied without implementing a supporting intervention<sup>24</sup>. Previous research has also reported that an intervention providing a predetermined amount of drinking water was more effective at overcoming dehydration in teenagers than other ages.

Several recommendations for designing an intervention include focusing on adolescents' behavior, using multi-component or multi-strategic measures,

making changes to the school milieu and living space activities, involving family, and featuring innovative multimedia applications<sup>25</sup>. A multi-strategic intervention in a school reportedly improved the drinking and eating behavior of children. Therefore, this study investigates whether a multi-strategic intervention can reduce dehydration problems among adolescents and improve their cognitive performance. This study also aims to determine the effect of education and drinking water provision on the drinking water consumption and hydration status of adolescents.

## II. METHODS

The study applied a quasi-experimental pretest–posttest group design to three treatment groups and one control group. The participants were 81 students, consisting 47 of male and 34 female dormitory students of Abu Bakar Integrated Islamic High School in Yogyakarta, Indonesia. The sample was obtained using non- probability consecutive sampling based on specific criteria to obtain the required number of participants. The three treatment groups were K1, K2, and K3. K1 received the education—water provision intervention, K2 received the education only intervention, and K3 received the water provision only intervention. K4 was the control group to which no intervention was applied. The variable to be measured for pre and post test are Hydration status, Physical activity, and drinking consumption. Hydration status is determined by observing of morning urine color, and Physical activity is determined by IPAQ (International Physical Activity Questionnaires).

The education intervention was conducted in advisory groups, comprising oral presentations, a video, and a mini-poster show presenting information on hydration and health, as well as a discussion and consultation held three times. During the research period, 48 cups with a 240 mL capacity for group K1 and K3 were provided each day for 2 weeks intervention, giving the participants in each group free access to drinking water. The participants' water consumption was recorded over three days (two school days and a day off), and their pre-intervention hydration status and knowledge level were measured during the first week. The same measurements were taken during the second week, following the education—water provision intervention, to measure the effect of the intervention and obtain post-intervention data. During the third week, after the drinking water provision

intervention, the participants' drinking water consumption and hydration status were recorded over three days as follow-up data. The mineral content of the water provided during the research period was classified as safe according to Indonesia National Standards.

Primary data used in this research were obtained by obtaining direct measurements through observations, interviews, anthropometric measurements, and questionnaires. The data consist of anthropometric data, participants' knowledge scores, drinking consumption, and hydration status. Data analysis was performed using computer software.

Descriptive analysis was applied to describe the participants' characteristics, such as gender, nutrition status, and activities. The Shapiro-Wilk test was applied prior to bivariate analysis to measure the data distribution<sup>26</sup>. As abnormal data distribution was reported, the non-parametric Kruskal-Wallis test was conducted to measure the differences in drinking water consumption among the groups. A Mann Whitney post-hoc test was then applied to measure which intervention had the most significant effect on the participants' drinking water consumption.

## III. RESULT

TABLE 1

CHARACTERISTICS OF THE RESPONDENTS (N=81)

Characteristic	Total (n=81)	K1 (n=22)	K2 (n=22)	K3 (n=21)	K4 (n=16)
<b>Sex (n %)</b>					
Male	47 (58.02)	13 (28.88)	13 (28.88)	13 (28.88)	8 (17.02)
Female	34 (41.98)	9 (26.47)	9 (26.47)	8 (23.52)	8 (23.52)
<b>Age (year)</b>	15,5± (Mean ±SD)	15,77± 0,43	16,22± 1,15	14,71±0 ,462	14,87± 0,619
<b>Nutrition Status (n,%)</b>					
Obesity	7 (8,64)	1 (14,28)	3 (42,85)	2 (28,57)	1 (14,28)
Overweight	13 (16,05)	4 (30,76)	4 (30,76)	1 (7,69)	4 (30,76)
Normal	61 (75,31)	17 (27,8)	15 (24,59)	18 (29,50)	11 (18,03)
<b>Physical activity</b>					
Low	44 (54,32)	10 (22,72)	15 (34,09)	12 (27,27)	7 (15,90)
Medium	36 (44,44)	12 (33,33)	7 (19,44)	8 (22,22)	9 (25)
High	1 (1,23)	0 (0)	0 (0)	1 (100)	0 (0)

Variable	K1 (n=22)	K2 (n=22)	K3 (n=21)	K4 (n=16)	Sig (p) <sup>1)</sup>
<b>Drinking consumption (Mean ± SD)</b>					
Pre	1556.52 ± 748.07	1587.63 ±919.44	1514.30 ±763.67	1569.14 ±791.33	0.996 5
Post	1739.42 ± 653.42	1607.87 ±977.33 <sup>ab</sup>	1403.53 ±750.62 <sup>ab</sup>	1152.44 ±546.31 <sup>b</sup>	0.044 5*
Follow up	1766.47 ±	1648.90 ±872.06	1236.55 ±582.98	1475.75 ±479.49	0.149 2
Δ1 (Pre-Post)	922.60	20.24± 497.11 <sup>a</sup>	- 110.77± 543.27 <sup>a</sup>	-416.70 ±632.57 <sup>b</sup>	0.016 4*
Δ2 (Post-Follow up)	182.89± 472.27 <sup>a</sup> 27.05 ±22.24	41.02 ±372.56 0.0001*	- 166.98± 473.56	323.30 ±578.93	0.075 7
Sig (p) <sup>2)</sup>	0.0005*		0.0006*	0.0047*	
<b>Urine Color</b>					
Pre	3.90± 1.50	3.36± 2.01	4±1.78	4.68±1.0 1	0.209 2
Post	3.22± 1.71 <sup>a</sup> -0.68 ±	4.18± 1.81 <sup>ab</sup> 0.81±	4.61± 1.46 <sup>b</sup> 0.61±	4.56± 1.09 <sup>b</sup> -0.12±	0.031 *
Δ	2.00 2209	1.36 0.0199*	1.96 0.1987*	1.31 0.7434	0.060
Sig (p) <sup>3)</sup>					

Table 2. Differences of Variable Measurement Results among Groups

Information

Data not normally distributed

Sig (p)<sup>1)</sup> = Inter-group significance was analyzed using the ANOVA test, *Post Hoc* Mann Whitney test.

Sig (p)<sup>2)</sup> = Significance between pre test, post test and follow-up using friedman test

Sig (p)<sup>3)</sup> = Significance between pre dan post test Wilcoxon matched paired sign rank test.

<sup>a,b,c,d)</sup> = Unequal alphabets show the significance of the results *Post Hoc* test,  $p < 0.05$ .

K1= Education-water provision

K2= Education

K3= Water provision

K4= Control group

The ANOVA test, which was performed to analyse the pre- intervention drinking water consumption, showed no significant difference among the treatment groups ( $p > .05$ ); however, the otherwise was found during post-intervention ( $p < .05$ ). The Mann-Whitney post-hoc test was conducted to measure the

differences among the treatment groups. The results showed a significant difference among the education groups treated with drinking water (K1) compared to the control group (K4), whereas a significant difference was not seen in the groups with other treatments compared to the control group, thus indicating that the difference in drinking water consumption among groups receiving a multi-strategic intervention compared to the groups with only single intervention of education or drinking water provision. The ANOVA statistical analysis indicated a significant difference in the average increase in drinking water consumption pre-and post-intervention in all treatment groups ( $p < .05$ ). Additionally, the Mann-Whitney post-hoc analysis, which was conducted to determine the most effective intervention at improving drinking water consumption, indicated a significant difference between the three treatment groups (K1, K2, K3) and the control group (K4). K1 showed the highest increase in drinking water consumption, and K3 had the lowest increase.

The ANOVA test, which examined the participants level of hydration during the pre-intervention, showed no significant difference between all groups ( $p > .05$ ); however, a significant difference was evident during the post-intervention in all groups ( $p < .05$ ). The Mann-Whitney post-hoc analysis indicated a significant difference in hydration status between the education-drinking water provision group (K1) and both the K3 and K4 groups, thus reflecting a difference in the hydration status among groups receiving a multi- strategic intervention compared to the groups receiving a single intervention or no treatment.

#### IV. DISCUSSION

This study found a significant improvement in the drinking water consumption of adolescents in the group receiving a multi- strategic intervention, which combined education with drinking water provision. During the sixth months after the intervention was started, recommended drinking water consumption became research subject's behavior thus significantly their hydration status. This finding could be considered in the design of a government policy to exploit online media as a means to promote health<sup>28,31</sup>. Combining an education intervention with environmental factors, such as improving the availability of drinking water in schools by installing water fountains and encouraging teachers' promotion of drinking water consumption, was previously reported to be effective for preventing incidences of overweight among school students<sup>29,30</sup>. The results of this study confirmed that implementing a single education intervention or providing drinking water without promoting the benefits could not

significantly improve the hydration status of adolescents; the highest improvement was obtained by providing a combined education with drinking water provision during the intervention period. Thus, a multi-strategic intervention is essential for improving hydration behavior.

This study has some limitations. First, assessing the urine color to measure the hydration status is somewhat unreliable because the color affected by fast body fluid turn-over. Participants who sustained around 5% body mass during the dry season or summer were found to have similar, sensitive responses to various measurements and showed a delayed response at each result change despite fluid loss replacement by rehydration using recommended drinking water consumption<sup>32</sup>. However, urine color change due to water consumption can also occur in normal individuals without organ function impairment associated with urinary excretion<sup>33</sup>. Another factor affecting the high incidence of dehydration in participants who consumed adequate amounts of drinking water is the inconsistency of a participant's behavioral change which started by research. In the Transtheoretical Model, which describes the six stages of change, such individuals are considered to have reached the preparation phase for the behavioral change action. In the action phase, the individual has already implemented the behavioral change plans with specific modifications to their thinking and behavior, but with the possibility of returning to the initial behavior. To create a new sustainable pattern to their behavior, individuals typically need interventional support to enhance their commitment to change and ensure they take measures planned during the preparation stage<sup>27</sup>.

The behavioral management procedures recommend drinking 1.25-2.5 L/day to overcome and prevent orthostatic hypotension; however, this recommendation is frequently ignored by society<sup>34</sup>. A possible reason for an insignificant relation between drinking water consumption and hydration status is orthostatic hypotension, which is yet to be studied in this research. Symptoms of orthostatic syndrome, such as nausea, blurred vision, head and neck pain, decreased concentration, and extensive fatigue, are caused by orthostatic hypovolemia related to the kidney's filtration rate<sup>35</sup>. Other factors that can cause the body's fluid volume to decrease include anemia (iron deficiency) and the consumption of neuro-related drugs<sup>36</sup>; anemia is prevalent among children and teenagers. Several factors related to teenagers' growth are high-iron or high-vitamin C food consumption, vegan or low-calorie diet, exercise endurance, and menstrual conditions<sup>37</sup>.

## V. CONCLUSION

This study found that education combined with the

provision of drinking water improved adolescents' drinking water consumption, without significant effects on hydration status. Further research with more complex parameters related to hydration status and with a more appropriate climatic period is needed, using more simple drinking water assessment methods which ensure data validity and reliability.

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